Who cares about research?!

Marc Schut

WHO CARES ABOUT RESEARCH?!

A STUDY ON THE ROLE OF RESEARCH IN POLICY PROCESSES IN COMPETING CLAIMS CONTEXTS

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This research was conducted under the auspices of the Wageningen School of Social Sciences.

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Marc Schut

Thesis
Submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. dr. M.J. Kropff
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Friday 20 April 2012
at 4 p.m. in the Aula.

Marc Schut
Who cares about research?! A study on the role of research in policy processes in competing claims contexts.
280 Pages

Thesis, Wageningen University, Wageningen, the Netherlands (2012)
With references and with summaries in English, Portuguese and Dutch

ISBN 978-94-6173-148-7

For my parents
For Sicco Kolijn (†)

PREFACE AND ACKNOWLEDGEMENT

Doing a PhD is not something that you do alone, nor is it a lonesome journey. Since the beginning of my PhD research in August 2007, I have worked with many interesting people and organisations that have all contributed directly or more indirectly to this thesis and the personal and professional learning curve that I have been through during the last years.

When my promoter Cees Leeuwis first approached me for this research after my graduation at the end of 2006, I was not particularly looking for a PhD position or a career in science. I was 27 years old, had just finished my MSc thesis and was tired of people always asking me whether I had yet finished 'school.' I wanted to enter the 'real' working life and gain experience by working abroad where the 'real' action takes place, not spend another four years in the books. However, the conversations I had with Cees and Annemarie van Paassen (my co-promoter) resulted in a project idea that very much reflected my interests and ideas at that moment. After three submissions, the project idea was adopted by the working group 'sustainable spatial development of ecosystems, landscapes and seas and regions,' which was developing a project under the same name funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation. A first thank you is therefore for the working group and in particular Paul Opdam, Eveliene Steingröver and Jolanda van den Berg for your trust and support in making the research idea become a real research project.

During the first months of the research in Wageningen I followed courses, participated in CERES (nowadays part of WASS graduate school) activities and developed my research proposal. The always growing pile of research articles, the long 'to do' lists and the insecurity about how to structure and organise the research would have been unmanageable if it had not been for the moral and humorous support of my roommates Laura, Maartje and Ellen, and during later phases also Sonja, Horacio, Herman, Fernando and Pushpa (†) who sadly passed away in January 2012. I also found out that the most important people are in the secretariat. I wish to thank Annette, Sjoukje, Sylvia, Joke, Mirjam, Mirjam, Carlotte and our financial manager Vera for their support, the joy they bring to the group, and in particular Sylvia for the never ending supply of candy and sweets. My gratitude to all COM and CIS colleagues for their interest in my work, for their patience and time to answer my questions, and – as promised – thanks Reint-Jan for sacrificing your office for me.

For the first case study, I interviewed different people from De Noordwaard, whose willingness and openness to share their personal stories with me is highly appreciated and has touched me. Several people at the Ministry of Infrastructure and Environment also contributed valuable insights to the research, and I thank colleagues from Alterra (Wageningen University and Research Centre) for sharing their experiences with me.

During the first phase of the research, I had already become involved in the Competing Claims on Natural Resources programme, funded by the Interdisciplinary Research and

Education Fund of Wageningen University and Research Centre. This PhD programme provided a platform for interdisciplinary collaboration and learning, which shaped my thesis significantly. I thank in particular Ken Giller, Maja Slingerland and Jens Andersson for their dedication, trust and support. Also the collaboration and friendships with other PhD students form an important part of the PhD learning experience. Fred, we both acknowledge that humour, music and Zhombwe are essential when doing research in the 'competing claims jungle.' I know that we will keep in touch. Jessica, you have been my buddy during the last phase of writing in Wageningen. I hope you understand how much I appreciate you as a colleague and as a person; I am delighted that you are one of my paranymphs.

The second case study in Mozambique was a life-changing experience in many ways. Anna Locke and Sicco Kolijn played crucial roles in starting up my work in Mozambique. The death of Sicco was a big shock for all of us. It was an honour to have known him, and we still think about him a lot. I dedicate this thesis to him, his work and his family. During the two years in Mozambique, I enjoyed working with Almeida Sitoe, Annie Sugrue, Lara Machuama, Wilson Leonardo, Madeleine Florin, Gerrie van de Ven, Floor van der Hilst, Jasper van de Staaij, Edward Smeets and the several MSc students that did fieldwork in Mozambique. A big thank you for my partner-in-crime Anna Lerner with whom I worked together for the full two years in Mozambique, who helped me reflect, and who became a very good friend along the way; I wish you all the best for the future. I also would like to give a big *obrigado* to my colleagues at CEPAGRI and DNER, especially Roberto Albino, Hercilia Estrela, António Saíde and Marcelina Mataveia. Within the inter-ministerial subgroup sustainability criteria I worked a lot with Hélio Neves, Aude Nowak and João Chidamoio. I thank them and the other subgroup members for their efforts and hard work to make Mozambique the first African country with a national policy framework for biofuel sustainability. I am grateful for the support of Célia Jordão of the Dutch Embassy in Maputo. Célia, you have been (and still are) of immense value for the biofuel policy process and always facilitated my work; thank you so much! I highly appreciate all investors, commercial and smallholder farmers, researchers, NGO representatives with whom I collaborated and who provided data and insights necessary for this study. I wish to thank Kees Kwant and Carmen Heinze of NL Agency (AgentschapNL) for their belief in the importance of continuing the support to the policy debate on biofuel sustainability in Mozambique. And Núria Cunha Soares for her hard work to operationalise the biofuel sustainability framework with the subgroup sustainability criteria in Mozambique; you are doing a great job! Of more personal note: Carmen, Simone, Heather, Karen and Mike thank you so much for always providing a real 'home' in Maputo. And last but definitely not least I thank the Chimoio crew for the lessons in life, relaxing, running, cycling, BBQing and organising trips to the beautiful countryside of Mozambique.

As for my supervisory team at Wageningen University: my promoter Cees Leeuwis and my co-promoter Annemarie van Paassen. Cees, it has been very inspiring to work with you, and I am glad that we will keep working together. Your style of supervision and coaching is special. You gave me the space to develop my own ideas and creativity, but you could also be to the point and provide direction when I needed it. Furthermore, you always took care of the more

'bureaucratic' stuff, and this created an environment in which I could work in an action-oriented way and do my research freely. I am aware of how privileged I have been. Your leadership style makes our department a very pleasant place to work, where there is room for the individual, but also team spirit. Annemarie, you were sometimes way ahead of me, providing me with literature and ideas that I only later realised I needed. Your detailed feedback on my work and the questions emerging from that created the foundation for inspiring discussions that we held face to face, on the phone, on the bike and in the train. You always had time for me, and also told me to 'let go' and 'relax' every now and then. Thanks for that, I know now that I needed it sometimes. I wish you all the best and I am sure that we will keep working together in the future.

Before I start to thank friends and family, I would like to express my gratitude to Catherine O'Dea for making this thesis accessible in terms of the English language, Bjorn Engelen for editing the Dutch summary and Núria Cunha Soares for editing the Portuguese summary. Furthermore, I highly appreciate the work of Joris Ketelaar in developing the figures for Chapter 9 of this thesis and designing the cover and the bookmark. Also I would like to thank my new colleagues in the PARASITE-project for providing me the time and space to finish my PhD project and prepare the defence.

I thank my friends for their support and interest, for visiting me in Mozambique and for the fact that we all know one another since we were young (we still are of course). We share a history, we know each another's families and we make time for one another; I hope we will grow old together and keep doing crazy stuff! Marleen and Peter, the time that we lived together in Utrecht was wonderful, I will never forget how normal it was to share a house with you. Peter, thanks for agreeing to be my paranymph. I also thank all other friends, old study mates and Sandra's parents, her sisters and their families for their interest in my work.

Pap en mam, een stukje in het Nederlands voor jullie. De basis voor dit proefschrift ligt bij jullie. Jullie hebben Kim en mijzelf altijd gemotiveerd om onze grenzen te verleggen en dingen te doen waar jullie zelf nooit de kans voor hebben gekregen. Jullie liefde, steun en interesse was altijd aanwezig, zelfs al waren we duizenden kilometers van elkaar vandaan. Ik wil en kan daarom niet anders dan dit proefschrift aan jullie op te dragen en ik hoop dat we nog vele jaren in goede gezondheid van elkaar kunnen genieten. Zus Kim, ik wens jou en je jongens hetzelfde. Ook al zien onze levens er misschien wat anders uit, je moet weten dat ik je enorm waardeer en liefheb om wie je bent.

Sandra, you have been the reviewer of all chapters in this thesis, the one who asked difficult (but very relevant) questions about my research and even contributed as co-author to one of the chapters. However, most of all you are my buddy, my lover and my best friend. Our time in Mozambique was amazing, we learned so much and it made us so strong. Even after being together for ten years now, I still every day look forward seeing you again when I come home from work. Our dreams are beautiful but challenging and I am sure that they will bring us an interesting future. I hope we can keep challenging each other like we do and I am looking forward to the years to come!

The long list of people and organisations in this acknowledgement shows that my PhD journey was not at all a lonesome journey. It was a real working experience in the real world, and I had the chance to develop myself as a researcher, but also personally by working with many different people and living abroad in Mozambique. For all those who were part of this journey I express my gratitude one last time; thank you very much, *muito obrigado*, dank jullie wel!

Marc Schut
Arnhem, 19 March 2012

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ACRONYMS

ADIPSA	Danish Development Organisation (in Portuguese: *Apoio ao Desenvolvimento de Iniciativas Privadas no Sector Agrária*)
ADPP	Humana Mozambique (in Portuguese: *Ajuda de Desenvolvimento de Povo para Povo*)
AGOA	African Growth and Opportunity Act
AGREF	Association for Responsible Forestry in Mozambique (in Portuguese: *Associação pela Gestão Resposável das Florestas em Moçambique*)
B5	Fuel blend of 5% of biodiesel with 95% of fossil diesel
BLRR	Bureau Lower River Region, the Netherlands (in Dutch: *Bureau Benedenrivieren*)
BSI	Better Sugarcane Initiative
CAP	Mozambican Agricultural and Livestock Census (in Portuguese: *Censo Agro-Pecuário*)
CCNR	Competing Claims on Natural Resources
CEPAGRI	Mozambican Agriculture Promotion Centre
CGIAR	Consultative Group on International Agricultural Research
Commission WB21	Commission Water Policy for the 21st century, the Netherlands
CONDES	Mozambican National Council for Sustainable Development
CPI	Mozambican Investment Promotion Centre
DGIS	Dutch Ministry of Foreign Affairs
DNER	Mozambican National Directorate for Renewable Energy
DNTF	Mozambican National Directorate for Land and Forestry
DUAT	State-granted right to use land as defined in the Mozambican land law (in Portuguese: *Direito de Uso e Aproveitamento da Terra*)
E10	Fuel blend of 10% of bioethanol and 90% of fossil gasoline
EC	European Commission
EIA	Environmental Impact Assessment
EPA	Economic Partnership Agreement
EU	European Union
FACT	Foundation for Fuels from Agriculture in Communal Technology
FAO	Food and Agriculture Organization
FAOSTAT	Statistic database of the Food and Agriculture Organization of the UN
FLO	Fairtrade Labelling Organizations International
FSC	Forest Stewardship Council
GBEP	Global Bioenergy Partnership
GDP	Gross Domestic Product
GHG	Greenhouse Gasses
GlobalGAP	Global Good Agricultural Practice
GPS	Global Positioning System

GSP	Generalized System of Preferences
GTZ	German partnership for technical collaboration (in German: *Deutsche Gesellschaft für Technische Zusammenarbeit*)
ha	Hectare
HDI	Human Development Index
hh	Household
hr	Hour(s)
ICRAF	International Center for Research in Agroforestry
IIAM	Mozambican National Institute of Agrarian Research
IITA	International Institute of Tropical Agriculture
IM	Innovation Management
INREF	Interdisciplinary Research and Education Fund of Wageningen University
IP	Investment Proposal
IPCC	Intergovernmental Panel on Climate Change
KM	Knowledge Management
km	Kilometre
KNMI	Royal Netherlands Meteorological Institute
kWh	Kilo Watt hour
l	Litre
LEI	Agricultural Economic Research Institute of Wageningen University and Research Centre (in Dutch: *Landbouw Economisch Instituut*)
Ltd.	Limited
m^3 sec^{-1}	Cubic metre per second
MADER	Mozambican Ministry of Agriculture and Rural Development
MIC	Mozambican Ministry of Industry and Commerce
MINAG	Mozambican Ministry of Agriculture
MZN	New Mozambican Metical
NARS	National Agricultural Research Systems
NBPS	Mozambican National Biofuel Policy and Strategy
NBT	Mozambican National Biofuel Taskforce
NE-DEED	Negotiation – Describe Explain Explore Design
NER	Net Enrolment Rates
NGO	Non-Governmental Organisation
NL	The Netherlands
NP	National Park
NRM	Natural Research Management
PARPA	Poverty Reduction Strategy Paper
PDA	Mozambican Provincial Directorate of Agriculture
PhD	Doctor of Philosophy
PJ	Petajoule
PKB	Spatial Planning Procedure (in Dutch: *Planologische Kern Beslissing*)
PPO	Pure Plant Oil
ProBEC	The Programme for Basic Energy and Conservation (executed by GTZ)

RSB	Roundtable on Sustainable Biofuels
RTFO	Renewable Transport Fuels Obligation
SADC	Southern African Development Community
SSA	Sub-Saharan African
t	ton(s)
TIA	Mozambican Agricultural Survey (in Portuguese: *Trabalho de Inquérito Agrícola*)
ToR	Terms of Reference
TS	Technical Secretariat
TU-Delft	Technical University Delft, the Netherlands
UEM	Eduardo Mondlane University (in Portuguese: *Universidade Eduardo Mondlane*)
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
US	United States
USAID	United States Agency for International Development
WTO	World Trade Organization
WUR	Wageningen University and Research Centre, the Netherlands
WFP	World Food Programme
WWF	World Wildlife Fund
yr	Year
ZLTO	Southern Netherlands Farmers' Organization, the Netherlands (in Dutch: *Zuidelijke Land- en Tuinbouw Organisatie*)

CHAPTER 1

General introduction

1.1 Introduction

This thesis investigates the role of research[1] in policy processes in the competing claims context of natural resource management and sustainable development. The study is based on a sequential case-study approach that consists of two case studies. The first case study on Room for the River in the Netherlands is exploratory and based on the reconstruction of the policy process that led to the depoldering[2] of an agricultural area in the west of the country. The policy reconstruction was carried out in collaboration with representatives from different stakeholder groups. The study reveals key drivers that influence the 'space' that research can create for groups of stakeholders, and how that space is captured during different phases in the policy processes.

These key drivers were studied in more detail during the second case study on the policy debate on biofuel sustainability in Mozambique. This part of the research is more action-oriented in terms of the role of the research and the roles of the researcher in the policy process. The second case study includes studies that describe and explain biofuel developments in Mozambique from an interdisciplinary, multiscale and multilevel perspective. The findings resulting from these studies served as input for exploring and designing a policy framework for biofuel sustainability in a multi-stakeholder context. This provided the basis for analysing the dynamics at the research-policy interface, and what kind of research approaches and researchers' roles may enhance the contribution of research to policy processes in competing claims contexts.

This first chapter provides a general introduction and background to the thesis. Only the main theories and concepts are elaborated, as each empirical chapter is embedded in a specific scientific debate. Subsequently, the general research objective and research questions are presented, followed by the research approach and the thesis outline.

1.2 Contexts of competing claims

Natural resource management and sustainable development questions lie at the heart of many local, national and international disputes (Giller et al., 2008). One of the reasons is that natural resources have characteristics (limited quantity, increasingly scarce, extractability, culturally defined meaning and unevenly distributed) that give rise to people having competing claims on those natural resources (Cloke and Park, 1985 p. 60). The notion of competing claims is increasingly relevant, both in so-called developing and developed countries. In competing claims contexts typically: "[F]acts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz and Ravetz, 1993 p. 744). This can easily lead

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[1] This includes the role of the 'researcher'. In this thesis, I use 'research' and 'researcher(s)', unless quoting colleagues who refer to 'science' or 'scientist(s)'. Reasons for this are elaborated in Section 1.3.
[2] Depoldering can best be described as returning a piece of reclaimed land (a polder) to the sea or river.

to distributive negotiations[3] and conflict in relation to the management and use of natural resources.

Contexts of competing claims are characterised by the involvement of a multiplicity of stakeholders, and competing claims problems are often embedded in dynamics that exceed different scales (e.g. spatial scale and administrative scales) and the different levels on those scales (Giller et al., 2008). Furthermore, competing claims problems are often surrounded by uncertainty and multidimensional which makes them highly complex. Below, the main characteristics of are elaborated.

1.2.1 Multi-stakeholder and institutional dynamics

The involvement of multiple stakeholders and the different organisations and institutions they represent is one of the key features of problems in competing claims contexts (Koppenjan and Klijn, 2004; Spielman et al., 2009). Following the definition by McNie (2007 p. 19), stakeholders are: "[I]ndividuals or groups with a vested interest in the outcome of a decision and can include just about anyone, e.g., scientists, citizens, farmers, resource managers, business, politicians, and the like." Stakeholders can participate as policymakers in the policy arena, but can also be positioned outside or be (strategically) excluded from the policy arena.

Stakeholder participation in policy processes has become an established way of addressing complex natural resource management problems and is perceived as a critical success factor for sustainable development (Opdam et al., 2007; Steyaert et al., 2007). However, the involvement of many stakeholders and their multiplicity of – often legitimate – perceptions and interests also complicate policy processes. It may delay taking action, as it is often impossible to identify a single best solution or correct approach for the problem at stake.

Furthermore, stakeholder perceptions, behaviour and actions are embedded in institutional dynamics such as formal legislation and policy, and the more informal 'rules of the game' (cf. World Bank, 2006a; Klerkx, 2008). Stakeholders tend to act strategically rather than collaboratively, resulting in multi-stakeholder processes becoming "arenas of struggle" (Leeuwis, 2000 p. 946). In such situations, stakeholders may end up investing more energy in defending their positions, or making sure that other stakeholders in the process do not gain or win, rather than investing in developing sustainable policy solutions (see also: van Eeten, 1999). Consequently, exploring and designing solutions to competing claims problems requires innovative institutional arrangements and an enabling environment for change (cf. Regeer et al., 2009).

[3] Aarts and van Woerkum (1999 p. 39) discuss distributive and integrative negotiations. Distributive negotiations refer to negotiations that are characterised by struggle and conflict (win-lose), whereas integrative negotiations focus on joint learning and fact finding and tend to be more harmonious (win-win) (see also: Pruitt and Carnevale, 1993).

1.2.2 Multiscale and multilevel dynamics

A second key feature of competing claims contexts is that problems are embedded in, and shaped by interactions that exceed different scales and different levels on those scales. According to Gibson et al. (2000 p. 218), scales are: “The spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon.” Termeer et al. (2010 p. 1) describe levels as: “[T]he units of analysis that are located at different positions on a scale.” Well-known scales are the spatial and temporal scales, but scales can also be more institutional or administrative. For example, the ‘spatial scale’ is an example of a ‘scale,’ whereas ‘local,’ ‘subnational,’ ‘national,’ ‘regional’ and ‘international’ are the ‘units of analysis’ or ‘levels’ within that scale. Cash et al. (2006 p. 2-4 emphasis changed) add that: “‘Cross-level’ interactions refer to interactions among levels within a scale, whereas ‘cross-scale’ means interactions across different scales [...]” and that: “‘Multilevel’ is used to indicate the presence of more than one level, and ‘multiscale’ the presence of more than one scale, but without implying that there are important cross-level or cross-scale interactions.”

In the light of globalisation, there is increasing awareness that solutions to complex problems need to be explored by going beyond the level of country, region and continent (climate change is probably the most used example). In line with what was described in Section 1.2.1, this multiscale and multilevel awareness has substantially increased the number of stakeholders in policy processes in competing claims contexts, and, in doing so, also the multiplicity of interests and objectives that affect the course and outcome of policy processes.

Figure 1.1 visualises the interactions across levels, and how developments at one level can both enable and constrain developments at other levels. The top-down interactions have been visualised as ‘stronger’ or ‘more influential’ than the bottom-up interactions, as local responses are often constrained by policies and regulation developed at higher levels (Giller et al., 2008). In a similar fashion, developments that take place at the regional, national or subnational level should take into account both global forces and local forces. Consequently, Giller et al. (2008 p. 4) hypothesise that: “[D]esirable change may emerge when societal negotiation processes in and between networks lead to a balancing of local entitlements, national developmental interests, and global environmental concerns with sustainable use strategies.”

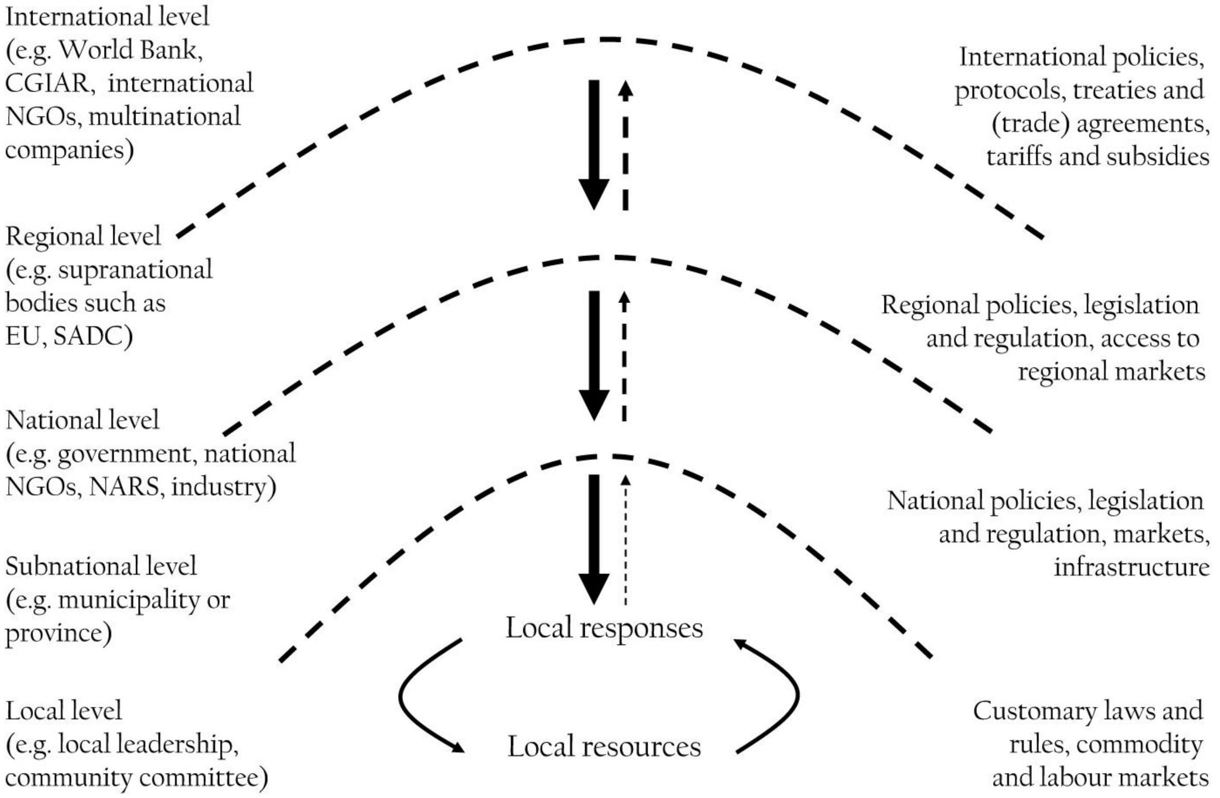

Fig. 1.1. Multilevel interactions[4] (adapted from: Giller et al., 2008 p. 5).

1.2.3 Multidimensional, uncertain and dynamic over time

Competing claims problems are inherently complex and multidimensional, meaning that they are an interplay of social-cultural, biophysical and economic, but also – as this study will show – of political and legal dimensions, which often have different meaning at different scales and levels (see also: Funtowicz et al., 1999). Consequently, exploring and designing sustainable solutions to competing claims problems cannot be successful if their dimensions are analysed separately. Rather, they require a holistic approach in which the dynamics between the different dimensions are analysed from an interdisciplinary perspective (Spielman et al., 2009 p. 400). Attention directed at, in particular, the political and legal dimension goes beyond the – generally accepted – definition of sustainability; that comprises the environmental, social and economic dimensions. It emphasises the increasing focus on institutional (legal) and power-related (political) drivers and how they influence the extent to which promising solutions can actually contribute to sustainable development.

Competing claims contexts are characterised by high uncertainty. The uncertainty relates both to the (changing) nature of the problem at stake and to the space within which solutions can be explored. It makes policy processes addressing competing claims problems

[4] Abbreviations: CGIAR: Consultative Group on International Agricultural Research; NGO: Non-Governmental Organisation; EU: European Union; SADC: Southern African Development Community; NARS: National Agricultural Research Systems.

unpredictable and therefore unsuitable for linear policymaking procedures. Furthermore, exploring or designing solutions requires understanding the historical evolution of problems, problem definitions and stakeholder dynamics in the face of the changing competing claims context (Cash et al., 2003; Hekkert et al., 2007; Giller et al., 2008). In other words, temporal dynamics and the changing policy context need to be taken into account.

1.3 Research in competing claims contexts

Before discussing the role of research in competing claims contexts, I need to explain why this thesis studies the 'role of research' in competing claims contexts, rather than the 'role of scientific knowledge' in competing claims contexts. In the scope of this thesis, there are a couple of reasons for this. Firstly, I regard doing research as something that is broader than producing scientific knowledge. Scientific knowledge and scientific knowledge production form an important part of research, but doing research may also include – amongst others – developing and linking stakeholder networks or facilitating processes of change. In so doing, researchers fulfil different types of roles, some of which go beyond producing scientific knowledge. Secondly, in this thesis, I do not want to go into discussions about the differences between scientific knowledge, expert knowledge and lay knowledge, and their various combinations and subcategories. I rather see research as the process that can nurture these different types of knowledge, and potentially contribute to exploring the synergies between them.

The sections below describe three schools of thought that provided the conceptual inspiration for developing the research objective and research questions addressed in this thesis.

1.3.1 Towards a negotiation approach: the NE-DEED framework

Although many have emphasised the distinctive contribution of research in shaping societal debates on natural resource management and sustainable development (cf. Haas, 2004), research in competing claims contexts may be prone to different types of dynamics. To use the words of Funtowicz and Ravetz (1993 p. 754): "In every age, science is shaped around its leading problems, and it evolves with them." As a consequence, research in the context of competing claims is likely to entail the development of new research strategies (theories and action) that can facilitate change across different scales and levels, realised in collaboration with heterogeneous groups of stakeholders, and concerned with understanding the multiple dimensions and changing nature of the problem at stake. In order to do so, Gibbons (1999 p. C84) recommended that research should "leave the ivory tower and enter the agora" to engage actively with society and enhance its effective contribution to describing and explaining real-life problems and exploring and designing feasible solutions (Giller et al., 2008).

Participatory research approaches have been promoted as a method that enables researchers to collaborate more closely with different types of stakeholders. Participatory approaches come in different forms, but generally aim at integrating multiple perspectives and different types of knowledge to reach supported, sustainable and so-called win-win solutions to problems. Although initial problems with participatory research approaches were attributed to "bad practice" (Pijnenburg, 2004 p. 15), later reflections emphasised the more fundamental shortcomings such as the limited attention paid to dynamics across scales and levels, power dynamics and conflict – typical characteristics of competing claims contexts (cf. Leeuwis, 2004; Giller et al., 2008). Furthermore, societal actors "tend to act strategically, rather than communicatively [...]" (Leeuwis, 2000 p. 946) and should therefore not be seen as a homogeneous group of "passive and obedient adopters" of research (Giller et al., 2008 p. 2).

As a response, Leeuwis (2000) proposed a shift towards positioning 'negotiation' at the centre of research approaches in competing claims contexts. In so doing, multi-stakeholder processes are approached as negotiation processes in which research can support stakeholders in negotiations or facilitate multi-stakeholder negotiation processes, but the research is itself also subject to negotiation (cf. Pleijte et al., 2011). Giller et al. (2008 p. 7-12) used this 'negotiation approach' to develop the NE-DEED framework[5] for research in competing claims contexts (see Figure 1.2).

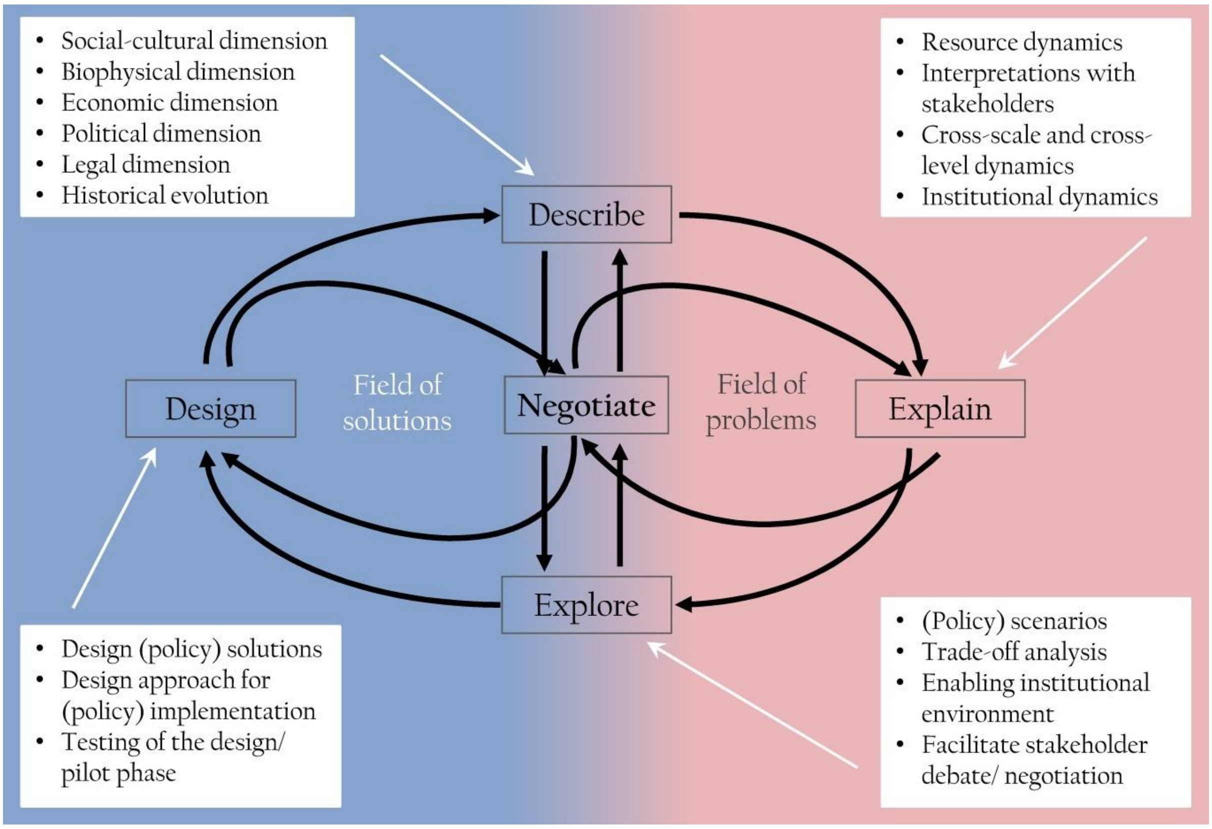

Fig. 1.2. NE-DEED framework (adapted from: Giller et al., 2008 p. 8).

The approach contains four iterative analytical phases. The first two phases, Describe and Explain, form part of descriptive and explanatory phases of research. During these phases,

[5] NE-DEED: NEgotiation – Describe – Explain – Explore – Design.

providing a historical and multidimensional perspective is key. This includes stakeholder analysis, the analysis of institutional dynamics, and describing and explaining interactions between different scales and levels in relation to the problem at stake. These phases provide the foundation for the Explore and Design phases in which policy scenarios and solutions can be developed and tested, and stakeholders negotiate and make compromises and trade-offs in their search for feasible solutions. Although the NE-DEED framework has been designed to guide research in competing claims contexts, processes of policy development often follow similar problem- and solution-oriented phases, usually followed by policy implementation.

The NE-DEED framework can provide the basis for more action- and impact-oriented research, where researchers actively engage with multiple societal stakeholders in defining problems, and developing, testing and modifying models and solutions in the context of application (Gibbons, 1994; Nowotny et al., 2003). Using the NE-DEED framework may have several implications for research in competing claims contexts. Firstly, due to the multiplicity of stakeholders and their different interests, research is likely to result in: "'[W]in–win' solutions for a certain subset of stakeholders, which may at the same time be 'win–lose' solutions for other sets of stakeholders" (Giller et al., 2008 p. 14). Secondly, and closely related to that, researchers need to think carefully about, on the one hand, who their clients are, and, on the other hand, how to remain credible and relevant to other stakeholders in the process (Giller et al., 2005).

1.3.2 Research in policy processes in competing claims contexts

In recent years, interest in the role of research in policy processes has increased considerably (Jasanoff, 1990; Steel et al., 2004; McNie, 2007; Pielke Jr., 2007; Boaz et al., 2009). In the context of this study, policy processes are perceived as the formal and informal negotiation processes in which research – but also other resources – are mobilised and used selectively and strategically by different (groups of) stakeholders to influence the development and implementation of policy.

Although research often strives to provide policymakers and other stakeholders with an objective body of knowledge to weigh up, justify and evaluate their decisions (Ozawa, 1996), practice shows that many research outcomes do not reach the policy arena (Opdam, 2006), arrive in fundamentally different ways than intended (Klosterman et al., 2009), or are used strategically or selectively as a "political weapon to legitimize an already advocated political position [...]" (Hoppe, 2005 p. 203; see also: Burton, 2006). Such insights put question marks around notions of evidence-based policymaking (cf. Sanderson, 2002b) and of more research leading to better policy processes ("The myth of knowing" by P.H.A. Frissen, quoted in: In 't Veld, 2000 p. 16). In the light of the increasing complexity of environmental policy debates, Hessels and Lente (2008 p. 744) claim that "a reassessment of the appropriate role of [...] research" is urgently needed.

In response, several authors have sought to better understand what influences the effective contribution of research to policy processes. Cash et al. (2003) refer to credibility, legitimacy and saliency as key criteria that determine the effectiveness of research in multi-stakeholder policy processes. In line with that, Haas (2004 p. 575) adds that research must be capable of "mobilizing sufficient political support," "generating solutions that can be implemented," and "generating solutions that are instrumental towards solving the problem for which they were designed." One critique of these responses is that such criteria are often too static and do not take into account the (changing) institutional and organisational policy context in which multiple stakeholders describe and explain policy problems, and explore and design solutions (Sanderson, 2002a). To use the words of Turnhout (2009 p. 450): "Instead of fixed notions of scientific validity, objectivity, usability and policy relevance that can be attributed to the quality of the [research] [...], the effectiveness [...] becomes a social matter", where more subtle variables play a role.

To better understand the dynamics at the research-policy interface, a variety of cross-cutting theories have emerged (cf. Hoppe, 2005; Tuinstra, 2007; Turnhout et al., 2008; Sterk et al., 2009; Runhaar and van Nieuwaal, 2010). Most of these theories are concerned with the notion of 'boundary work,' referring to the process of safeguarding, withdrawing and redefining boundaries between research and policy (cf. Jasanoff, 1990; van Buuren et al., 2004). Hoppe (2005 p. 208) proposed "models of boundary arrangements" to structure conceptions on the division of labour and responsibilities between research and policy. Turnhout and colleagues (2007 p. 224; 2008 p. 229) developed a "science-policy typology" that describes the relation between different types of policy problems (ranging from 'well-structured' to 'unstructured' problems), types of policy processes, and the roles of research and researchers. Although boundary arrangements and science-policy typologies are useful concepts, they present a rather static image of the role of research in policy processes in competing claims contexts. Both Hoppe and Turnhout and colleagues acknowledge that: "The observed context dependence of science-policy interactions warrants a much more nuanced view on how to organise the relation between science and policy" (Turnhout et al., 2008 p. 237). However, there is still limited understanding of the implications for research when – for example – 'well-structured' policy problems become 'unstructured' policy problems or *vice versa* as a result of (new) research or perspectives entering the policy arena, unpredictable contextual changes, the entry of new stakeholders or changing power relations. Consequently, a key question becomes how to deal with the changing research-policy interface, and the multiple roles of research and researchers as policy processes in the competing claims contexts unfold through time.

1.3.3 Solution space and space for change in policy processes

As described by Villarreal (1992 p. 248): "Society is composed of actors, thinking agents, capable of strategizing and finding space for manoeuvre in the situations they face and manipulating resources and constraints." Extrapolating from Villarreal's definition, this implies that stakeholders are capable of continuously exploring 'space for change' in policy processes (cf. Gaventa, 2006; Leeuwis and Aarts, 2011). Exploring and capturing space for change:[6] "[I]mplies a degree of consent, a degree of negotiation and a degree of power – not necessarily power stored in a given economic or political position, but the possibility of control, of prerogative, of a degree of authority and ability, be it front- or backstage, for flickering moments or for long periods" (Villarreal, 1992 p. 256). However, spaces can also be of a more open character, when stakeholders are invited or expected to participate in policy processes, which Gaventa (2006 p. 26) calls: "invited spaces."

A key question then is: What is the role of research in policy processes in competing claims contexts in terms of its ability to create space for change or influence the space within which policy solutions can be developed and implemented; and for whom? Answering this question requires a twofold approach. Firstly, a better understanding is required of how stakeholders mobilise and use research to influence the course and outcome of policy processes (or solution space). This includes analysing power dynamics that have often been neglected in the practice of participatory and multi-stakeholder processes (Aarts and Leeuwis, 2010). Secondly, and in line with the hypotheses developed by Giller and colleagues (2008), it is essential to explore the potential contribution of research in terms of: (1) facilitating more integrative multi-stakeholder negotiation in policy processes, and the degree to which research and researchers in competing claims contexts are capable of addressing questions and uncertainties experienced by different stakeholders; (2) bringing in new perspectives regarding the problem at stake; and (3) facilitating bridge-building activities to explore solution space or space for change towards more sustainable policy solutions to competing claims problems.

1.4 Research objective and research questions

This thesis aims to contribute to a better understanding of the dynamics that influence the role of research in policy processes in competing claims contexts.

In order to reach this objective, the following research questions are formulated:

1. How is research mobilised and used in policy processes in competing claims contexts?
2. What factors influence the extent to which research can create space for stakeholders in policy processes in competing claims contexts?
3. What kinds of research approaches have the potential to enhance the contribution of research to policy processes in competing claims contexts?
4. What researcher's roles or combination of roles may enhance the contribution of research to policy processes in competing claims contexts?
5. How do dynamics at the interface of research and policy influence the role of research in policy processes in competing claims contexts?

In the next section, the research approach is described, followed by the thesis outline providing the reader with an understanding of the structure of the thesis, which is a compilation of six research articles.

[6] Villarreal (1992 p. 248, 256) mainly refers to "space for manoeuvre" or "room for manoeuvre," which has a similar meaning as space for change.

1.5 Research approach

The role of research in policy processes in competing claims contexts can be studied in a variety of ways. One can study the role of research by reconstructing a policy process *ex-post*,[7] one can study the role of research (executed by others) in policy processes *ex-durante*,[8] or a researcher can adopt a more embedded and action-oriented research approach by trying to contribute to an on-going policy process and systematically reflect on the role of the research. In this thesis, all strategies were explored. The latter – embedded and action-oriented – research approach formed the point of departure at the start of the study. In the next section, I elaborate my ideas about this research approach and how it differs from so-called action research. Next, the sequential case-study approach used in this thesis is explained, followed by the case-study selection criteria and a description of the process of case screening. This description will show that the embedded, action-oriented research approach to study the role of research in policy processes and the strategy to collaborate with other researchers *ex-durante* was not always feasible in practice, and how this led to the exploration of the *ex-post* strategy.

1.5.1 Embedded and action-oriented research

The intended strategy was to conduct embedded and action-oriented research. In so doing, I sought to actively engage with stakeholders to describe and explain policy problems, and to explore and design – and potentially implement – policy solutions. Although action-oriented research is not the same as action research (cf. Collier, 1945; Lewin, 1946), some of its conceptual foundations are quite similar. For example, it was my intention to become part of an on-going policy process to study it from within; not, however, with the intention of engaging stakeholders in the process of researching their own problems in order to solve them, which would be part of an action research approach (Patton, 1990 p. 157). Furthermore, this was not always feasible or desirable and could have complicated the embedded position of the researcher, for example when addressing problems of a political or personal nature.[9] A second feature borrowed from the action research approach is its iterative cycles of "acting, reflecting, learning and change" (cf. Pleijte et al., 2011 p. 224). It is based on a philosophy that "research should lead to change," which also requires that "change should be incorporated in the research itself" (Kibwika, 2006 p. 49). This iterative and reflexive approach enables the researcher to adapt the research approach during the research process, on the basis of active and systematic reflection. On the basis of such reflections, I continuously tried to adapt the operational research questions, and the research approach and methods to the (changing) context in which the research was embedded (Trondsen and Sandaunet, 2009 p. 14). This thesis will demonstrate that embedded and action-oriented research in policy processes can

[7] *Ex-post* = afterwards or after.

[8] *Ex-durante* = during.

[9] The extent to which a researcher is in a position to reflect on political or personal problems, or whether such problems are discussable in the first place, is moreover culturally determined and therefore highly contextual.

be "intentionally political" or "value laden" (Kibwika, 2006 p. 51). This makes action-oriented research approaches different from research that continuously seeks to emphasise its independence and objectivity, although – as this thesis will show – the two are not mutually exclusive and can even be mutually reinforcing.

1.5.2 Sequential case-study approach

Addressing complex problems in competing claims contexts requires a holistic research approach that seeks to understand processes and events in their real-life context (cf. Nowotny et al., 2003 p. 186). According to Gibbons (1999 p. C82): "[T]he increasing importance of 'context' is also reflected in a relatively rapid shift within science from the search for 'truth' to the more pragmatic aim of providing a provisional understanding of the empirical world that 'works'." The case-study approach permits the researcher to develop in-depth, holistic and meaningful characteristics of real-life social phenomena or processes (Yin, 2009). The approach is particularly useful when one is studying multidimensional phenomena that cross multiple scales and levels (de Vaus, 2001 p. 220), and when the boundaries between phenomena under study and context are blurring (Yin, 2009 p. 18).

Case studies may be organised around (groups of) people, stakeholders, policy or decision-making processes, or other elements of life (Kumar, 2005 p. 113). In this study, the case studies are policy processes, within which there is a particular focus on the role of research, and how research influences – be it directly or indirectly – the policy process and *vice versa*. The policy process may entail different phases of decision making, from describing and explaining policy problems, to exploring and designing policy solutions, to policy implementation, and the monitoring and evaluation of policy. By using the case-study approach, this study seeks to understand policy processes from a holistic perspective, examining how phases of decision making in policy processes are organised, how stakeholders are included and excluded, and how research is mobilised and used to influence the course and outcome of the policy process.

There exist different types of case-study designs. Case studies can be descriptive, explanatory or exploratory, theory testing or theory building, single case or multiple case, parallel or sequential and retrospective or prospective; between which multiple combinations and cross-classifications exist (de Vaus, 2001 p. 228). This thesis is based on the multiple case-study approach, which can be organised as parallel or sequential. The exploratory nature of the study, as well as practical considerations (parallel case-study approach would imply the involvement of more than one researcher which is uncommon in PhD research) led to the sequential case-study approach in which case studies "follow one another" (de Vaus, 2001 p. 227). Furthermore, the sequential case-study approach enables the researcher to adapt the research approach of the second case study consequent to the outcomes of the first case study; this is particularly useful within an action-oriented research approach. Although the sequential case-study approach may reduce the comparativeness of case studies as different units of analysis may be studied, it often leads to a better understanding of the problems at stake, and what is driving them. De Vaus (2001 p. 227) adds that: "When adopting a more inductive, theory building approach a sequential design is more appropriate than a parallel approach." However, as the cases follow one another, and ideally build upon each other, they may be very different in terms of their conceptual focus, data collection techniques, analytical framework and the roles played by the researcher. In this thesis, the sequential case-study approach is applied to identify drivers that influence the role of research in policy processes in a competing claims context in the first case study, and, in the second case study, apply and study these drivers in more detail.

1.5.3 Case-study selection criteria

The strategic selection of case studies includes developing case-study selection criteria and screening preselected case studies to increase the likelihood of the cases contributing to answering the research questions. Based on the research objectives and research questions, the below case selection criteria were developed:

1. The cases focus on competing claims on land-use planning or natural resource management;
2. The cases are situated at the research-society interface;
3. There is (the intention of) cooperation between researchers, practitioners, policymakers and other stakeholders;
4. The cases are concerned with exploring solutions to competing claims problems;
5. The cases are from different countries and continents in order to gain insight into how different contextual factors influence how stakeholders mobilise and use research in negotiations.

On the basis of the case selection criteria, a number of cases were purposefully preselected. According to Russell Bernard (2006 p. 191), there are many reasons for purposefully selecting case studies. In this study, it was a combination of complying with the case-study selection criteria, and having an entry point or contact person that could facilitate access to the policy process and the relevant stakeholders involved.

1.5.4 Case screening and description

This section elaborates the process of case screening, resulting in a description of the two case studies that provide the empirical data for this thesis. I have decided to describe the process of case selection and case screening in a detailed and transparent manner, as this process in itself provides information on the complexity and sensitivity of studying the role of research in policy processes in competing claims contexts.

Case 1: Room for the River, De Noordwaard, the Netherlands

The suggestion to explore Room for the River as a case study came from a colleague at Wageningen University and Research Centre (WUR). The colleague was working as senior consultant at a Dutch consultancy company hired by the Dutch Ministry of Infrastructure and the Environment (former Ministry of Transport, Public Works and Water Management) to explore the possibility of depoldering parts of *De Noordwaard*, an agricultural polder of 2,050 ha near Rotterdam, in the west of the Netherlands.

Room for the River is a €2.3 billion inter-regional spatial planning programme with 39 projects in different parts of the Netherlands. The Room for the River policy was initiated following the high water levels in 1993 and 1995, resulting in the evacuation of around 250,000 people (in January 1995) and causing an estimated economic damage of US$1 billion (van Stokkom et al., 2005 p. 78). The main objectives of Room for the River are that: "(1) by 2015 the branches of the Rhine will be able to cope with a discharge capacity of 16,000m^3 sec^{-1} without flooding; (2) the measures implemented to increase safety will also improve the overall environmental quality of the river region; and (3) the extra room the rivers will need in the coming decades to cope with higher discharges due to the forecast climate changes, will remain permanently available" (Project Organisation Room for the River, 2009 p. 5). Room for the River includes measures such as the lowering of floodplains, depoldering, relocation of levees, water storage, but also more traditional measures such as the strengthening of levees. The depoldering of De Noordwaard: "[W]ill make by far the greatest contribution to the necessary reduction (30 cm) of the water level at Gorinchem [...]" (Project Organisation Room for the River, 2009 p. 16). On the basis of an initial analysis, I decided to explore whether De Noordwaard could fit the case-study selection criteria.

On 29 January 2008, I had an exploratory meeting with two senior consultants at the consultancy company in Arnhem. Based on the meeting, both the consultants and myself concluded that a collaboration could be mutually beneficial, and that the consultancy company would propose the collaboration to the Dutch Ministry of Infrastructure and the Environment who was hiring them. On 25 March 2008, the contact person at the consultancy company wrote: [10]

After all this time, I am afraid I have bad news... The Bureau Noordwaard has decided that they are not willing to cooperate in the research, and they have moreover requested me – as representative of the consultancy company – not to collaborate with you. In sum, I am afraid that this is the end of De Noordwaard as a case study. I regret this very much, because it seemed to me both fun and interesting.

When I asked about the reasons and arguments provided by the Ministry, the contact person responded:

The reason was above all vague. That they themselves also had done something similar and that it did not seem a good idea at the moment etcetera, etcetera. The bottom line is that the project is not running very well at the moment and that people are afraid of the personal consequences [of the research outcomes].

Notwithstanding the limited space to collaborate with the Ministry or the consultancy company in the De Noordwaard case, I was convinced that De Noordwaard would perfectly fit the case-study selection criteria. Furthermore, the case was well documented, and

[10] Translated from Dutch by the author.

colleagues from Wageningen University and Research Centre had been actively involved in supporting a citizens' platform (Platform Save De Noordwaard) in designing an alternative plan to the Ministry's proposal to depolder De Noordwaard (see Photo 1.1). However, it was clear to me that a different research strategy was needed to study the competing claims context of Room for the River in De Noordwaard.

Photo 1.1. Citizen protest against depoldering De Noordwaard (In English: "We pay for dry feet"). Photo taken by M. Schut in May 2008.

In April 2008, I decided to go cycling in De Noordwaard. The objective was to explore whether I could bypass the formal system (entering was apparently controlled by the Ministry) and apply a different strategy to get in touch with key informants in the area. I visited the Biesbosch Museum, which is located in the area and – at that time – hosted an exhibition on Room for the River. Moreover, I joined in a boat trip through the Biesbosch National Park and engaged in many informal conversations with people from the area. Those conversations led me in the direction of a local newspaper journalist, who was identified as a key informant as he had covered the policy process for quite some time. I contacted and interviewed the journalist who provided the historical context and background on the intended depoldering of De Noordwaard and assisted me in identifying and contacting other key informants. In May 2008, during the opening ceremony of a nature development project in De Noordwaard, I managed to speak to the Ministry's project leader. Despite two constructive meetings at the Ministry, formal access to participate in the policy negotiations between the government and the people from De Noordwaard was denied. The sensitivity of the process as well as violated trust between the government and other stakeholders were given as the principle reasons.

Despite all difficulties, I was able to reconstruct the policy process based on interviews with the key stakeholders in De Noordwaard case. Although access to the policy process was denied and my research was less embedded and action-oriented than intended, the first case study enabled me to identify key drivers that influence the role of research in policy processes in competing claims contexts. Moreover, all the difficulties during the process of selecting and screening the case study had raised awareness of the tensions and dynamics involved in conducting research in competing claims contexts, and can be considered part of the empirical data in this thesis.

During a later phase in the research (2009–2010), I actively reflected with two researchers from Wageningen University and Research Centre who had conducted action research to support the Platform Save De Noordwaard. This reflection resulted in a book chapter entitled: "Reflexivity in action research: two spatial planning cases" (see: Pleijte et al., 2011).

Case 2: Policy debate on biofuel sustainability, Mozambique

During an early stage of the study, I became involved in the Competing Claims on Natural Resources (CCNR) programme (http://www.competingclaims.nl), funded by the development oriented Interdisciplinary Research and Education Fund of Wageningen University and Research Centre (http://www.inref.wur.nl). The CCNR programme focuses explicitly on the contribution of research to stakeholder negotiation processes by describing and explaining resource dilemmas from an interdisciplinary and holistic perspective, and exploring and designing pathways and solutions through multi-stakeholder negotiation processes (Giller et al., 2008). The project setting is highly dynamic, driven by emerging policies surrounding land rights and land distribution (South Africa and Zimbabwe), the creation of new transfrontier conservation areas (Mozambique, South Africa and Zimbabwe) and the influence of changing global and regional policies on access to external markets (Giller et al., 2005). With its action-oriented research approach, the CCNR programme provided many interesting case studies in sub-Saharan Africa that fitted the case selection criteria.

The initial idea was to collaborate with other PhD researchers in the CCNR programme and to study the role of their research in policy processes or processes of change *ex-durante*. This did not work out for a number of reasons. The main difficulty was that the majority of projects were in the process of being established, and this complicated discussing concrete collaboration, mutual benefits, and the coordination of responsibilities, expectations and activities between myself and the other researchers. Furthermore, the collaboration did not appear to be very action-oriented with regard to my own role as researcher; this did not fit the ideas I had about embedded and action-oriented research. Lastly, my research proposal was rather sensitive and confrontational for my colleagues, as studying the role of research would also entail analysing the roles played by the researchers.

While exploring a more action-oriented case study, I got in touch with the project coordinator of the DGIS-WUR[11] partnership programme Competing Claims – Competing Models. One of the research themes focuses on: "The role of knowledge and science in enhancing societal negotiation about biofuel production [in Mozambique] in the context of competing interests." Between July and October 2008, I developed a proposal in close collaboration with a senior policymaker working for the Mozambican Ministry of Agriculture. The objective of the study was formulated as follows: "Getting more grip on different stakeholders' perceptions on sustainability", that could provide "the basis for establishing a national set of biofuel sustainability criteria or a certification scheme." The policymaker provided the necessary background and facilitated contact with other government officials and private and public sector stakeholders. Eventually, the proposal was approved and the study was scheduled to take place between December 2008 and June 2009.

To cut a long story short, the Competing Claims – Competing Models assignment provided the basis for my involvement in the policy debate on biofuel sustainability in Mozambique; not until the planned June 2009, but until November 2010. The project produced a significant amount of empirical data on the sustainability of commercial and community-based biofuel developments in Mozambique; which was the first in its kind for Mozambique. Furthermore, the project team summarised lessons learned from the debate on biofuel sustainability in Brazil, and gathered existing experiences with certification and sustainability in other sectors in Mozambique. As a result of the preliminary outcomes of the research and my active participation in different stakeholder platforms, I was approached to become part of a Technical Secretariat, responsible for supporting a working group in developing and implementing a national policy framework for sustainable biofuel production. I supported this working group for nearly two years in developing a policy framework that includes biofuel sustainability principles, sustainability criteria and a guide for implementation, and I actively contributed to organising three multi-stakeholder workshops in different parts of the country at which the policy framework was discussed. The embedded and action-oriented character of the second case study enabled me to study, from within and much more in-depth, the key drivers that had emerged from the first case study.

[11] Dutch Ministry of Foreign Affairs (DGIS) and Wageningen University and Research Centre (WUR).

1.6 Thesis outline

This thesis unfolds across nine chapters (Figure 1.3). Chapter 2 describes the study methods used in this thesis, including the data collection techniques and sampling strategies, techniques for data analysis, quality control and the methodological challenges encountered during the study.

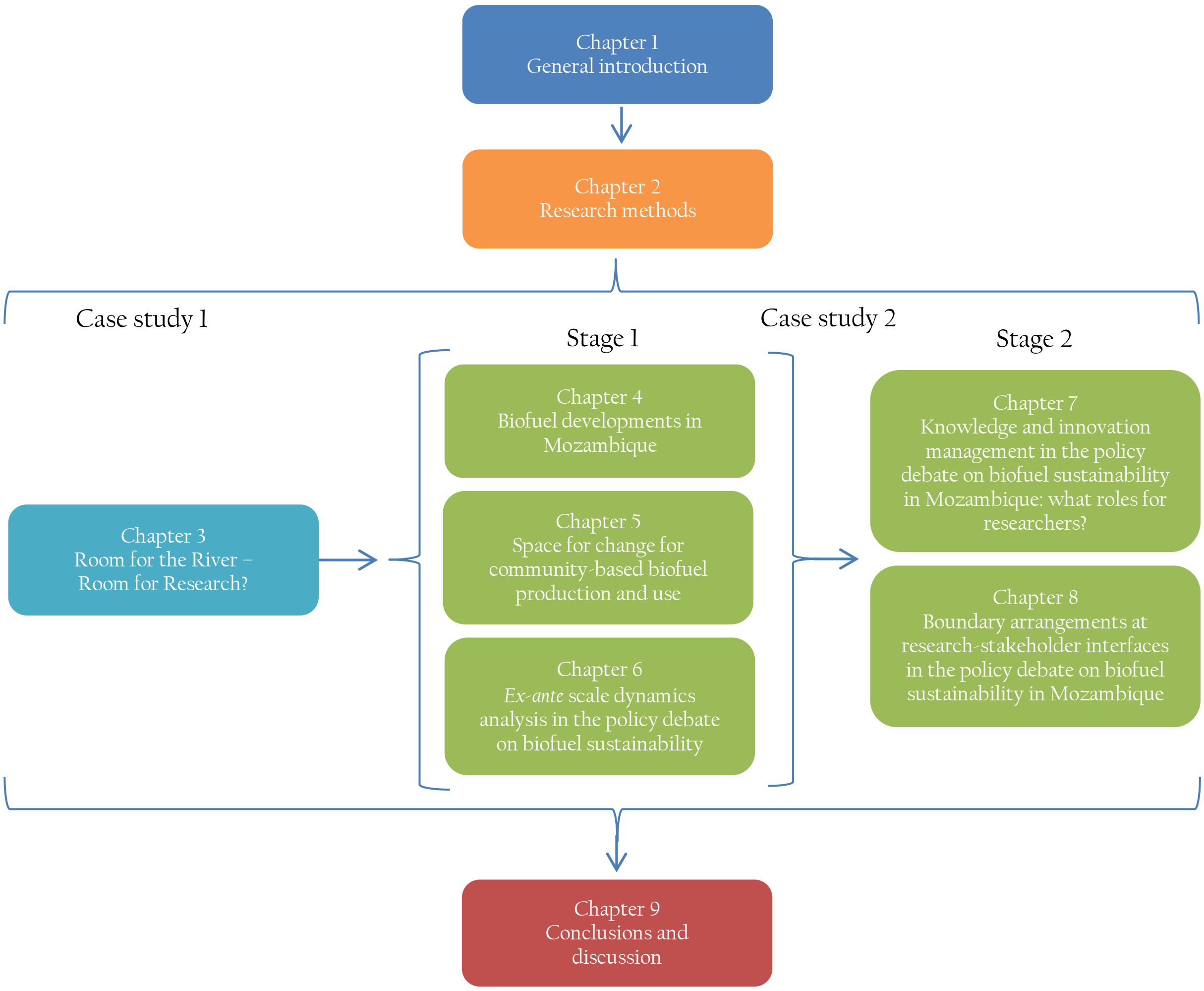

Fig. 1.3. Thesis outline.

The first case study studies the role of research in the policy context of Room for the River in the Netherlands. Chapter 3 is the first empirical chapter of the thesis and reconstructs a decennial policy process that led to the decision to depolder De Noordwaard. The policy reconstruction is based on the analysis of policy documents, and interviews with key stakeholders. The chapter contributes to answering research questions 1 and 2, as it analyses how stakeholders mobilise and use research in policy processes in competing claims contexts, and the extent to which this way of mobilising and using research influences solution space or creates space for stakeholders in the policy process. The first case study concludes with a number of drivers and sensitising issues that – following the sequential case-study approach – provide the basis for more in-depth study in the second case study.

The second case study explores the role of research in the policy debate on biofuel sustainability in Mozambique. The case study contains two stages. During the first stage the emphasis was on sharpening and aligning the research questions with the priorities and objectives of different stakeholders in the policy process. The core of this exercise was exploring what research questions, methods and theories can generate research that is perceived credible, legitimate and salient for different stakeholder groups. This provides the basis for Chapters 4, 5 and 6 in this thesis. The second stage, reported in Chapters 7 and 8, provides insight into the roles and dynamics for research and researchers when exploring and designing policy solutions in a multi-stakeholder policy setting (referring to the NE-DEED framework, see Figure 1.2).

Chapter 4 introduces the second case study and provides background on Mozambique, describes the history of the biofuel debate in the country and gives an up-to-date overview of biofuel developments in Mozambique. Biofuel developments in Mozambique are analysed from different disciplinary perspectives, as the first case study suggested that such an approach could potentially enhance the contribution of research to policy processes in competing claims contexts (research question 3). This chapter analyses the development of biofuel legislation and political developments, summarises existing data on Mozambique's biophysical potential for producing biofuels, discusses social and economic drivers and provides a detailed inventory and analysis of the emerging (commercial) biofuel sector in Mozambique. The chapter concludes with a number of recommendations on how a policy framework for sustainable biofuels can harmonize the different objectives of biofuel investors and those of the Mozambican government.

Chapter 5 follows a similar structure as Chapter 4, but focuses on community-based biofuel developments. The inventory of biofuel developments in Mozambique triggered thinking about the differences between commercial and community-based biofuel projects, and that both need different enabling environments to promote their sustainability. The objective of this chapter is to provide insights into the opportunities and constrains that influence the 'innovation space' for sustainable community-based production and processing of biofuel feedstock for local use or for local marketing. The introduction and performance of *Jatropha curcas* Linnaeus (a biofuel oil-crop) in Nhambita community in the centre of Mozambique is described and analysed from social-cultural, biophysical, economic, political and legal perspectives and by combining theories and methods from different scientific disciplines. In line with findings from Chapter 3 and 4, the chapter is rooted in the idea that policy recommendations based on holistic and interdisciplinary research have the potential to enhance the contribution of research to policy development in competing claims contexts; thus contributing to research question 3.

Chapter 6 puts Chapters 4 and 5 in perspective by conducting *ex-ante* scale dynamics analysis. In this chapter, the policy debate on biofuel sustainability in Mozambique is positioned within the broader international debate on biofuel sustainability. Both Chapters 4 and 5 demonstrate how commercial and community-based biofuel developments, as well as developing a national biofuel policy, are affected by dynamics and interactions across different scales and levels. The objective of Chapter 6 is to study how *ex-ante* scale dynamics analysis can contribute to addressing challenges related to scale and level interactions that influence solution space in policy processes. Furthermore, the chapter explores the opportunities and challenges of *ex-ante* scale dynamics analysis as part of an action-oriented social science research approach that seeks to enhance its contribution to policy processes in competing claims contexts. In so doing, it contributes to addressing research question 3. The chapter includes comparative analyses of biofuel policy development in other countries (Brazil) and existing experiences with certification and sustainability in other Mozambican sectors (e.g. sustainable forestry). These analyses provide valuable scenarios on how challenges in the policy debate on biofuel sustainability in Mozambique can be addressed.

The research conducted during Stage 1 of the second case study resulted in policy recommendations that provided the basis for fulfilling a more embedded and action-oriented role in the policy debate on biofuel sustainability in Mozambique during Stage 2. This active involvement in the policy process provided insights into how stakeholder mobilised and used research to create space in the policy debate, thus contributing to addressing research questions 1 and 2.

Chapter 7 reflects on the roles of researchers in policy processes in competing claims contexts, addressing research question 4. The first case study showed that embedded researchers can fulfil a multiplicity of roles in policy processes (Chapter 3). How this can enhance the contribution of research to policy processes in competing claims contexts is studied more in-depth in this chapter. The objective of the chapter is to explore the relationship between knowledge and innovation management roles in policy processes, with particular attention for how combinations of knowledge and innovation management roles can enhance the contribution of research and researchers to policy process in competing claims contexts. Additionally, the chapter also discusses what types of research and research approaches may enable researchers to fulfil different types of roles, contributing to addressing research question 3.

Chapter 8 explores how interactions at the interface of research and policy influence the role of research in policy processes in competing claims contexts (research question 5). The results from Chapter 3, but also from Chapter 7 provide reasons to rethink the concept of research effectiveness, as what constitutes effective research is strongly related to stakeholder perceptions and their interests. In Chapter 8 this idea is operationalized by studying the role of research and the concept of boundary arrangements (ideas about the division of labour and responsibilities) at multiple research-stakeholder interfaces. The objective is to explore how boundary arrangements at research-stakeholder interfaces are influenced by multi-stakeholder and temporal dynamics in policy processes. Consequently, we discuss the implications of such dynamics for the role of research in policy processes in competing claims contexts and provide recommendations for further research.

Chapter 9 synthesises the two case studies and provides the main findings for each of the research questions. Subsequently, this results in the overall conclusions of the thesis that are discussed within broader debates on research and policy.

CHAPTER 2

Research methods

2.1 Introduction

The empirical data presented in this thesis result from a variety of quantitative and qualitative data collecting techniques and methods. Although each of the empirical chapters contains a methodology section, I decided to include a chapter that describes the overall methodological choices and the trade-offs made during the study. In the research papers that form the empirical chapters, there is often limited space to elaborate on methodological choices, and furthermore, some analytical tools refer to the analysis of the case study as a whole or cross-case analysis, that is not discussed in the individual research articles.

This chapter describes how data were collected and analysed, and how the quality of data collection and data analyses was controlled. Finally, the methodological challenges are presented, followed by some notes from the author.

2.2 Data collection techniques and sampling strategies

For this thesis, data were collected from so-called primary sources and secondary sources (cf. Kumar, 2005 p. 118). In the next sections, I elaborate on the primary and secondary data collection techniques used, how data were gathered and documented, and the sampling strategies applied.

2.2.1 Primary data collection

Primary data sources provide first-hand information, i.e. data originally collected for the purpose of the research and interpreted by the researcher him/herself. The primary data collection techniques used in this study are participatory and non-participatory observations, interviews and questionnaires.

Participant and non-participant observation
According to Kumar (2005 p. 119): "Observation is a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place." In participant observation, the researcher is "not merely a passive observer" but participates in the case being studied (Yin, 2009 p. 111). Doing this for a longer period provides the researcher with a profound and real-life image of the case under study, as people may gradually behave more naturally, and not feel like they are an 'object of study.' Participant observation is essential to develop in-depth insights about discourses, behaviour, decision-making processes and power relations that influence how problems are described and explained, and where solutions can be explored and designed.

In non-participant observation, the researcher "remains a passive observer" (Kumar, 2005 p. 120). Ideally, non-participant observations by a researcher should not influence the object, phenomenon or group under study; the researcher is unobtrusive. Some phenomena or events are more suitable for conducting non-participant observation than others. For example, in public events such as the opening of a building, the researcher can be a passive observer, without influencing the behaviour of other participants or stakeholders. In more 'closed' settings such as invitation-only meetings or workshops, it is difficult not to influence the event, as stakeholders may feel studied and not speak freely.

In this study, both participant and non-participant observations were conducted. In the first case study, I was not allowed to observe the negotiation process between government and other stakeholders. I did conduct non-participatory observations, by going cycling in De Noordwaard, going on the boat trip, visiting the museum in the area, and participating in the opening of the nature development project in De Noordwaard.

During the second case study, participatory observations were gathered during the numerous field visits to biofuel plantations and communities growing biofuel crops. Transect-walks – "[W]alks through an area, with key informants, observing and asking for explanations of everything [...]" (Russell Bernard, 2006 p. 352) – enabled me to better understand farming activities, social and cultural activities and the biophysical diversity in the area of study. Appendix A provides an overview of the field visits conducted during the first stage of the second case study. Participatory observations were of particular importance for data collection during stage 2 of the second case study, when I was part of a Technical Secretariat, and became embedded in the policy process. This enabled me to develop a profound understanding of the policy process and the dynamics that influence the role of research in policy processes in competing claims contexts.

Both participant and non-participant observations were documented in written jottings and field notes, and photographs were used to capture specific situations or events. Jottings are the brief words or phrases written down while at the field site or in a situation, and are intended to support remembering things when writing the full-fledged field notes (Chiseri-Strater and Stone-Sunstein, 1997). Just as the photographs were used to capture observations, I also used GPS to locate projects, farmers' homesteads and fields, plot transect-walks and measure farmers' field size.

Interviewing

Interviewing is one of the most used data collection techniques within the case-study approach, enabling the researcher to investigate dimensions of the case that cannot be observed (Yin, 2009 p. 106). There exist various types of interviews. "Unstructured interviews" are very flexible in terms of their structure, content and interview questions, whereas "structured interviews" are much more rigid (Kumar, 2005 p. 123). I moreover distinguish between formal and informal interviews, where formal interviews can be considered as planned conversations, and informal interviews as spontaneous, unplanned conversations with informants. Informal interviewing was particularly useful at the beginning of the first case study when I was trying to get in touch with stakeholders in De Noordwaard (e.g. during the cycling trip) (cf. Russell Bernard, 2006 p. 211). The approach was also used during the second case study when I was talking to farmers during field visits, and to interview government officials and representatives of private sector and civil society organisations in informal settings.

The formal interviews had a semi-structured character and provided the basis for Chapters 3, 4, 5 and 6. An average interview took around two hours. Semi-structured interviews can be positioned somewhere between structured and unstructured interviewing. To guide the interview, a topic list or key questions were prepared and fine-tuned for each interview depending on the specific role of the respondent in the case, building on and validating information gathered from previous interviews. Using a topic list provided a degree of flexibility to identify and to anticipate interesting storylines that were relevant for the research. This strategy sometimes resulted in unexpected and new perspectives on the issue at stake. Appendix B shows the list of formal interviews for the first case study. Nearly all interviews were taped using a voice recorder, and parts of the interviews were fully transcribed. At a given point during the first case study, I decided to stop fully transcribing the interviews. This decision was based on the time consuming character of transcribing interviews (an hour-long interview can easily take up to a day of transcribing), but mainly that detailed note taking during the interview served the purpose of reconstructing the policy process. On the basis of the interview notes, I would sometimes transcribe part of the recorded interview, for example to provide an exemplar quote to illustrate a specific view or stakeholder perception.

During the second case study, interviews were not taped on a voice recorder. The main reason was that I felt that using the voice recorder could create a barrier between the researcher and the respondent. I decided that the chances of retrieving reliable information and building a trust relationship with respondents were highest when the interviews were not taped, but instead detailed notes were taken. Especially during the second stage of the field work in Mozambique, when I became more embedded in the policy process, taping meetings or policy debates would have been inappropriate, with the risk of endangering the personal relationships and the embedded position that had been so carefully obtained. A second reason for not using the voice recorder was that it was practically unfeasible for the vast majority of interviews. Many interviews were held during breaks at conferences or workshops, in noisy bars, in farmers' fields, while driving around in a car, or sitting in the back of a pickup truck, where note taking was already quite challenging. Appendix C provides an overview of the formal interviews that were held to gather data for the second case study.

Questionnaires

In order to gather data on the potential for community-based biofuel production and use in Mozambique (Chapter 5), two sets of questionnaires were prepared that guided in-depth, face-to-face interviews with smallholder households and local shopkeepers in the community where the study was conducted. The biggest advantage of administering face-to-face questionnaires is that respondents who could otherwise not provide information (e.g. because of illiteracy) can be interviewed. Moreover, the researcher has the opportunity of probing or asking for clarification (Russell Bernard, 2006 p. 256).

The farming systems questionnaire (Appendix D) enabled information to be gathered on the different types of livelihoods in the community and the quantification of – for example –

household size, household members contributing labour to the household's activities, income and expenditures and some of the livelihood assets, such as ownership of livestock. The baseline energy questionnaire that was developed by GTZ (Appendix E) provided an idea about household and community energy consumption, creating the basis for developing scenarios for local marketing and use of biofuels.

2.2.2 Secondary data collection

Secondary data are data collected and documented by someone else, which the researcher can use for the purpose of the study (Kumar, 2005 p. 141). Secondary data collection is relevant for almost "every case study topic" (Yin, 2009 p. 101). Examples of secondary data gathered and analysed in this thesis are: [12]

- Letters, emails, memoranda of understanding, terms of reference and other communiqués;
- Agendas, announcements and minutes of meetings and other written reports of events;
- Administrative and policy documents, such as proposals, progress reports and other internal records;
- Legislation and legislative procedures;
- Studies or monitoring and evaluation reports on the issue under study;
- Scientific papers and reports that contain empirical data gathered by other researchers;[13]
- Newspaper clippings and other news articles appearing in the mass media;
- Organisational records, such as organisational charts and budgets over a period of time;
- PowerPoint® and other presentations;
- Conference proceeding;
- Maps and charts of geographical characteristics;
- Lists of names and other relevant items;
- Investment proposals and investment data;
- Survey data;
- Computerised scenario-planning and decision making models;
- Personal records of stakeholders, including field notes, jottings, letters, memos and calendars.

Specific secondary data collection techniques per case study are elaborated in the empirical chapters. What is worth noting is that during the first case study, I was offered the complete personal dossier of one of the inhabitants of De Noordwaard. The dossier included amongst other things newspaper articles, (draft) reports, faxes, maps, and personal letters and memos.

[12] See Kumar (2005 p. 141) and Yin (2009 p. 103, 105) for more examples.

[13] Whether the analysis of scientific papers and reports should be considered secondary data is a moot point. According to Kumar (2005 p. 141), research articles can be secondary data sources if they discuss, evaluate or re-interpret someone else's original empirical data.

2.2.3 Sampling strategies

The sampling techniques used in this research are selective, meaning that the majority of key informants and study sites were not selected randomly. The most important sampling techniques used are purposive sampling and snowball sampling.

Purposive sampling

Patton states that: "The logic and power of purposeful sampling lies in selecting *information-rich cases* [including informants] for in-depth study. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research, thus the term *purposeful* sampling" (Patton, 1990 p. 169 italics as in original). When purposefully sampling, the researcher selects respondents who are likely to have the required information and are willing to share it. Purposive sampling is useful and widely used in e.g. "pilot studies" or "studies of hard-to-find populations" (Russell Bernard, 2006 p. 190). In this thesis, purposive sampling was used in both case studies to identify key informants representing different groups of stakeholder. For Chapter 5, a study area and a community in that area were purposively sampled as I was aware that a community-based biofuel project had been developed there.

Simple stratified and random sampling

In Chapter 5, purposive sampling was combined with a simplified stratified sampling approach. Stratified sampling ensures that "key subpopulations" are part of the study by dividing "a population [...] into subpopulations [...]" (Russell Bernard, 2006 p. 153). In Chapter 5 it was used to select case-study households representing different categories of resource endowed farms in the community. Purposive sampling was also used to identify one farmer who grows a specific biofuel oil-crop within one of the categories. The farming systems questionnaire (Appendix D) was used to interview the selected farm households. The baseline energy questionnaire (Appendix E) was used to structure the interviews with project staff, local shopkeepers and other community members, who were selected randomly.

Snowball sampling

Snowball sampling is a "network sampling method" (Russell Bernard, 2006 p. 192). Key informants are asked to identify other people in the group, organisation or network, and those people selected become part of the sample. The snowball sampling technique is useful when a researcher knows little about the group or individuals under study, or has limited contacts with informants (Kumar, 2005 p. 179). An advantage of approaching informants through snowball sampling is that one can refer to the person that identified the informant, and this builds some kind of trust relationship. This may provide access to informants who are normally difficult to reach. The biggest disadvantage is that: "The choice of the entire sample rests upon the choice of individuals at the first stage" (Kumar, 2005 p. 179). If these informants have a particular frame of reference or bias, the whole study may be biased, possibly creating a one-sided perspective on the issue at stake. It is therefore essential for the researcher to identify stakeholders with different interests and perspectives at the initial phase of the research, which I did.

Snowball sampling – in combination with purposive sampling – was applied in both case studies. In the first case study, a journalist was purposively contacted, and this provided the basis for identifying and contacting other key informants using snowball sampling (cf. Russell Bernard, 2006). This combined technique enabled me to conduct in-depth interviews with key informants representing the most important stakeholder groups involved in the case study. During the second case study also, snowball sampling was used, as I initially did not have a network of informants in Mozambique. One of the last questions in every interview was: Who must I definitely contact regarding this topic?

2.3 Data analysis techniques

Throughout the study, multiple analytical techniques were used to analyse the primary and secondary data collected. In the empirical chapters, different data analysis techniques are combined. These techniques do not exclude one another but were applied in ways that make them mutually reinforcing.

There exist different levels of data analysis: (1) the analysis of data resulting from specific data collection techniques, (2) the integral analysis of the case study as a whole and (3) the type of analyses that allow for comparison across multiple case studies. The first refers to analysing the observations, interviews and questionnaires, and analysing secondary data. The second form of analysis refers to combining them to construct the case study and explain the phenomenon under study. In this thesis, the third refers to analysing the patterns, similarities and differences between the first and the second case study in line with the sequential case-study approach.

2.3.1 Data analysis at the level of individual data collection techniques

Below, the techniques that were used to analyse observations, interviews and questionnaires and secondary data will be clarified.

Analysing observations

The documented participatory and non-participatory observations were analysed in multiple ways and for multiple purposes. In the first case study, observations were used mainly to describe the study area and events in which I participated. During the second case study, participatory observations took place over a longer period of time, thus enabling me to describe and analyse the course of the policy process and stakeholder perceptions, but also the evolving dynamics between (groups of) stakeholders chronologically (cf. Patton, 1990 p. 377). The participatory observations during the second stage of the case study in Mozambique provided the basis for critical reflection among the researcher and his colleagues with regard to the researcher's roles throughout different phases in the policy process (Chapter 7) and the interactions between research and different groups of stakeholders in policy processes (Chapter 8).

During the second case study, GPS software by Garmin MapSource® and the web-based mapping service of Google Earth™ were used to structure and analyse observations with regard to the geographic spread of biofuel developments in Mozambique. The maps in Chapter 4 were made using Microsoft PowerPoint® software. As Figure 2.1 shows, GPS was also used to analyse the location of farmers' homesteads and agricultural fields, to provide insights into biophysical variation in the study area and to measure farmers' field size (Chapter 5). Photos were used to recall and analyse observations made in the field, such as the composition of a farmer's homestead.

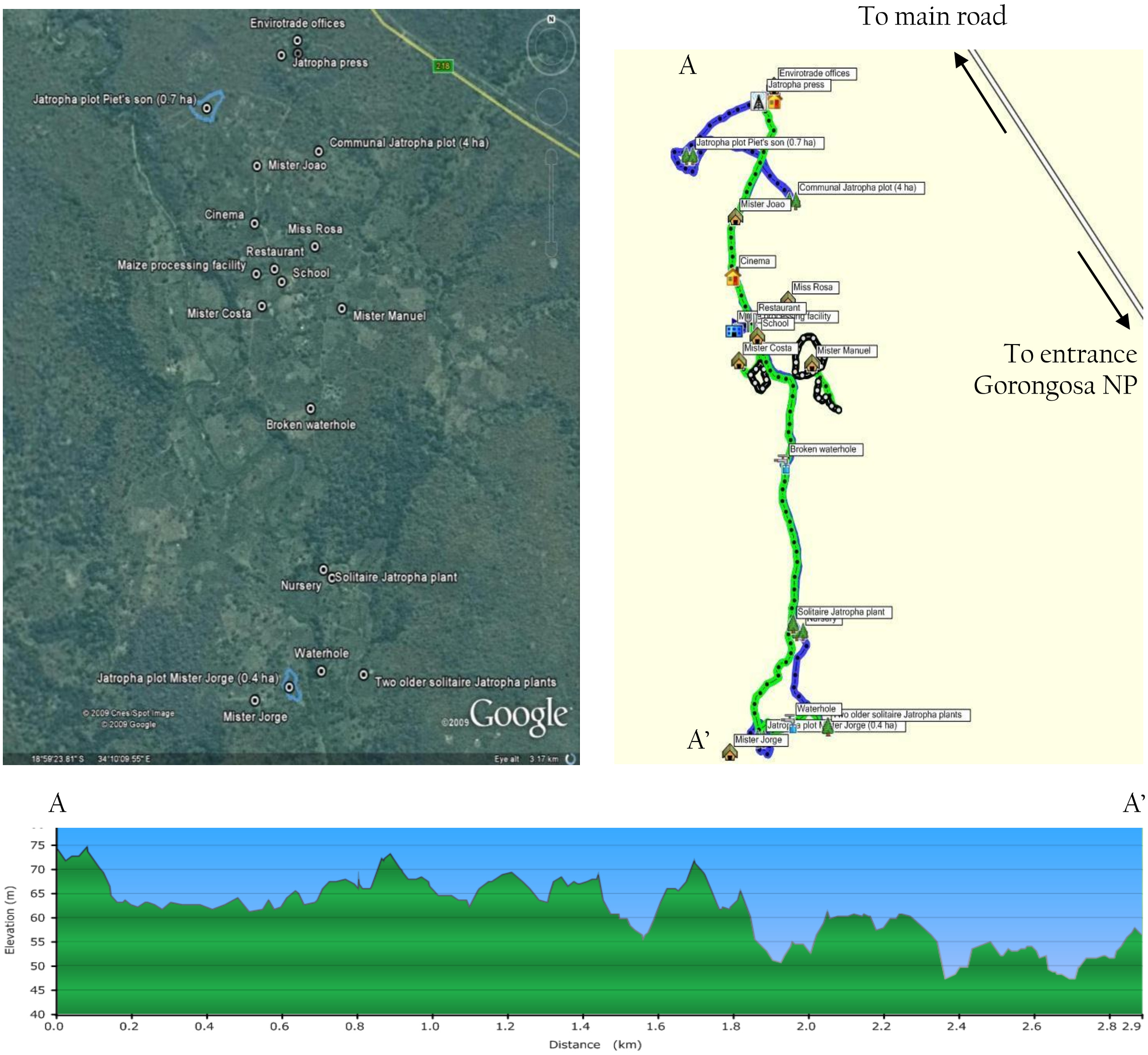

Fig. 2.1. Example of the use of GPS in Google Earth™ and Garmin MapSource® software.

Analysing interviews and questionnaires

In the first case study, interviews were analysed using the 'grounded theory approach' (cf. Glaser and Strauss, 1967). Grounded theory enabled me to identify analytical categories or drivers that influence the role of research in policy processes in competing claims contexts. These drivers originated from the data through an "iterative process" by which the researcher becomes "more grounded in the data" throughout the case study (Russell Bernard, 2006 p.

492). This analytical approach is in line with the embedded and action-oriented research approach of this thesis (see Section 1.5) that enables the researcher to adapt the research approach and methods (including the interview questions and analytical focus) as the study unfolds. In the first case study, exemplar quotes from the respondents are used to illustrate the key findings and conclusions from the study.

In the second case study, formal interviews were mainly conducted during the first stage and provided input for Chapters 4, 5 and 6. As little written information on biofuels in Mozambique was available at the start of the research, the interviews with policymakers and representatives from private sector and civil society organisations provided valuable empirical data on biofuel developments in Mozambique, necessary to identify and map the spread of projects throughout the country. The interview topic list was used as a "descriptive analytical framework" to structure and group data from the interviews, although the interview topics could change (Patton, 1990 p. 276). This enabled me to identify patterns in the way government, civil society and private sector stakeholders conceptualised 'biofuel sustainability' and where such conceptions overlapped or differed between stakeholders. Furthermore, the interviews led to tangible information with regard to the location of biofuel projects in the country, their status and sustainability, but also with regard to the direction in which government policy was evolving. During stage 2 of the second case study (Chapter 7 and 8), data were mainly gathered through participatory observations as a member of the Technical Secretariat and less by conducting formal interviews.

The questionnaires used in the second case study (Chapter 5) resulted in both quantitative and qualitative data. The quantitative data were analysed using descriptive statistical analysis, which describes the main features of raw quantitative data (Marshall and Jonker, 2010). In Chapter 5, they were used to analyse land requirements to achieve food self-sufficiency for different types of households and to developed scenarios for community-based biofuel production and use. For all calculations, Microsoft Excel® software was used. The qualitative data resulting from the questionnaires were analysed using matrices that provided insights into, for example, the main expenditures, the types of food and cash crops grown and ownership of livestock for different categories of farm households.

Analysing secondary data

Secondary data were analysed in both cases using different techniques. The vast majority of secondary data were organised using the computer, and clustered according to their origin (e.g. policy documents or newspaper articles), topic or phase in the policy process. For example, the around 130 newspaper articles on the first case study were ordered chronologically, providing the basis for reconstructing the policy process. The same was done for policy documents and minutes of (policy) meetings. I used basic tools in Microsoft Word® to search the document for keywords such as 'research' or 'science'. Exemplar quotes from the policy documents, newspaper articles and other media reports were used to illustrate the role of research in the case.

For the second case study, secondary data were organised and analysed in a way that was similar to the technique used in the first case study; order the data chronologically, per topic or per stakeholder group. Additionally, descriptive statistical analysis was used to analyse quantitative secondary data provided in existing research, biofuel investment proposals and agro-ecological zoning conducted by the Mozambican government (Chapter 4). For all calculations, Microsoft Excel® software was used.

2.3.2 Data analysis at the level of the case study

There exist many different ways of analysing an individual case study, as much depends on whether the case is a person, a groups of people or – as in this thesis – a policy process. Authors such as Yin (2009) and de Vaus (2001) provide several tools for analysing case studies, of which the ones used in this thesis are elaborated below.

Timeline analysis and critical event analysis

For both case studies, case descriptions using timeline analysis were developed (Yin, 2009). The timelines include critical events such as policy decisions, the publication of reports or articles, the introduction of new laws and regulation, the establishment of a platform or meetings. The timelines and critical events analysis were based on data from observations, interviews and secondary data such as policy documents, minutes of (policy) meetings and newspaper clippings. For the first case study in particular, timeline analysis contributed significantly to reconstructing the policy process, to identifying critical events and analysing the role of research during those events. In the second case study, timeline analysis was used to identify different episodes and phases in the research and policy processes, providing the basis for analysing researchers' roles during different phases in the process (Chapter 7) and to study dynamics between research and different groups of stakeholders during the second case study (Chapter 8).

Explanation building and interdisciplinary data analysis

The objective of explanation building is: "[T]o analyse the case study data by building an explanation about the case" (Yin, 2009 p. 141). In the first case study, this process of explanation building can be seen as a "hypothesis-generating process," as the conclusions of the first case study generated the drivers that were to be studied in-depth during the second case study (Yin, 2009 p. 141). During the second case study, interdisciplinary analysis of empirical data was used to build explanations about biofuel developments in Mozambique and the direction in which the sector was developing. Interdisciplinary analysis explicitly forms the theoretical and analytical framework in chapters 4 and 5 of this thesis. In Chapter 4, the geographic spread of biofuel developments in Mozambique is analysed using insights from investment theory and social-economic development theory, but also by analysing political developments and legal frameworks such as trade agreements, laws, regulation, and incentive structures for investors. In Chapter 5, the potential for community-based biofuel production, and its local marketing and use, is analysed from different disciplinary perspectives, using basic elements of farming systems theory, innovation systems theory and rural social-economic development theory, in combination with the analysis of legal and political developments over a certain period of time.

Scale dynamics analysis
In this thesis, scale dynamics analysis refers to the process of describing and explaining interactions between different scales and levels (Cash et al., 2006). Scale dynamics analysis is based on interviews and secondary data, and enables the researcher to analyse how developments at – for example – the global level influence developments at the local level and *vice versa* (see Figure 1.1 in Section 1.2.2). In the context of this thesis, it – amongst others – provides insights into the different perceptions of stakeholders (e.g. on biofuel sustainability) representing various policy or administrative levels. It also reveals more institutional factors such as the formal and informal agreements at the interface of different policy levels that influence the space within which policy solutions can be explored. Scale dynamics analysis provides the analytical framework for Chapter 6 of the thesis.

Reflexive analysis on the role of research and the researcher
In this thesis, the reflexive analysis of the role of researcher(s) in the two case studies was conducted in two different ways. With regard to the first case study, the reflection is based on a collaboration with two researchers who undertook action research in De Noordwaard. This reflection has been published as a book chapter (Pleijte et al., 2011) and has not been included in this thesis.

In the second case, the reflexive analysis was based on regular reflections together with the other member of the Technical Secretariat in Mozambique. According to Pleijte et al. (2011 p. 242-243): "A first level of reflexivity can be organised by a second action researcher who at least includes a similar theoretical framework." As the Technical Secretariat consisted of two members,[14] this stimulated active and regular reflection upon the roles we played in the policy process, both during the process and *ex-post*. We did this during informal meetings, and by writing notes and memos to each other. The analysis of these reflections resulted in Chapter 7, which studies the different roles of researchers in policy processes in competing claims contexts, and also in Chapter 8 that elaborates on interactions between research and different groups of stakeholders in policy processes.

2.3.3 Analysis at the level of multiple case studies

In this thesis, the two case studies "follow one another" (de Vaus, 2001 p. 227). This sequential case-study approach also requires a sequential way of building explanations across the two cases. In the thesis, this analytical "explanation building process" (Yin, 2009 p. 143) is organised as follows. The first case study is used to identify sensitising issues and key drivers that influence the role of research in policy processes. These issues and key drivers form the basis for the second case, where they are studied in more detail.

[14] The other member of the Technical Secretariat was not working as researcher, but as a technical assistant for a development agency.

Although the key objective is that the two cases elaborate upon each other, I also compare them and analyse the similarities and differences between them, primarily to analyse how the more contextual factors influence the role of research in policy processes in competing claims contexts. Lastly, I would like to clarify that key drivers that did not emerge from the first case study, but that did play a crucial role during the second case study, are (of course) included in the analysis and synthesis of this thesis.

2.4 Quality control

According to Yin (2009 p. 40), there exist four tests through which the quality of empirical social research, and thus case study research, can be ensured: "construct validity, internal validity, external validity and reliability." Validity means "truth" (Silverman, 2006 p. 47), whereas reliability refers to the: "[Q]uality of a measurement procedure that provides repeatability and accuracy" (Kumar, 2005 p. 6). Below, I address how the four tests have been applied to control the quality of the case studies used in this thesis.

2.4.1 Construct validity

Ensuring construct validity refers to measures that: "[P]roduce a more accurate, comprehensive and objective representation of the object of study" (Silverman, 2006 p. 291). There exist three tactics to enhance construct validity in case study research. Firstly, researchers should triangulate when describing a phenomenon or process. According to Patton (2002 p. 187), triangulation implies using (1) "a variety of data sources," (2) "several different researchers," (3) "multiple perspectives to interpret [...] data," and (4) "multiple methods." All forms of triangulation have been applied in this thesis, for example by using multiple methods of data collection and data analysis, verifying respondents' stories with data transcribed in minutes of policy meetings, discussing and validating observations with students and other researchers, and through the interdisciplinary analysis of the case studies. Secondly, a chain of evidence has been established. This means that data can be traced back to their original source. Recordings of interviews, notes (including field notes) and memos are available. Moreover, all secondary data were filed electronically or manually, providing a detailed database for the two case studies described in this thesis. A third method to ensure construct validity is to validate empirical data by key informants. We attempted to do this for the first case study (Chapter 3), but one of the key informant with a good overview of the case (and who agreed more than once to review the empirical section of the draft research article) never returned the manuscript. Chapters 4, 5 and 6 are based on research reports (see: Bos et al., 2010; Schut et al., 2010a) that were validated and coedited by people with whom I worked. In particular, the analysis of investment data in Chapter 4 was reviewed by the Mozambican Ministry of Agriculture. Furthermore, because of some of its technical content, experts were asked to review parts of Chapter 5, including an oil-crop specialist from Wageningen University and Research Centre, two farming systems experts, and two experts with experience in community-based biofuel projects in Mozambique and other developing countries. Chapters 7 and 8 are based on systematic reflections between myself and the other member of the Technical Secretariat. These reflections in the form of meetings, notes and personal memos form the basis for these chapters.

2.4.2 Internal validity

The internal validity of research refers to the plausibility that process *x* leads to changes in process *y* and is mainly a concern when the case study is explanatory (Yin, 2009 p. 41). In experimental research, this implies ruling out "the influence of variables other than the key causal variables" (de Vaus, 2001 p. 233). However, in case study research that investigates real-life processes or events, it is unfeasible and even undesirable to isolate participants from "outside influences" (Patton, 1990 p. 114). On the contrary, case studies are used to describe an event, phenomenon or process holistically and in its broader context. Furthermore, it is essential to understand the context, as the meaning of processes or phenomena is often embedded and constructed in that context. Consequently, safeguarding the internal validity of case study research requires including contextual and historical textual data that influence the process under study as this leads to a "fuller and richer understanding" of the case, and moreover contributes to a better understanding of how a changing context in which the research is embedded influences the relation between *x* and *y* (de Vaus, 2001 p. 236).

To enhance the internal validity of the case studies in this thesis, I adopted a holistic approach that pays attention to the historical evolution of policy processes and the changing (policy) contexts of the two case studies. Chapters 3, 7 and 8 describe events, phases and episodes of the research and policy processes through time, and in so doing address the temporal dynamics of the role of research in policy processes. Additionally, I sought to identify matching or coinciding findings or theories identified by other researchers; so-called "pattern matching" (de Vaus, 2001 p. 253). "If patterns coincide, the results can help a case study to strengthen its *internal validity*" (Yin, 2009 p. 136 italics as in original). Lastly, we selected the majority of our respondents purposefully and through snowball sampling. This implies that there may be some selection bias in the way we identified our respondents. However, by including respondents from different stakeholder groups and by triangulating and cross-checking interview data with secondary data, I believe that this did not pose a major threat to the internal validity of the study.

2.4.3 External validity

The external validity of research addresses the question whether the research findings provide a basis for generalisation beyond the case (de Vaus, 2001 p. 237). Yin (2009 p. 43) adds that the external validity of case study research relies not so much on "statistical generalization" as on "analytical generalization," where the researcher strives to: "[G]eneralize a particular set of results to some broader theory [...]." Although the sequential case-study approach applied in this thesis is not aimed at demonstrating the logic of replication, the analytically generalised findings from the first case study provided the basis for in-depth analysis in the second case study. Furthermore, I strove to test analytical or theoretical replication by comparing the research findings with findings from similar case studies conducted by other researchers, and I used the case study findings to further develop scientific theories and concepts.

2.4.4 Reliability

Reliability refers to the question of whether, if a case study were to be conducted "all over again," the researcher would "arrive at the same findings and conclusions" (Yin, 2009 p. 45). Particularly the first case study (Chapter 3) – a reconstruction of a policy process based on secondary data and interviews with key stakeholders – is likely to arrive at similar conclusions. The timeline and critical events are based on the analysis of secondary data, complemented by insights gathered from recorded interviews.

The second case study was much more dynamic, unpredictable and sensitive to 'outside disturbance' that continuously changed the context in which biofuel developments in Mozambique and the study itself were embedded. Nonetheless, Chapters 4 and 5 in particular are partly based on quantitative data that leave little space for multiple interpretations. For example, the geographical spread of biofuel projects in Mozambique at a particular point in time is rather fixed, and, similarly, the quantitative analysis of biofuel investment data is rather straightforward. The second stage of the second case study would be difficult to conduct in a similar fashion. Because of my embedded position in the Technical Secretariat and in the policy process, the role of the research and my role as researcher in that policy process were much more the result of interpersonal relations with different (groups of) stakeholders. Although I critically reflect on the methodological choices and trade-offs that were made, and the roles I fulfilled as researcher during this stage, it is unlikely that, if this part of the research were done all over again by another researcher, a similar course in the policy debate on biofuel sustainability in Mozambique would result. Moreover, it seems practically unfeasible, as it would imply redoing the policy process. However, this does not mean that doing the same type of research would not result in similar analytical findings and conclusions with regard to roles of researchers in policy processes in competing claims contexts (Chapter 7) and dynamics at the interface of research and different groups of stakeholders in policy processes (Chapter 8).

2.5 Design and methodological challenges

In this section, the methodological challenges encountered during the study are described. It forms part of my approach to be transparent and reflexive about the trade-offs that were made, and the strengths and weaknesses of the research approach and research methods, as these influence the role of research in policy processes, which is central in this thesis.

2.5.1 Sequential case-study approach

The general idea behind the use of the sequential case-study approach in this thesis is that the first case study is used to identify drivers that influence the role of research in policy processes in competing claims contexts, and subsequently study those drivers in more detail during the second case study. The fact that these drivers were identified in the Dutch policy context and elaborated in the Mozambican policy context could be criticised as both countries have different policymaking cultures, and different bureaucratic and administrative systems.

This was dealt with by means of analytical generalisation, meaning that the drivers that emerged from the first case study were formulated in a general analytical way that made them applicable and researchable in the second case study.

2.5.2 Data collection techniques

Every data collection technique has its advantages and disadvantages. Some of these have been summarised by Yin (2009 p. 102) and Kumar (2005 p. 130-131). In retrospect, I conclude that the in-depth interviews with key informants in the first case study took a very long time. Although I indicated that an interview would take around one and a half hours, the average interview took around two hours. From non-verbal communication (e.g. distracted, checking watch), I concluded that respondents were losing their attention and focus. Furthermore, one could argue that all interviews from the first case study should have been transcribed. As indicated, I decided not to because of time constraints and because detailed note-taking served the purpose of reconstructing the policy process.

For the second case study, an extensive interview guide in the form of a questionnaire was developed. However, it turned out that the questionnaire contained too many questions and took too long. In practice, investors and policymakers had limited time for the interview; this forced me to be very selective in the questions that I could actually pose. Also, the questionnaires used for Chapter 5 (Appendices D and E) turned out to be too long, and eventually only parts were used in the analysis.

2.5.3 Sampling issues

Chapter 5 describes the potential for community-based biofuel production, and local marketing and use of biofuels. This study was originally initiated as a consultancy assignment funded by the *Deutsche Gesellschaft für Technische Zusammenarbeit* (GTZ) in collaboration with the Mozambican Ministry of Energy. I was part of the consultancy team, participated in the four-day mission to the community and contributed to writing the report (see: Bos et al., 2010). During the mission, the team was supported by a senior extensionist working for a project in the community who assisted us in identifying and approaching farmers, and translating interview questions and answers. On the basis of the mission, I continued doing fieldwork in the community as the case contained unique data on community-based biofuel production and use. I decided to follow the four farm households that formed part of the consultancy, and the analysis of the three most contrasting households were used to develop Chapter 5. I acknowledge that the analysis of smallholder farming systems and the potential role of biofuel-crops in those farming systems could itself provide enough research for a PhD. Furthermore, the sample is small and potentially biased by the involvement of the extensionist who assisted in selecting the case study farm households. Nonetheless, the uniqueness of the material and the general lack of data on community-based biofuel projects in Mozambique made me decide to publish the study in a scientific journal.

2.5.4 Analytical issues

The analysis of interviews during both the first and second case study could have been done in a more structured manner. Using the grounded-theory approach enabled me to adapt the interview questions and analytical focus as the case studies unfolded, but also prevented me from having a consistent interview guide that would result in data that could be coded, analysed and compared across groups of stakeholders or research themes.

The analysis of researchers' roles (Chapter 7) and dynamics at the research–policy interface (Chapter 8) during the second case study are mainly based on reflexive analysis between me and the other member of the Technical Secretariat, and during a later stage between me and my supervisors at the university. According to Pleijte et al. (2011 p. 242), it can be considered a "mission impossible" for an embedded, action-oriented researcher to be fully engaged with stakeholders and the policy process, and be reflexive at the same time. They propose that the involvement of a "second action researcher" or a colleague with a "similar theoretical framework" could stimulate a "first level of reflexivity" (Pleijte et al., 2011 p. 243). By reflecting on the process with the other member of the Technical Secretariat, I sought to do so.

Nevertheless, it would have been interesting if such reflections had been carried out together with the different groups of stakeholders with whom I worked. The main reason for not doing this was that it could have consequences for my embedded position in the Technical Secretariat and in the policy process, as policymakers and other stakeholders perceived me as someone who was supporting the policy process, rather than analysing and studying it.

2.5.5 Publication of sensitive data

In both case studies, I was confronted with data sensitivity issues. During the first case study, the transcribed interviews were sent to the respondents to provide them with the opportunity to give feedback. Respondents were sometimes shocked or unhappy when they read their statements on paper, and they asked me not to use them in publications. From an ethical point of view I respected these requests, despite the fact that these statements or quotes sometimes contained useful information for the study.

During the second case study, the sensitivity concerned access to, and publication of, investment data that biofuel investors had provided to the Mozambican government. Although I could access and analyse the data, I had to negotiate the extent to which, and the form in which, it could be published. Eventually, I aggregated the data to the extent that they did not contain sensitive information about individual investors, but still provide an interesting overview about the biofuel developments as such. Additionally, in publications I only named those projects that had been formally approved by the Mozambican government.

As I collaborated closely with the Mozambican Ministry of Agriculture and the inter-ministerial working group on biofuel sustainability, I was careful when publishing sensitive data or making critical remarks about government policy. Although I could and did constructively criticise government policy, I was always aware that maintaining a good relationship with governmental and other stakeholders in the policy process provided the basis for the continuation of the embedded position of the research in the policy process, and in so doing, the ability to study the role of research in policy processes from within and work in an action-oriented way. However, this also created challenges, which are addressed in Chapters 7 and 8.

2.5.6 Cultural bias and language

Especially at the beginning of the second case study in Mozambique, cultural bias and language formed a challenge. Although a lot of the initial interviews were conducted in English, I initially could not grasp what was being discussed in meetings that were held in Portuguese. After a few months of intensive language training, my Portuguese gradually improved, and made it possible for me to conduct interviews, and to participate in and observe meetings in Portuguese.

Being a foreigner working in a developing country provided advantages as well as disadvantages. The advantage was not being restricted by cultural and political hierarchical structures. The biggest disadvantage was that certain stakeholder groups questioned the researcher's mandate and legitimacy of being so closely involved in the policy process, when they themselves were only consulted on the outcome at a late stage.

2.5.7 Reflections on the role of the researcher

For me, action-oriented research is principally an approach that stimulates the researcher to continuously adapt the operational research questions, research approach, data collection techniques and analytical strategy depending on the changing context in which the research is embedded. Action-oriented research has often been criticised for being less objective, less systematic and less generalisable. I believe that such notions of action-oriented research are outdated, as action-oriented research enables the researcher: "[T]o become embedded and subsequently better understand the context in which research can effectively contribute to exploring sustainable solutions" (Pleijte et al., 2011 p. 221).

In the first case study, the action-oriented elements in the research were limited to changing the research strategy when the Ministry did not allow me to participate in the policy process or to collaborate with the consultancy company. As a result, the nature of the case study – reconstructing a policy process based on the analysis of secondary data and interviews with key stakeholders – focused more on studying the role of other action-oriented researchers in practice, rather than playing a very action-oriented role myself. The embedded and action-oriented research approach became much more prominent during the second case study. During the first stage of the work in Mozambique, I continuously adapted the research questions and research approach in order to produce and communicate policy-relevant information, and in doing so increase the relevance of the research for the stakeholders involved. The nature of the (mainly quantitative) data enabled me to remain rather neutral in the process. This changed during the second stage of the case study in Mozambique when I became actively involved in the development of the policy framework for biofuel sustainability in Mozambique. During this period, I became part of the Technical Secretariat, which positioned me at the centre of the policy process. According to Kibwika (2006 p. 50), when a researcher is "inside the situation", s/he will "inevitably influence what is happening." This role of researchers is still seen as rather controversial and as "a 'threat' to the validity of the research" (Trondsen and Sandaunet, 2009 p. 18). The boundary between research and policy was sometimes blurred. As part of my position in the Technical Secretariat I engaged in political lobbying, issue advocacy and fundraising for stakeholder workshops; activities that some would not categorise as part of doing scientific research. However, undertaking these activities as part of my embedded position also provided insight into how the contribution of research to the policy debate on biofuel sustainability could be enhanced, and thus contributed considerably to addressing the research questions in this thesis. Lastly, the highly sensitive nature of competing claims contexts did not always allow for reflexive monitoring and evaluation of the research process and the role of the researcher together with stakeholders.

2.6 Notes from the author

The empirical chapters (Chapters 3, 4, 5, 6, 7 and 8) in this thesis have been written in the form of research articles. In order not to create inconsistencies, these research articles have been included in their original form in this thesis. The only changes made relate to: (1) words that refer to the 'article' or 'paper' have been changed into 'chapter' or 'section', (2) consistent numbering of chapters, sections subsections, figures, tables and photos throughout the thesis, (3) consistent numbering of footnotes, (4) minor editorial changes due to errors discovered after the research articles were published, (5) consistent hyphening such as 'policymaker' instead of 'policy-maker,' and (6) consistent use of quotation marks and consistent layout of quotes, references and bibliography throughout the thesis.

This thesis has been written using English U.K. spelling. English U.S. spelling is used on some occasions when quoting or paraphrasing the work of colleagues, or referring to official names of organisations. In this thesis, double quotation marks ("…") are used to indicate quoting from the work of colleagues or from policy documents, minutes of meetings, etcetera. If text has been added, left out or modified from the original quote this is put between square brackets […]. Single quotation marks ('…') are used to emphasise a specific word or concept. *Italics* are used for individual letters (*x*, *y*, *z*) and when words or names of organisations are in a language other than English. Latin abbreviations in citations (such as et al. and cf.) have not been italicised.

CHAPTER 3

Room for the River – Room for Research?

The case of depoldering De Noordwaard, the Netherlands

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Published as:
Schut, M., C. Leeuwis and A. van Paassen (2010). Room for the River – Room for Research? The case of depoldering De Noordwaard, the Netherlands. Science and Public Policy 37(8): 611-627.

KEYWORDS

Research

Policymaking

Negotiation

Competing claims

Space for change

Room for the river

ABSTRACT

This chapter explores the role of research in the context of the Dutch spatial planning procedure 'Room for the River'. We start from the idea that research is strategically used to create space in negotiation processes, where stakeholders often have competing claims on natural resources. Multiple data collection techniques allowed us to reconstruct and understand critical events that led to the decision to depolder De Noordwaard. Within each critical event we describe and analyse how research and other resources were mobilised by policymakers and other stakeholders to open up or close down negotiation space. By doing so, this chapter contributes to insight into the factors that influence the effective mobilisation and contribution of research towards exploring sustainable solutions to complex environmental problems.

3.1 Introduction

One of the largest challenges of our time is to find sustainable solutions to increasingly complex environmental problems. Complexity has two dimensions: firstly, the high level of uncertainty and ambiguity surrounding the nature of the problems; and secondly, the increasing number of stakeholders involved in exploring sustainable solutions. Complexity is not by definition a negative concept. The involvement of the general public, (agricultural) entrepreneurs, interest groups and other stakeholders could improve the quality of decision making by opening up the decision-making process towards seeking legitimate, feasible and context specific solutions (Huitema et al., 2009). Nevertheless, natural resource management (NRM) is often subject to adversarial or distributive negotiations and conflict. It is difficult to find one solution that fits all stakeholders' objectives, and land and other natural resources have characteristics (limited quantity, extractability, culturally defined meaning and unevenly distributed) that by their nature lead to conflict (Cloke and Park, 1985 p. 60). This often gives rise to people having competing claims on natural resources and their management.

Most research strives to provide policymakers and other stakeholders with an objective body of knowledge to weigh up, justify and evaluate their decisions (Ozawa, 1996 p. 221; Turnhout et al., 2007). However, recent studies claim that research is rarely used in decentralized planning practice (cf. Opdam, 2006 p. 153). This has led us to rethink the concept of research effectiveness. Instead of fixed notions of research objectivity, credibility, legitimacy and relevance that can be attributed to the quality of the research itself, effectiveness becomes a social matter, where more subtle variables determine the impact of research in practice (Turnhout, 2009 p. 405). In line with Giller et al. (2008 p. 6), we believe that research in the context of competing claims may require new roles and responsibilities for research and researchers towards integrative negotiations and widening the space within which solutions can be sought.

The objective of this chapter is to contribute to insight into the dynamics that influence the effective mobilisation and contribution of research to negotiation processes in the context of competing claims. In doing so, we hope to identify factors that determine how and to what extent research opens up or closes down space for stakeholders to explore sustainable solutions to complex environmental problems.

Empirical data for this study were gathered by analysing the Dutch spatial planning procedure 'Room for the River'. Room for the River was initiated to explore and implement spatial security measures to accommodate water and increase the spatial quality of landscape, nature and culture. Our case study focused on the decision-making process that led to the depoldering of De Noordwaard, an agricultural area in the south-western part of the Netherlands, which is the most substantial of the Room for the River projects. Depoldering can best be described as returning a piece of reclaimed land (a polder) to the sea or river.

3.2 Research, negotiation and space for change

In recent years, interest in the policy-informing role of research and research organisations has grown considerably (Boaz et al., 2009 p. 255; Sterk et al., 2009 p. 434). Although we have good reasons to assume that research does contribute to sustainable decision making, experience shows that research is often not used in practice, or that it arrives in the public policy arena in fundamentally different ways than intended (Klosterman et al., 2009 p. 13, 19). It has increasingly become clear that societal actors should not be seen as passive and obedient adopters of science-based policy solutions (Beck, 1992; Wynne, 1996; Giller et al., 2008). Moreover, more research does not solve multiple interpretation of problems and possible solutions, and it cannot prevent research and its results from being ambiguous and contested (van Bueren et al., 2003 p. 194). Other concepts used in this study are explained in the following two sections.

3.2.1 Research and negotiation in the context of competing claims

We start from the idea that research is strategically used by stakeholders to influence negotiation processes on spatial planning and NRM; we call this the 'contexts of competing claims'. According to Funtowicz et al. (1999 p. 14): "[T]he environment is a site of conflict between competing perspectives, values and interests, and the different groups and communities that represent them." Van Eeten (1999 p. 185) and Koppenjan and Klijn (2004 p. 5-6) would describe such conflicts as "wicked problems", generally characterized by: (1) the involvement of many actors; (2) disagreement about the nature of the problem and the desired solutions; (3) highly complex decision making that is unsuitable for standard operation procedures and organisational arrangements; and (4) the blurring boundaries between research and politics. Many have described the need to facilitate harmonious communication between stakeholders so that they can develop new – at least partly shared – problem definitions and cognitions on the basis of creative, participatory social learning processes (Habermas, 1981; Cloke and Park, 1985; Röling, 1994). However, in practice these participatory decision-making processes often emerge as "arenas of struggle" and "dialogues of the deaf" with stakeholders acting strategically, rather than communicatively (van Eeten, 1999; Leeuwis, 2000; van Buuren and Edelenbos, 2004). "The very spread and adoption by powerful actors of the language and discourse of participation and inclusion confuses boundaries of who has the authority and who does not, who should be 'inside' and who is on the 'outside' of decision making and policy making arenas" (Gaventa, 2006 p. 23).

As a possible solution, Giller et al. (2008) propose that, in the context of competing claims, negotiation should be at the heart of research approaches and conceptual frameworks, as it has the potential to enhance the constructive contribution of research to societal negotiation processes. The development of a negotiation framework to effectively mobilise and use research is also increasingly recognized as an essential component to promote sustainable development.

3.2.2 Research and space for change

According to Leeuwis and Aarts (2011), space for change is a valuable concept for the analysis of the complex problems that are likely to be encountered in the context of competing claims. Negotiation processes are composed of stakeholders who are capable of strategizing and finding space for change in situations by manipulating resources and constraints (Villarreal, 1992). Creating space for change implies a degree of consent, a degree of negotiation and a degree of power – not necessarily power stored in a given economic or political position (cf. Gaventa, 2006), but the possibility of control, of privilege, of a degree of authority and ability, be it in the spotlight or backstage, for fleeting moments or for long periods (Villarreal, 1992). This change is not realized in the arbitrary, isolated and formalized space of a project, but arises from multiple interactions in and between networks, whereby phenomena like coincidence and self-organisation play an important role (Aarts and Leeuwis, 2010). In order to understand how research may create negotiation space for stakeholders, it is necessary to study the interactions and discourses in which research is packaged and mobilised (cf. Hajer, 1995).

For this study, space for change is conceptualized as the momentum or critical point at which the interaction and configuration between social-cultural, biophysical, economic, political and legal spaces or perspectives provide space for innovation, breakthroughs or decision making in negotiation processes.

3.3 Research approach

In order to understand the role and use of research, it is crucial to have insight into the specific characteristics and dynamics of the negotiation processes in which research is embedded and used (Turnhout et al., 2007 p. 216). A first step towards this is therefore the development of an empirically based understanding of how research performs in practice. This was one of the reasons for adopting a case-study approach that permitted us profound insight into complex processes, thereby providing holistic and meaningful empirical data of real-life events (Yin, 2003). The Room for the River programme complied with our main case-study selection criteria. The project is characterized by high complexity regarding the nature of the problem and the wide variety of stakeholders involved. We decided to focus on De Noordwaard as this case provides a high level of competing claims, is well-documented, and is the most substantial measure within the Room for the River programme.

Adopting a constructivist approach allowed us to step outside the constraining dualism of right and wrong, subjectivity and objectivity, and to focus on how these interpretations arose among stakeholders, and what sustained them (Jasanoff, 1996 p. 275). It helped to prevent us from taking a normative position, and provided access to different (sometimes competing) stakeholders – all of which was necessary to develop a holistic understanding of the case.

Data for this study were gathered between February and November of 2008. In a triangular fashion we have used multiple data collection techniques to describe the case. Initially, we held four exploratory interviews with informants, who had a good historical overview of the case, without having a real stake in the problem. Subsequently, we held and recorded 12 in-depth interviews with key informants representing the most important stakeholder groups. In addition we paid several visits to the area and conducted informal interviews during these visits. We analysed multiple sources of secondary data, including over 130 newspaper clippings, numerous policy documents, technical and scientific reports and articles, and minutes of political and other meetings that enabled us to understand the case from multiple perspectives. It is important to mention that we would have liked to collect more data on negotiation by participating in the planning process. Unfortunately the ministry was not keen on granting us access to the negotiation process, principally because of the sensitivity of the process as well as trust issues between the government and the stakeholders in the area.

Interviews with our key informants combined with secondary data analysis allowed us to reconstruct and interpret the process. We used timeline analysis to identify critical events in the process, analysed the role of research during these critical events and whether, how, and for whom research opened up or closed down space in the negotiations process.

3.4 Setting the scene: Dutch water management

Whoever writes about Dutch water management must mention the 1953 floods in the southwest of the Netherlands, as they have significantly influenced Dutch water management since then. During the night of 31 January – 1 February 1953 a spring tide and a north-western storm caused flooding that killed more than 1,800 people and led to the evacuation of 72,000 people and huge economic damage (Ellemers, 1956 p. 7).

The Dutch are known worldwide for their battle with water, but the high water periods of 1993 and 1995 showed the inadequacy of dealing with peak discharges in the main rivers Rhine and Meuse. In January 1995, around 250,000 people and much livestock had to be evacuated from the Meuse floodplain as the water levels rose in areas where many homes had been built on or near the water meadows in the floodplain (Wiering and Driessen, 2001 p. 286, 288). Although the levees along the rivers Rhine, Waal and IJssel held, the total economic damage was estimated at US$1 billion (van Stokkom et al., 2005 p. 78). Subsequently, the Dutch government was compelled to act and made a radical break, moving from vertical (levees) to horizontal (spatial) security provisions (Warner, 2008 p. 173). Shortly after the high water of 1995, the policy guideline Room for the River was established (De Boer, 2003 p. 33), and in 1997 the concept of Room for the River was officially introduced in the Fourth National Policy Document on Water Management by the Ministry of Transport, Public Works and Water Management (1997). In 2000, the Commission Water Policy for the 21st century (Commission WB21) concluded a study recommending that besides traditional measures such as strengthening levees, the government should explore spatial measures that could accommodate water, and at the same time increase the spatial quality of landscape, nature and culture (Ministry of Transport Public Works and Water Management, 2000).

In February 2001 the national government, provinces, municipalities and water boards signed a Starting Agreement WB21 to explore the opportunities for creating 'Room for the Rivers'. In line with the policy document Room for the River, the parties agreed to explore solutions for the short to medium term (5-20 years), but also take into account the longer-term consequences (20-50 years). The country was divided into the upper river region and the lower river region. In this chapter we focus on what happened in the lower river region, although some empirical findings relate to both. Another recommendation by Commission WB21 was the early integration of the general public and entrepreneurs in the planning process to increase awareness for the water problems, and create public support for future interventions (Ministry of Transport Public Works and Water Management, 2000 p. 21-23). To ensure a decentralized approach, the policy process was organised according to a spatial planning procedure, which gives stakeholders legal rights to participate in the design, negotiation and decision-making process. A spatial planning procedure is divided into different phases. During the first phase, the government presents its proposal, accompanied by an Environmental Impact Assessment (EIA), to the Parliament. The second phase provides the public with the right to formally react on both the government's proposals and the EIA, and results in the third phase: the cabinet's standpoint. Subsequently – during the fourth phase – this proposal has to be approved by the Parliament and the Senate to result in a formal government decision.

3.5 Depoldering De Noordwaard

De Noordwaard (*Noord* = North, *waard* = dwelling mound) is an agricultural polder of 2,050 ha located southwest of Werkendam. Polders are low-lying, flat areas reclaimed from the sea or rivers and protected by embankments or levees, very typical in the Dutch landscape. De Noordwaard is wedged between *Brabantse* and *Sliedrechtse* Biesbosch which are divided by the river Merwede, which forms part of the Rhine river delta. In the southwest, the polder borders the National Park de Biesbosch, one of the biggest National Parks in the Netherlands. De Noordwaard accommodates 75 households, of which 26 are farms (van der Meulen, 2007). For centuries De Noordwaard has been subject to floods, diking and poldering projects. The first plans for nature development projects along the river Merwede originated in 1992. In line with the Ecological Main Structure (EU Natura 2000 legislation), part of De Noordwaard (600 ha) was identified as forming a natural corridor between *Sliedrechtse* and *Brabantse* Biesbosch. Six farms were resettled and 600 ha of agricultural land was made available for nature development. This made Brabant Province promise farmers that the rest of De Noordwaard would not be touched in the near future. In the literature we could only ascertain that *De Kievitswaard* would not be claimed for nature for at least 15 years (1998-2013) (RIZA and Bosch Slabbers, 1999, 2000). The nature development project was completed and opened in May 2008.

3.5.1 Critical events leading to the depoldering of De Noordwaard

Interviews with key informants and the analysis of secondary data allowed us to reconstruct the timeline that led to the decision to depolder De Noordwaard. Together with the informants we identified critical events along the timeline. Within each critical event, special attention was paid to the mobilisation and role of research, and how it potentially opened up or closed down space for stakeholders in the negotiation process. Each section concludes with a short analytical reflection on what happened during the phase in question.

Event 1: Establishment of flood risks and discharge norms

After the flood in 1953, a delta commission was established to come up with a set of hydro-technical measures that should prevent the Netherlands from immediate flood threats. One of their measures was the development of a normative protection system, based on flood risk. Initial norms for the river basin area were established at a flood risk of once every 3,000 years; this corresponded with a water discharge capacity of 18,000m^3 sec^{-1} at Lobith, the town where the river Rhine enters the Netherlands.

Lack of support for ongoing strengthening of levees led to the formation of the Becht Commission (1977) and the Boertien Commission (1993). The Becht Commission advised changing the flood-risk norm from once every 3,000 years to once every 1,250 years, corresponding with a water discharge capacity of 16,500m^3 sec^{-1} for the river Rhine at Lobith (Project Organisation Room for the River, 2005 p. 34). In 1993, the Boertien Commission recommended the maintenance of a flood-risk level of once every 1,250 years, but new mathematical methods resulted in a lower corresponding water discharge capacity of 15,000m^3 sec^{-1} for the river Rhine (Project Organisation Room for the River, 2005 p. 34). According to emeritus professor hydraulic engineering Kees d'Angremond of the Technical University Delft, both commissions used incorrect data for calculating flood risk and water discharge capacity. He warned that: "Discussions are often based on incomplete knowledge about historical and physical backgrounds, which can lead to misunderstandings and unwise decisions" (d'Angremond, 2001).

After the high water of 1993 and 1995, the Dutch government concluded that a turnabout in river management was necessary. Although the highest ever measured discharge at Lobith was 12,760m^3 sec^{-1} in 1926 (Roth et al., 2006 p. 25), new predictions on climate change, changing rainfall and river discharges opened up new extreme horror scenarios. The norm for peak discharge returned from 15,000m^3 sec^{-1} to 16,000m^3 sec^{-1}, and scenarios for 18,000, 19,000 and even 20,000m^3 sec^{-1} were now taken seriously (Silva, 2001 p. 4; Roth and Warner, 2007 p. 521). Uncertainty about future discharge peaks led the government to decide that Room for the River's primary objective should be to make the delta flood proof up to a level of 16,000m^3 sec^{-1} in the short to medium term (till 2015) and 18,000m^3 sec^{-1} in the long term (2015-2050). Room for the River comprised the start of a national resilience study to provide more insight into the long-term capacity of the Dutch water system and its ability to discharge 18,000m^3 sec^{-1}. In parallel, a spatial planning procedure was initiated to ensure early participation of the general public in the planning process to increase awareness about the water problems, to create public support, and to provide a platform to share their vision on the proposed measures, and – if possible – co-design alternative solutions (Ministry of Transport Public Works and Water Management, 2000 p. 21-23). The measures in the spatial planning procedure focused on achieving the short- to medium-term discharge objective of 16,000m^3 sec^{-1}.

Reflection: Although the scientific foundations of the discharge norms were questioned by scientists like d'Angremond, Commission WB21 used them to shape the solution space in which Room for the River measures could be explored. The natural disaster and its human and economic consequences had created a sense of urgency and political space to tighten the discharge norms, forming the starting point (and financial space) for the resilience study and the spatial planning procedure; including legal procedures and 'rules of the game' for public participation.

Event 2: Resilience study and 'box of blocks'

In December 2002 the resilience study was published by the Ministry of Transport, Public Works and Water Management. The study put forward 600 potential measures for creating Room for the River in the Netherlands. Three key indicators: sustainable safety (based on 18,000m^3 sec^{-1}), spatial quality and cost-benefit analysis, determined the selection of the 600 measures. The resilience study based its safety objectives on the third climate report of the Intergovernmental Panel on Climate Change (IPCC) and the Royal Netherlands Meteorological Institute's (KNMI) climate scenarios, which also had been used by Commission WB21 (Project Group Resilience Study, 2002 p. 15-17). Spatial objectives were based on the government's Fifth National Policy Document on Spatial Planning Part 3. The ranking system used in the resilience study for each of the key indicators resulted in a classification from top measures (scoring well on all three indicators) to negligible measures (low scores). The resilience study also contained a set of maps that displayed the geographical spread of potential measures.

Another output of the study was a computerized hydraulic model/scenario planning tool called 'box of blocks' (*blokkendoos* in Dutch). Whereas some describe the box of blocks as merely an indicative tool (Pleijte et al., 2005 p. 75), others describe it as an instrument to: "Quickly calculate the hydraulic consequences of a combination of measures" (de Boer quoted in: GeoVisie, 2006 p. 4). Initially, the box of blocks was mainly used by hydraulic engineers. During later phases, after the software was made more user-friendly, it was also used to facilitate the dialogue between policymakers from different regions, demonstrating and visualizing the interdependencies of river delta management at the national level.

It is important to mention that depoldering De Noordwaard was not part of the 600 potential measures presented in the resilience study, mainly because of Brabant Province's promise to keep their hands off the area. To comply with safety objectives in the region, it was proposed to run two 'green rivers'[15] through the nearby land of Heusden and Altena. The green rivers were hydraulically "very effective", but also "highly problematic" given the environmental and social impact of the measure in the area (Project Group Resilience Study, 2002 p. 113-114).

[15] The term 'green river' is quite misleading, because no river or ditch is involved. The 'river' will consist of two levees through the landscape that can discharge water in the event of high water.

Reflection: During this phase, research manifested itself in multiple ways, and was used to further elaborate and operationalize the space in which solutions to create Room for the River could be explored. The box of blocks was used to visualize the multi-criteria analysis of potential Room for the River measures and their water-lowering effect. As a research-based instrument, it facilitated dialogue and cooperation between policymakers by visualizing the interdependencies of water management at the national level. During this phase, space for depoldering De Noordwaard seemed closed; green rivers were preferred, but equally contested in the region.

Event 3: Interactive design sessions in the lower river region

Parallel to the resilience study, four interactive design sessions were organised for stakeholders in the lower river region. The Bureau Lower River Region (BLRR) (in Dutch: *Bureau Benedenrivieren*), part of the Ministry of Transport, Public Works and Water Management, facilitated the sessions. The BLRR took the long-term discharge objective of 18,000m^3 sec^{-1} as the starting point, whereas the spatial planning procedure had been initiated to devise short-term solutions for discharging 16,000m^3 sec^{-1}. According to the bureau's facilitator: "Focusing on 18,000 instead of 16,000m^3 sec^{-1} was psychologically essential as the question became not *what* to do, but *when*." This approach led stakeholders to conclude that: "A big bang was preferable to cumulative smaller measures" (Bureau Benedenrivieren (BLRR), 2004 p. 25, 27). During the sessions, stakeholders were supported by hydraulic experts brought in by the BLRR. Ecologists were not invited, because they would slow down the process, according the bureau's facilitator. After the first design session, ideas were translated into maps. During the second session the maps were discussed and specified, leading to a list of 42 potential measures for the lower river region. Formally, depoldering De Noordwaard was still not part of the 42 potential measures. Informally, however, the measure had been discussed during the design sessions. Stakeholders started to understand that something substantial had to be done in the area to secure future safety. Besides the green rivers, the only alternative was "doing something" in De Noordwaard, which would significantly contribute to the government's Room for the River objectives. Subsequently, the facilitation of the design sessions was mentioned by our respondents as another important factor in making the concept of "doing something" in De Noordwaard discussable. The process facilitator described depoldering as a: "Very interesting, large-scale measure", and added that: "Creating green rivers on peat soils was an idiotic idea that would ruin the landscape". About creating public support for depoldering he said: "It is a matter of sowing the seed, giving water, and after some time the plant will flower."

Reflection: During this phase of operationalization of Room for the River policy, space for depoldering De Noordwaard as a potential measure within Room for the River was strategically re-opened. The BLRR was in firm control on who could sit at the negotiation table, the objectives, what got on the agenda, and what type of information and research were mobilised to inform the citizens about their options. This allowed the BLRR to create public support for depoldering by persuading stakeholders that: "A big bang was preferable to cumulative smaller measures", as this would reduce uncertainty and public unrest in De Noordwaard. During later phases, the BLRR tactically used the 'big bang argument' to defend the BLRR's choices and preferences, even though the initial conditions that had resulted in public support for depoldering De Noordwaard had changed.

Event 4: Two critical developments in December 2002
In December 2002 two critical developments took place. Firstly, the 42 potential measures were presented to the regional steering committee lower river region, chaired by the Brabant Province delegate. The committee had the task of categorizing each of the 42 measures according to a 'go/no-go' classification system. During the meeting the green rivers through Heusden and Altena were classified as no-go. Several politicians claimed that there would be no public support for the measure. Depoldering De Noordwaard was discussed as a potential alternative, but was found to be far too sensitive because of the province's promise to the people of De Noordwaard. During the meeting, a rethink of the go/no-go classification system was suggested. An alternative system was proposed and accepted. Measures would now be classified as: unacceptable, controversial or non-controversial. Both the green rivers and depoldering De Noordwaard were classified as controversial.

Secondly, a representative of the Southern Netherlands Farmers' Organisation (ZLTO) reacted in the regional newspaper *Brabants Dagblad* on the idea to depolder De Noordwaard. He claimed that: "Sooner or later it will be over with agriculture in De Noordwaard. If that is the case, then preferably soon, so we can build a new living elsewhere. This will also create clarity for the people in the area of Heusden and Altena. Room for the River is a case of national importance. If this is so, then the government should also reap the consequences and pay a good price for our land" (Brabants Dagblad, 7 December 2002).

On 17 December 2002 the BLRR responded in the media that: "We are doing everything in our power to prevent green rivers through the land of Heusden and Altena", and that: "The bureau is currently examining measures to discharge water through De Noordwaard; this can make the green rivers superfluous" (Brabants Dagblad, 17 December 2002). The focus had officially shifted from green rivers to depoldering De Noordwaard.

Reflection: The events in December 2002 formed the final stages that created sufficient space for the BLRR to include depoldering of De Noordwaard as a potential measure for Room for the River; something the BLRR's facilitator had described as the "flowering of the plant". Preceding this momentum, public support had been tactically and patiently created during the interactive design sessions by "sowing the seed and giving water". Subsequently, broadening the classification system created the political space to include the measure in the spatial planning procedure, while simultaneously the province was not directly violating their promise to the people of De Noordwaard. For antagonists of the green rivers this critical event opened up space, whereas for the antagonists of depoldering De Noordwaard space was closing down. For some farmers in De Noordwaard, who thought that depoldering was inevitable, this momentum opened up (financial) space in terms of the expected compensation, which shows that the opening up and closing down of space is closely related to stakeholder objectives.

Event 5: From non-negotiable to preferred alternative
By the end of January 2003, an information evening was organised to inform the broader public about the outcome of the first two design sessions (Bureau Benedenrivieren (BLRR), 2004 p. 8). An increasing number of stakeholders entered the arena; some in favour of the green rivers, other of depoldering De Noordwaard. The BLRR took the position that: "The suggestion to make De Noordwaard a flowing-area comes from the ZLTO management" (Brabants Dagblad, 26 March 2003).

After the last of the four design sessions in November 2003, the steering committee determined their preferred measures for the lower river region. They presented a combination of measures, including the depoldering of De Noordwaard. In the media the BLRR explained that: "The chance that De Noordwaard will be turned upside down is growing" (Brabants Dagblad, 7 November 2003). Within less than a year the status of depoldering De Noordwaard had changed from non-negotiable, to controversial, to preferred. Depoldering was now seen as inevitable, although not everybody in the area agreed on that.

Reflection: The space for depoldering De Noordwaard as Room for the River measure was captured by including it as one of the government's preferred measures in the spatial planning procedure. The BLRR's explanation that depoldering was suggested by farmers from the area, does not fully grasp the strategic shaping of space by the BLRR that made depoldering negotiable in the first place. Moreover, not all stakeholders from the area shared the idea that depoldering was inevitable.

Event 6: Additional research on discharge peaks
In 2004, transfrontier research by Gelderland Province, the Dutch Ministry of Transport, Public Works and Water Management and the German Province *Nordrhein-Westfalen* studied the probability of having peak discharges of 18,000m^3 sec^{-1} at Lobith. The study used one-dimensional and two-dimensional hydrological simulation models that – amongst other things – included data on rainfall, groundwater and morphological projection, IPCC-climate change scenarios and evaluation of policy objectives by countries along the river Rhine. The research concluded that theoretically 18,700m^3 sec^{-1} could be possible, but that practically – by the time the water reached Lobith – floods in Germany would have reduced it to 16,500m^3 sec^{-1} (with a margin of error of 500m^3 sec^{-1}) (Gelderland Province et al., 2004 p. 3-6). A similar argument had been mobilised by Technical University Delft (TU-Delft) researcher De Boer, whose report: "Ridiculed the 18,000m^3 sec^{-1} scenario, claiming that the German river banks will flood long before the river reaches the Netherlands since current German efforts aim to control flooding at 14,600m^3 sec^{-1}" (Warner, 2008 p. 184). In his report, the TU-Delft researcher concluded that: "The problem of 18,000m^3 sec^{-1} is therefore unrealistic" (De Boer, 2003 p. 75). In a newspaper article the BLRR would later respond that: "Germany is fulfilling its agreement to take measures to lower the water levels. But what if Germany takes extra measures [such as heightening levees] to speed up the discharge of water?" (Brabants Dagblad, 20 April 2006). However, it had been the Dutch government who had urged for mandatory EU Water Guidelines legislation to prevent countries such as Switzerland and Germany from passing on responsibility for dealing with high water.

Reflection: Research by Gelderland Province et al. and TU-Delft re-opened the negotiation space by providing contra-expertise on Room for the River's objectives. The studies questioned the assumed discharge peaks that had formed the theoretical basis for exploring solution space in the resilience study. The studies were confuted by the BLRR with arguments (What if Germany were to heighten the levees?) that had no legal basis, as EU water guidelines legislation prevents other Rhine-delta countries from passing on responsibility for dealing with high water. The research did create space for Noordwaard activists, who – on the basis of lower discharge peaks – had powerful arguments to question the necessity of depoldering De Noordwaard.

Event 7: Platform Save De Noordwaard and TU-Delft
Platform Save De Noordwaard was established in 2004, representing a number of agrarians and inhabitants in De Noordwaard who believed that no serious consideration had been given to a combination of smaller measures that could comply with Room for the River objectives, and could make both the green rivers and depoldering De Noordwaard superfluous. One of the platform's objectives was to involve independent experts to discuss the measures and their contribution to Room for the River's objectives on equal terms with the ministry (Pleijte et al., 2005 p. 6).

In October 2004, the platform mobilised research conducted by TU-Delft, famous for its expertise on hydraulic engineering and water management. TU-Delft was coordinating this student research project to explore alternatives to depoldering De Noordwaard taking natural (e.g. geological, environmental and morphologic dynamics), hydraulic (discharge distribution), social-cultural (characteristic scenery and livelihood functions), legal (laws and procedures) and economic criteria (costs related to hydro-technical measures) into account. The report concluded that measures in De Noordwaard were necessary to discharge 18,000m^3 sec^{-1}, but suggested alternative technical solutions for controlled flooding. By creating inlet and exhaust pipes, De Noordwaard could be used as a 'flowing-area' when really necessary: once every 500 years for discharges of more than 15,000m^3 sec^{-1}, and once every 2,000 years for 18,000m^3 sec^{-1}. By doing so, De Noordwaard could retain its agricultural function. Moreover, the researchers claimed that this plan would be far cheaper than the proposed measures (€100 million instead of €280-360 million) (TU-Delft, 2004 p. 4). In their conclusion they summarized: "Questions remain on the necessity of a bypass through De Noordwaard, as alternative solutions might function equally well for the river system. The priority given in some reports to the environment are exaggerated and undermine the interests of the residents of De Noordwaard" (TU-Delft, 2004 p. 4).

The outcome of the research was not satisfactory for either the platform or the BLRR. From the platform's perspective, the study did not result in alternative measures for 'doing something' in De Noordwaard. According to BLRR, the proposed technical solution was: "Unreliable and extremely dicey", and would: "Never be accepted." The bureau continued that: "The proposed solutions will lead to water inconvenience every 25-100 years and will cost at least €400 million." The bureau proposed to write a letter together with TU-Delft: "To inform the people about the facts, because this story by TU-Delft should not live a life of its own" (Brabants Dagblad, 27 January 2005). Eventually, the alternative proposed by TU-Delft did not lead to anything tangible in the region.

Reflection: The platform mobilised the TU-Delft research to explore alternatives to depoldering De Noordwaard. Through the TU-Delft research, they tried to open up economic (lower costs), biophysical (flooding when necessary) and social-cultural space (housing and agriculture function remains intact) (TU-Delft, 2004). Although the research created space, not much momentum was generated, as the proposed alternative did not match the platform's objective sufficiently.

Event 8: Platform Save De Noordwaard and Wageningen University
Early in 2005, the Platform met some researchers from Wageningen University and Research Centre (Wageningen University). By that time, the Platform had received support from a hydraulic engineering emeritus professor in exploring alternative measures that could save De Noordwaard. After learning that the Ministry was not willing to study their alternative, the Wageningen University researchers recommended the Platform to apply for research funds through Wageningen University's 'science-shop'.[16] After funds had been approved, the research started with two workshops in February and March 2005. During the workshops, experts from different Universities agreed on a threefold approach, aiming to: (1) underpinning the Platform's alternative with a qualitative landscape ecological system analysis, (2) critically reviewing the government's hydraulic model and its basic assumptions, and (3) criticising the democratic process and finding ways to penetrate political agendas (Pleijte et al., 2011).

The group was aware of the sensitive situation: "We knew that we were acting in a politically sensitive context, and then you know that is not only about rational argumentation, but also about going along in the political process." As a result, the Platform lobbied for political support, which resulted in the Ministry's promise that a valid alternative to depoldering De Noordwaard would be studied seriously.

In June 2005, the research report was published and presented to the Ministry. The study mobilised previous studies by Gelderland Province et al. (2004) and TU-Delft researcher De Boer (2003) that questioned the scientific underpinning of the sustainable safety objective of discharging 18,000m^3 sec^{-1}; one of the basic assumptions used in the resilience study and the hydraulic model box of blocks. These arguments were not mobilised without careful consideration, as the Platform's alternative was capable of discharging 16,000m^3 sec^{-1}, without depoldering De Noordwaard. This alternative measure, a trench through the *Sliedrechtse* Biesbosch, had been discussed during the interactive design sessions, but was found infeasible because of the existing European Bird Habitat Guidelines in that area. As the Ministry had mobilised this argument before, the study included scientific findings by Maas

[16] The science-shop works as an intermediary between science and society, where civil society interest groups and organisations can seek funds and scientific support.

et al. (2003) to underline that: "The s*troomdalgrasland* vegetation [vegetation type present in *Sliedrechtse* Biesbosch] could actually benefit from being alongside a trench."

Besides questioning the scientific underpinning of discharge peaks, critique on the hydraulic model focused on its inability to run scenarios that would cause water from the river Rhine to flow into the river Meuse as a result of water level disparity. Moreover, the model could only calculate water management effects downstream and not upstream, and the effect of rising sea level was not included in the model (Pleijte et al., 2011).

Based on the analysis of democratic process the study challenged the focus on a 'big bang' over cumulative smaller measures. Both had advantages and disadvantages, but the BLRR's focus on the long-term objective of 18,000$m^3 sec^{-1}$ made the 'big bang' look inevitable. In their argumentation the Platform referred to other Dutch large-scale projects whose scale had become its costly weakness. Moreover, the initial conditions that had resulted in public support for depoldering De Noordwaard (clarity and good financial compensation) had changed. Neither of the conditions had been met, which fostered public unrest and uncertainty. Lastly, the study reviewed legal procedures, such as the selective use of the European Bird Habitat Guidelines. Alternatives to depoldering were often ridiculed by the government as a violation of these guidelines. However, if the government itself violated them, they could compensate for the loss of habitat in other areas. Another controversial legal issue was the so-called forerunner status of the project. One of the conditions for becoming a forerunner project was: "Full support in the region for the preferred alternative of depoldering" (Pleijte et al., 2005 p. 21). As long as the Platform was still exploring alternatives, there was not full support for depoldering. According to Platform members the forerunner status worked as a "paralysing instrument" and a form of "blackmailing" (Brabants Dagblad, 17 June 2005). It created social pressure, fuelled by the idea that a forerunner project would speed up procedures and positively influence financial compensation (Pleijte et al., 2005 p. 23-24). Social pressure from the area eventually led to the end of the Platform's search for alternatives.

Reflection: When analysing this phase, we see that research was conducted and mobilised in a strategic manner. Qualitative landscape-ecological system analysis combined with the policy analysis and intertwined with local knowledge was used to improve the Platform's alternative and question the official government plan (Pleijte et al., 2011). The study provided arguments that had been successfully mobilised in other (Room for the River) contexts, and questioned the basic assumptions behind Room for the River (discharge peaks), its hydraulic model (box of blocks), and democratic and legal procedures (e.g. forerunner status). Moreover, the Platform's alternative was proactively defended by providing answers to arguments the Ministry would use to contest the alternative plan. In their approach, the Platform's lobby created political space, and the science-shop provided the financial space for research which mobilised a strategic combination of social-cultural, biophysical, economic, political and legal arguments to create space for alternatives to depoldering De Noordwaard.

Event 9: The ministry responds
In the aftermath of the Wageningen University research a number of events occurred. In July 2005, a regional newspaper reported that the ministry had formally granted forerunner status to De Noordwaard. In a personal letter, the state secretary informed the platform that their proposal was "off the table" (Brabants Dagblad, 20 July 2005). In an additional letter send by the BLRR, three arguments for rejecting the platform's alternative were presented. Firstly, they explained that the alternative was not new. A combination of measures had been discussed before, but found infeasible during the design sessions; a 'big bang' was preferred over a combination of measures. Secondly, the alternative was short-term proof (16,000m^3 sec^{-1}), but insufficient for discharging 18,000m^3 sec^{-1} in the long term. According to the bureau, this indicated that De Noordwaard had to be reserved for depoldering until 2015; a perspective found infeasible by the farmer and citizen organisation. Thirdly, this would lead to extra costs.

Legal, procedural and financial – rather than biophysical and hydrological – arguments formed the main response to the research. In their feedback, the bureau did not specifically criticize the platform's alternative, nor did they respond to the argument that 18,000m^3 sec^{-1} was physically impossible according to other research.

Reflection: The ministry's ambivalence towards giving credence to research is remarkable. On the one hand they stressed the importance of scientific research, but on the other hand the ministry easily ridiculed scientific research findings that conflicted with Room for the River policy. During interviews we heard arguments such as: "These were emotions [not scientific data] presented by activists [non-objective scientists] who were subjective in their analysis and conclusions"; this suggests that the ability of research to create space is strongly related to the phase in the policy process, and the stakeholder objectives it seeks to support.

Event 10: Government's Research and Verification Commission
Despite the ministry's feedback on the platform's alternative, a hearing for clarification was organised on 20 April 2006, at which members of the government, researchers and experts, regional policymakers and citizen participated. Platform members and researchers from Wageningen University were also present. During the hearing, experts claimed that: "18,000m^3 sec^{-1} at Lobith is physically impossible" and has therefore "no legal basis" (Research and Verification Bureau, 2006 p. 10). Moreover, the platform's proposed alternative: "Better fits in the history of the landscape" and "has less negative effects on Bird Habitat Guidelines as suggested by the ministry" (Research and Verification Bureau, 2006 p. 11).

On the basis of the hearing, the Commission for Transport, Public Works and Water Management asked for verification research on the (financial) argumentation behind the spatial planning procedure Room for the River (Research and Verification Bureau, 2006 p. 3). The research was conducted by the Research and Verification Commission, a commission that advises and supports the Dutch government through research, and by assessing research offered to the government. On 14 June 2006, the Research and Verification Commission offered its findings to the Commission for Transport, Public Works and Water Management.

About the platform's alternative to depoldering De Noordwaard the Commission concluded that: "Different configurations are presented, almost all with different variables and not elaborated in detail. These have to be studied coherently if they are to be compared to the government's preferred alternative. The comparison in this verification research was therefore to remain very general" (Research and Verification Bureau, 2006 p. 11).

Nevertheless, the commission acknowledged that: "Presenting a worthwhile alternative was made difficult and was constrained by giving De Noordwaard forerunner status. Progressive thinking [by the platform] about a good alternative was undervalued, and the last version of the alternative was hardly evaluated individually" (Research and Verification Bureau, 2006 p. 11). Moreover, the commission concluded that: "It is not easy to compare alternatives from the region with the alternatives of the government. Citizens' alternatives are often less detailed; this subsequently increases the chance that the government's alternative will be preferred" (Research and Verification Bureau, 2006 p. 15). About the discussion on discharge norms the commission concluded: "The choice of 18,000m^3 sec^{-1} has been explained by the state secretary, but is shrouded in uncertainty. That has been a constraint, because the choice of 18,000m^3 sec^{-1} has been a determining factor in evaluating the several alternatives" (Research and Verification Bureau, 2006 p. 25).

Despite the commission's evaluation, the spatial planning procedure Room for the River was unanimously approved by the Parliament in July 2006.

Reflection: Although the Research and Verification Commission acknowledged that: "Citizens' alternatives are often less detailed, and that this subsequently increases the chance that the government's alternative will be preferred", the alternative presented by the platform was found too general to be compared with the government's preferred option. Although the platform had offered a research-based alternative to depoldering and the commission had agreed with some of its findings, it did not create enough space to call into question the decision to depolder De Noordwaard. Besides the level of detail, this also had to do with the fact that the policy process had advanced to a phase where decisions had to be made. Validating the platform's research would have had far-reaching consequences, as it challenged basic assumptions (discharge peaks) behind the Room for the River policy. Subsequently, this could have provided jurisprudential space to other interest groups opposing Room for the River measures.

Event 11: "Room for the River not based on solid scientific proof"
On 14 November 2006, Room for the River was discussed in the Senate. When the Minister of Transport, Public Works and Water Management could not satisfactory answer the Senate's questions, the debate was suspended (Senate, 2006). Soon thereafter a 'technical briefing' was organised, where the ministry's experts informed the Senate about the strategic choices behind Room for the River. One of our interviewees explained that: "A technical briefing is often used to push something through the Senate". We assume that besides the credibility and probability of Room for the River's safety objectives (discharge norms), financial, procedural and legal issues must have been discussed.

On 19 December 2006, the suspended debate in the Senate continued. When the peak discharge norms were discussed, the state secretary for Transport, Public Works and Water Management explained that: "Half of the experts say that under certain conditions 18,000m^3 sec^{-1} can flow into the Netherlands, the other half of the experts say that this cannot happen, because areas in Germany will have flooded by then. We have never argued that we have solid scientific proof, it is an administrative norm" (Senate, 2006 p. 560).

During the debate a Senator proposed a motion for project Veessen-Wapenveld; one of the other projects that – besides De Noordwaard – had been studied by the Research and Verification Commission. The Senator requested a: "Renewed planning process towards a reconstruction plan that does justice to agricultural values, spatial quality and the high-water task" for Veessen-Wapenveld (Senate, 2006 p. 569). The state secretary approved the motion (Senate, 2006 p. 573).

In December 2006, the Senate approved Room for the River, and the spatial planning key decision (fourth part of the spatial planning procedure) was published (Project Organisation Room for the River, 2006).

Reflection: Although all activities in the Senate have to be codified and made available to the public, this is not mandatory for technical briefings. How research was mobilised and how it influenced decision making during the technical briefing can therefore not be analysed. We assume that that besides Room for the River's safety objectives (discharge norms), financial and legal issues must have been discussed. Nevertheless, it is remarkable that the state secretary admitted that 18,000m^3 sec^{-1} was a less scientific norm than initially claimed. Subsequently it turned out that there was still space to revise the spatial planning processes for Noordwaard-like areas such as Veessen-Wapenveld.

3.6. Analysis and discussion

The objective of this chapter was to contribute to insight into the dynamics that influence the effective mobilisation and contribution of research to negotiation processes in the context of competing claims, and to what extent research opened up or closed down negotiation space for stakeholders. In our analysis, we have tried to highlight what appear to be the key drivers that influence this.

3.6.1 Manifestation and packaging of research

The reconstruction of critical events demonstrated that research manifested itself in different forms, for multiple purposes, and during different phases in the process (Table 3.1). Research proved to be a powerful tool that influenced the policy and negotiation process, but whether it created space, and for whom, depended on numerous controllable and less controllable contextual factors. Good examples of less controllable factors can be found in the high water of 1993 and 1995 that opened up political and financial space to rethink Dutch water management, and the interview with the ZLTO representative that provided space for the

BLRR to include De Noordwaard as a potential measure in the region. More controllable factors can be found in the way research is packaged (cf. Hajer, 1995). Increasingly, norms, criteria and indicators, interactive scenario planning tools, maps and other visualizations form an attractive and accessible way of packaging complicated research-based data that are strategically used to facilitate negotiation and decision-making processes. Such packaging enhances the accessibility and usability of research to which different groups of stakeholders can easily relate (cf. Klerkx et al., 2010). However, these tools require close attention and guidance as to their interpretation and the accuracy of their meaning; as was the case with the box of blocks. Packaging of research also includes the discourses used by researchers and experts when mobilizing their knowledge to support or facilitate negotiation processes and decision making.

Critical event	Manifestation of research	Packaging of research	Role of research in policy process
1. Flood risks and discharge norms	Flood risk norms, discharge norms, improved mathematical and statistical methods for calculating discharge peaks, hydro-technical measures, climate change scenarios, rainfall data, normative framework for public participation	Research reports and policy documents by Commissions Becht, Boertien and WB21, Fourth National Policy Document on Water Management, Policy Guideline Room for the River	Evaluate policy; Elaborate policy; Contra-expertise
2. Resilience study and box of blocks	Flood risk norms, discharge norms, 600 potential hydro-technical measures and their contribution to Room for the River objectives, indicators for sustainable safety and spatial quality, cost-benefit analysis, IPCC and KNMI climate change scenarios	Research reports, maps, models, policy documents such as Fifth National Policy Document on Spatial Planning, classification system based on key indicators, decision-supporting software (box of blocks), list of potential measures	Elaborate policy; Operationalize policy
3. Interactive design sessions	Discharge norms, 42 hydro-technical measures and their contribution to Room for the River objectives, normative framework for public participation	Advice and expertise by researchers, minutes of meetings, maps, facilitation of decision making, list of potential hydro-technical measures, brochures	Elaborate policy; Operationalize policy
4. Two critical developments	Potential hydro-technical measures (including depoldering De Noordwaard) and their contribution to Room for the River objectives, indicators for sustainable safety and spatial quality, cost-benefit analysis	List of potential measures, advice by researchers, facilitation of political decision making	Operationalize policy
5. From non-negotiable to preferred alternative	Preferred hydro-technical measures and their contribution to Room for the River objectives	Advice and expertise by researchers, minutes of meetings, facilitation of decision making, maps, list of preferred hydro-technical measures	Operationalize policy

6. Additional research on discharge peaks	International flood risk projections and discharge norms, hydro-technical measures and their contribution to Room for the River objectives, morphological and hydrological developments, rainfall and groundwater index, IPCC-climate change scenarios, evaluation of (inter)national policies, laws and legal procedures	International research reports, including one-dimensional and two-dimensional hydrological simulation models and scenarios, maps, tables and graphs	Evaluate existing (inter)national policy; Operationalize policy; Contra-expertise
7. Research TU-Delft	Flood risk projections, discharge distribution, tidal movements, potential hydro-technical measures and their contribution to Room for the River objectives, analysis of geological, morphological and environmental data on the areas, analysis of social-cultural value and livelihood functions, cost-benefit calculations of different hydro-technical measures, policy analysis	Advice and expertise by researchers, research report including hydraulic models, maps, technical designs of hydraulic solutions and photos	Evaluate (inter)national policy (treaties, laws and legal procedures); Operationalize policy; Contra-expertise
8. Research platform and Wageningen University	Funding (science shop), qualitative landscape-ecological system analysis, critical review of hydraulic model and its basic assumptions (e.g. discharge norms), alternative hydrological measures and their contribution to Room for the River objectives, policy analysis (Bird Habitat Guidelines, EIA, cost-benefit analysis, use of 'box of blocks'), process monitoring and evaluation of legal procedures (spatial planning procedure and forerunner status), analysis of social-cultural value and livelihood functions, mobilizing lessons learned from comparable (research) projects	Advice and expertise by researchers, research report including photos, maps, alternative hydrological measures, research used for political lobby	Evaluate (inter)national policy (treaties, laws and legal procedures); Contra-expertise; Operationalize policy
9. The ministry responds	The ministry mobilised mostly non-research based arguments, referring to the interactive design sessions and the original discharge norms, on which more up-to-date research was already available	Letter by the ministry and the BLRR	Defend the elaboration of policy; Operationalize policy

10. Research and Verification Commission	Research used as tool to verify and determine the credibility of other research, discharge norms, evaluation of hydro-technical measures and their contribution to Room for the River objectives, analysis of financial argumentation, evaluation of policymaking and legal procedures (forerunner status and stakeholder's legal rights in the spatial planning procedure)	Advice and expertise by researchers, research report/ policy advice including analysis of discharge norms, legal procedures and financial argumentation, comparing government preferred alternative and alternatives by interest groups	Monitor and evaluate policymaking; (Verify) contra-expertise; Operationalize policy
11. "Room for the River not based on solid scientific proof"	Unknown due to lack of transparency on the government's part. We assume that besides Room for the River's safety objectives (discharge norms), financial, procedural and legal issues must have been discussed	Technical meeting organised by the ministry's experts to facilitate political decision making	Operationalize policy; Monitor policymaking; (Verify) contra-expertise

Table 3.1. Overview of the manifestation, packaging and role of research during the policy process.

3.6.2 Research and stakeholder perceptions

The reconstruction of negotiation during the policy process demonstrates that the interpretation of what constitutes effective research relates strongly to stakeholder perceptions and objectives. Research in line with stakeholders' objectives is likely to be framed as credible and legitimate, whereas research mobilised by the opposition is often seen as less valid, credible and reliable. This is illustrated by the BLRR example that described the research by the platform and Wageningen University as: "Driven by emotions", conducted by: "Activists who were subjective in their analysis and conclusions." The latter quote indicates that it is not only the interpretation of the research findings that is stakeholder dependent, but consequently also the role of the researchers. When research is being conducted in the context of competing claims it is therefore realistic to consider research findings as 'negotiated truths', and subsequently ask the question: truths for whom?

3.6.3 Phases and power

Our case study shows that how research is perceived and given credence is related to the different phases of policy and negotiation processes, visualized in Figure 3.1 An example is the research conducted by Gelderland Province et al. and TU-Delft researcher De Boer who questioned the probability of having discharge peaks of 18,000m^3 sec^{-1} at Lobith. In the Room for the River context, this research was framed and approached as contra-expertise, threatening the elaborated Room for the River policy. However, eight years earlier a similar type of research had formed the foundation of the policy. The research by Gelderland Province et al. was furthermore international, and showed interdependencies that could have facilitated dialogue between the Netherlands and the other Rhine-delta countries, Germany and Switzerland. Eventually, the state secretary described the 18,000m^3 sec^{-1} as an administrative rather than a science-based norm, whereas by that time (2006) more recent and more accurate research findings on discharge peaks by De Boer (2003) and Gelderland Province et al. (2004) were available to the government.

Solution space is often narrowed down in early phases of policymaking. By the time a spatial planning procedure enters the legal public participation phase, both the preferred solutions, and procedures for evaluating alternatives by the general public have been elaborated. This implies a degree of power, affecting the: "[O]pportunities, moments and channels through which citizens can act to potentially affect policies, discourses, decisions and relationships that affect their lives and interests" (Gaventa, 2006 p. 26). As was acknowledged by the Research and Verification Commission, this made it difficult for citizens to present alternatives, within the appointed time, that contain the same level of research and detail as the government's preferred solutions.

Moreover, the interpretation of phases is stakeholder dependent, meaning that whereas some stakeholders may believe that a phase is concluded – e.g. De Noordwaard not being amongst the 42 potential Room for the River measures in the lower river region – others may understand that such options are still negotiable.

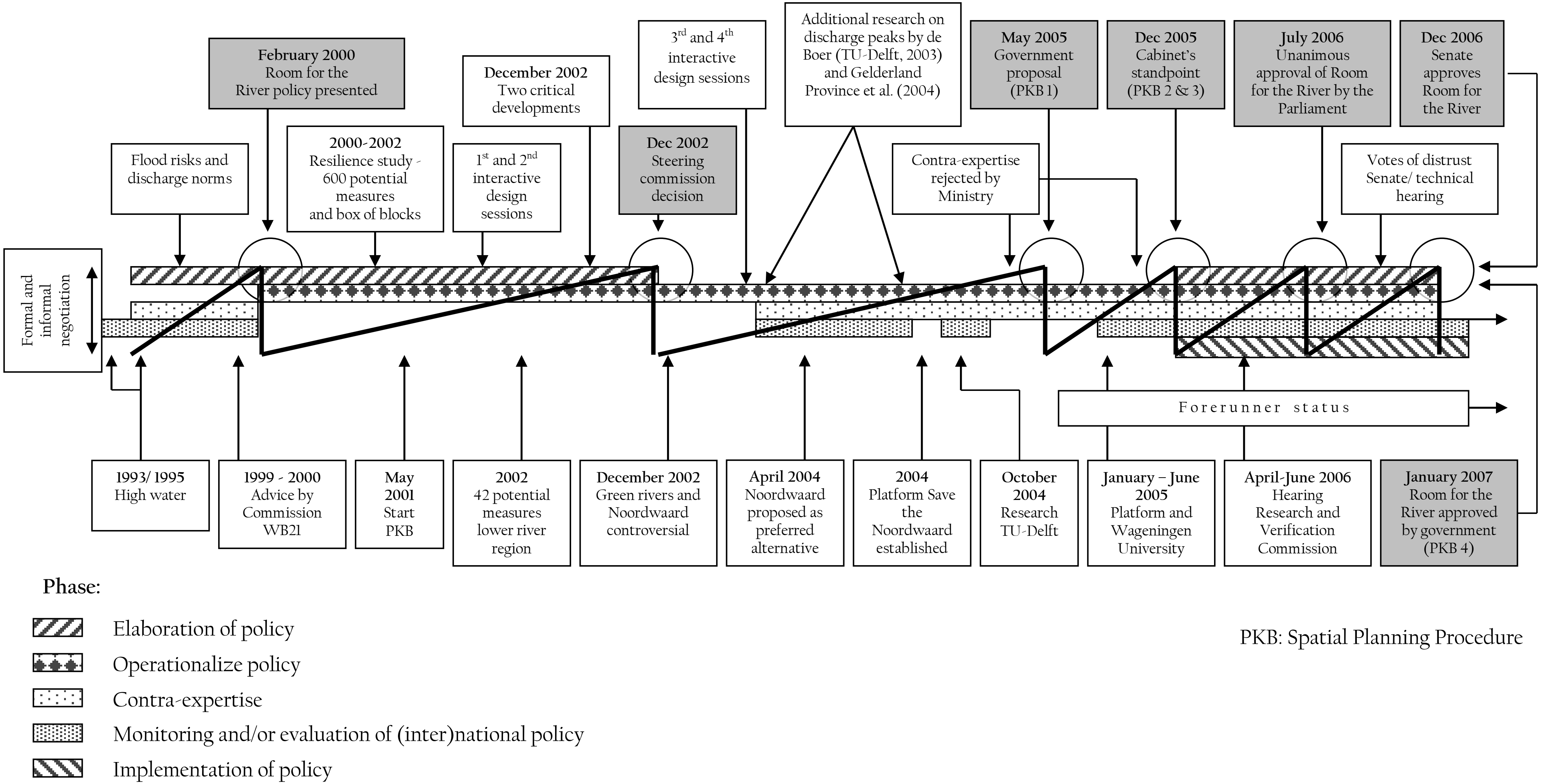

Fig. 3.1. Timeline analysis of critical events in the Room for the River/ Noordwaard case study.

3.6.4 Negotiation and space

During each negotiation phase we could identify formal and informal negotiations. When negotiations provided an acceptable configuration between social-cultural, biophysical, economic, political and legal spaces (Table 3.2 provides examples), the momentum was captured, frozen or fixed, be it in (in)formal agreements, policy documents, minutes of meetings, maps or a list of potential measures. The formal decision making moments in the policy process are indicated by the circles and grey boxes in Figure 3.1. However, we have seen that preceding such events, multiple formal and informal interactions in and between networks, and phenomena such as coincidence and self-organisation (cf. Aarts and Leeuwis, 2010) influenced their course and outcome. The newspaper interview with the ZLTO representative shows that capturing these momentums does not have to be based on broad consensus, but can also be the result of an individual actor capable of finding space in negotiations by making use of mass media.

The momentums when space was fixed often formed the starting point for a new phase of negotiations. Once momentums of space had been captured, it became difficult to defreeze, change and refreeze them, something that was strategically used by the BLRR as a safeguard in the process. As described in the previous section, this suggests that the mobilisation of research in the right place at the right time by the right person is of crucial importance in relation to the effectiveness or impact of research. Nevertheless, the research by the platform and Wageningen University shows that, if strategic attention is paid to mobilizing the 'right' combination of social-cultural, legal, economic and biophysical arguments, combined with political lobbying, space can still be created in phases when decisions appeared to be fixed.

Spaces	Examples from the case study
Social-cultural space	Communication space, space for dialogue, space to participate, negotiation space, protest space, emotional space, relational space, space for trust, institutional space, cultural space, agricultural space
Biophysical space	Technical space, hydrological space, (agro-)ecological space, environmental space, geographical space, morphological space, meeting space
Economic space	Financial space (for research), cost-benefit analysis, compensation space
Political space	Space for political will, space for lobbying, space to revise policy processes
Legal space	Legal space to participate, negotiate and influence policymaking, procedural space, jurisprudential space, laws

Table 3.2. Examples of spaces from the case study.

3.6.5 Embeddedness of researchers

The embeddedness of a researcher in formal and informal negotiation processes may enhance the effective mobilisation of research in the context of competing claims. It can lead to better insight into the dynamics of the process (the history of the debate, stakeholder objectives, power relations, interdependencies and phase of the process) that influence when and in what form research can contribute to exploring sustainable solutions. Embeddedness during phases when policy is elaborated or operationalized may be more effective in terms of influencing the course of policymaking than criticizing or providing contra-expertise on decisions taken earlier in the process. This relates to both the content of the issue at stake, as well as to how procedures (e.g. space for public participation) could be organised.

However, we are aware that, especially in the context of competing claims, researchers are selectively and strategically involved and excluded from negotiation and policy processes. During this study we were repeatedly told that researchers who would slow down the process were strategically kept out from the interactive design sessions. This suggests a relation between the nature of the problem, who is controlling the process, research disciplines, and the reputation of researchers and their institutes that influence the degree to which research can effectively contribute during different phases of policy or negotiation processes. That this is not univocal was illustrated by a staff member of the ministry who explained that: "TU-Delft and not Wageningen University should provide the hydraulic expertise to evaluate measures." But when TU-Delft did so, their alternative to depoldering De Noordwaard was described as "unreliable and extremely dicey" and research by De Boer on the probability of dealing with 18,000m^3 sec^{-1} discharge peaks was ignored.

3.7 Conclusions

This study demonstrates the relation between the different phases in the policy and negotiation processes, the objectives and perceptions of stakeholders during these phases, and how research is interpreted and given credence. Research manifested itself in different forms and during different phases in the process. On the basis of their objectives, stakeholders tactically and selectively mobilised research as a 'strategic weapon' to manipulate the course and outcome of negotiation processes. This supports our idea that research, conducted or mobilised in the context of competing claims, will often be disputed and contested (cf. van Bueren et al., 2003), and could benefit from a negotiation-based approach. Within such an approach, research can support certain stakeholder perspectives or facilitate negotiations, but is also itself subject to negotiation (cf. Leeuwis, 2000; Giller et al., 2008).

The degree to which research can open up or close down negotiation space, and for whom, depends on numerous contextual factors. These factors can be found in the (changing) nature of the problem and the composition of stakeholders, their objectives and power relations during different phases in the process. As Gaventa (2006 p. 29) explains: "Certain powerful people and institutions maintain their influence by controlling who gets to the decision making table and what gets on the agenda", often to the disadvantage of less-powerful societal groups. Insights into the interrelationship between time (phases), spaces and forms of power are crucial for determining when, where and in what form research could contribute to configurations of social-cultural, biophysical, economic, political and legal space that allow stakeholder to explore and identify sustainable solutions to complex environmental problems.

Increasing the effectiveness of research could benefit from more impact- or action-oriented research approaches where research and researchers are embedded in negotiation processes (cf. Adam et al., 2006). Embedding can enhance the probability for researchers to participate in both formal and informal negotiations, and adequately anticipate changing contextual factors that influence the effective contribution of research to exploring sustainable solutions during different phases in the process. However, we feel that the practical and institutional challenges posed by the current academic system and incentive structures do not always allow researchers the time, resources and mandate to become embedded.

This chapter provides an incentive to rethink the roles of research, researchers and research institutes in the context of competing claims, but we would also like to stress that similar rethinking is needed for policy processes. Our analysis shows that policy processes leave very little space for the integration of new research findings once procedures have been elaborated or decisions have been made. We conclude that creating space to increase the effective contribution of research to integrative negotiations and exploring sustainable solutions to complex environmental problems consequently requires inventive restructuring of research, policy processes and the interfaces where they meet.

Acknowledgements

This research is part of the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions,' funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation (former Ministry of Agriculture, Nature Conservation and Food Quality).

The authors acknowledge the valuable contributions of colleagues and the reviewers of Science and Public Policy who provided constructive feedback on earlier versions of the chapter. Special thanks to the people from De Noordwaard, interviewed researchers and policymakers for their openness to share their experiences with us.

CHAPTER 4

Biofuel developments in Mozambique

Update and analysis of policy, potential and reality

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Published as:
Schut, M., M. Slingerland and A. Locke (2010). Biofuel developments in Mozambique. Update and analysis of policy, potential and reality. Energy Policy 38(9): 5151-5165.

KEYWORDS

Biofuels

Development

Mozambique

ABSTRACT

Climate change, rising oil prices and concerns about future energy supplies have contributed to a growing interest in using biomass for energy purposes. Several studies have highlighted the biophysical potential of biofuel production on the African continent, and analysts see Mozambique as one of the most promising African countries. Favourable growing conditions and the availability of land, water and labour are mentioned as major drivers behind this potential. Moreover, the potential of biofuel production to generate socioeconomic benefits is reflected in the government's policy objectives for the development of the sector, such as reducing fuel import dependency and creating rural employment. This chapter provides an overview of biofuel developments in Mozambique and explores to what extent reality matches the suggested potential in the country.

We conclude that biofuel developments mainly take place in areas near good infrastructure, processing and storage facilities, where there is (skilled) labour available, and access to services and goods. Moreover, our analysis shows the need to timely harmonize current trends in biofuel developments with the government's policy objectives as the majority of existing and planned projects are not focusing on remote rural areas, and – in absence of domestic markets – principally target international markets.

4.1 Introduction

Increases in the price of fossil fuels, and growing concerns regarding their finite availability, use and impacts (including climate change) have driven the demand of biomass for energy purposes worldwide (Commission of the European Communities, 2006; van Dam et al., 2008 p. 750). Biofuels are perceived to be a good alternative to fossil fuels and 'a pathway out of poverty' for developing countries. Biofuels may provide new incentives for investments in agricultural research and development, offer farmers a new source of income (Smeets et al., 2007 p. 103-104), and stimulate linkages to input and food markets that currently do not exist (FAO, 2008a). On the other hand, concerns raised in the food-fuel-feed debate provide a good example of how biofuel production might lead to competing claims on land, water, labour, and other resources.

Like many other countries, Mozambique has explored the potential for renewable energy options to meet its energy needs (Jumbe et al., 2009). There is a growing interest in the production of biomass for biofuels, and large-scale, mainly foreign investments have been made. Evidence of Mozambique's biophysical suitability for biofuel feedstocks exists with the long-term presence of sugarcane plantations in different parts of the country. As the first biofuel projects are becoming tangible, there is a need to monitor and analyse the factors that are driving the direction of biofuel developments in Mozambique; exploring to what extent reality matches the suggested potential in the country.

4.2 Background on Mozambique

Mozambique is one of the fastest growing economies in sub-Saharan Africa, with a growth of around 7% per annum since the early 1990s (World Bank, 2008). Although poverty rates had dropped from 69% in 1997 to 54% in 2003 (Arndt et al., 2008a p. 1), Mozambique is still among the world's poorest countries. On the August 2007 U.N. Human Development Index (HDI) (USAID, 2009b) it ranked 172 out of 182 countries, the lowest among the 14 Southern African Development Community (SADC). Average income levels are low, with a GDP per capita of US$364 in 2007 (World Bank, 2008). The country has approximately 21.4 million inhabitants with an average life expectancy of 42 years at birth (World Bank, 2008). Prevalence of malnourishment in the total population was 44% between 2002 and 2004 (FAO, 2008b p. 17). For 2007, the HDI indicated adult literacy rates of 44.4% for the population of 15 years and above (UNDP, 2009).

Despite its relatively high rates of economic growth, Mozambique still faces widespread poverty which is claimed to be the result of historical factors including the Portuguese colonization and armed conflicts that uprooted social networks and destroyed most of Mozambique's commercial and transport infrastructure, educational and health systems. Moreover, the country is vulnerable to natural disasters (floods and droughts); is facing limited and uneven market development; rural-urban differentiation; and socioeconomic differentiation in relation to control and access to assets (particularly land). According to De Matteis et al. (2006 p. 7), 35% of the population is highly vulnerable to food insecurity, which besides food availability is believed to be a result of the ineffective access, storage and distribution of food (cf. Batidzirai et al., 2006 p. 55; Arndt et al., 2008b; USAID, 2009a). Despite having much more propitious agro-climatic conditions, vulnerability to chronic food insecurity is highest in the Northern provinces.

Mozambique stretches 2,500 km along the coast of southeast sub-Saharan Africa and has a land area of 799,390 km^2 (PARPA II, 2006). Of this land area, 36 million hectares (ha) are arable, of which approximately 10% is under cultivation (FAO, 2007). Because of the country's fertile lands and favourable climate, Mozambique is attractive for agriculture, which employs 80% of the estimated 8.8 million labour force (African Development Bank, 2008 p. 3; Econergy, 2008 p. ES4). The remaining 20% is involved in the industrial, transport, communication and service sectors (World Bank, 2009).

As Mozambique is 100% dependent on oil imports (FAO, 2008b p. 17), a considerable and increasing amount of the total GDP is being spent on fuel and energy; 10% of the total value of imports in 1997, 15% in 2006 and 17% in 2007 (World Bank, 2008), which explains the government's interest in exploring alternative energy sources, such as biofuels.

4.3 Biofuel timeline in Mozambique

The biofuel discussion in Mozambique became prominent in 2004. During the election campaign, the government encouraged Mozambican farmers to produce jatropha on all unused, marginal soils so Mozambique could become an oil exporting country instead of being wholly dependent on oil imports. The government promised that: "Biofuels will not displace Mozambican farmers from their lands, and that government policy would require the use of underutilized or empty lands, would avoid using lands allocated for food production, and that Mozambique will refine its own raw materials" (Frontier Markets, 2008). The initial idea was that five hectares of jatropha were to be planted in each of Mozambique's 128 districts. The Mozambican extension service started sourcing jatropha seeds, mainly from Malawi. Most of the seeds were of poor quality; they had been stored for a long time and often under adverse conditions, resulting in low germination rates (TechnoServe and ICRAF/IIAM, 2006 p. 18). Apart from distributing the seed, there was lack of real follow-up, hence crop maintenance was neglected, and many plants died. The few farmers who produced jatropha seeds did not know what to do with them, as organised markets and supply chains were absent. Nevertheless, the promotion of biofuels by the Mozambican government had by that time attracted numerous private investors as well as some biofuel-related development projects. Plantations of jatropha were established with only limited information available regarding seed varieties, good agronomic practices, production systems, markets and scale of operations. In addition, the belief that jatropha hardly requires nutrients for its growth and is drought resistant stimulated investments on marginal land, which later turned out to be unsuitable for growing jatropha.

While interest in jatropha as a 'miracle crop' spearheaded the political promotion of biofuels, there was also significant private sector and government interest in the production of ethanol.

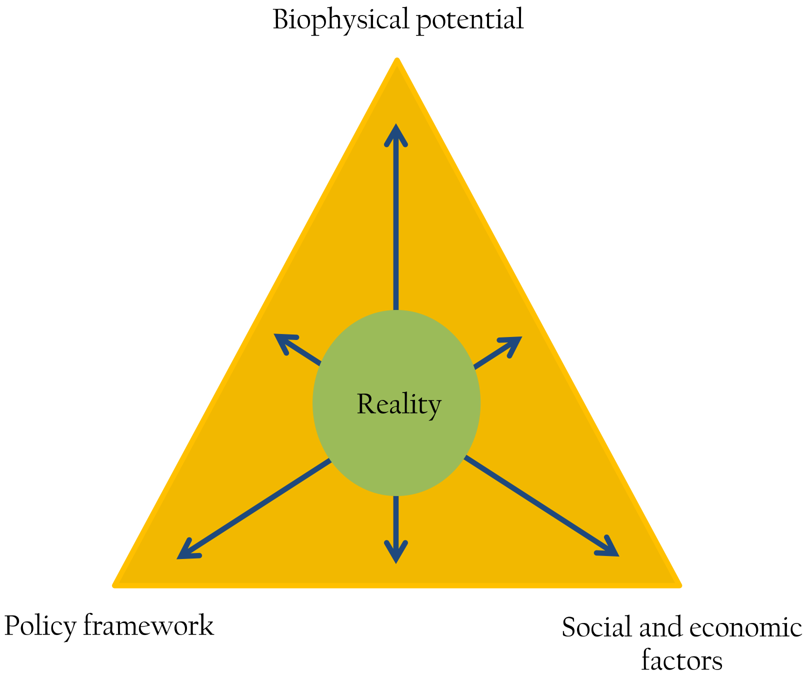
The principal feedstock considered was sugarcane, although an increasing level of interest began to be shown in sweet sorghum over the last two years.

Concerns about potential pressure on land, water, food production and lack of control over this process resulted in an intense discussion between government, private sector, NGOs and academics. As a result, large-scale land requests were frozen between October 2007 and May 2008, while the government undertook agro-ecological land zoning. The first biofuel project in Mozambique was approved in October 2007; since then, three more large-scale projects have been formally approved by the government. In March 2009, the Mozambican government approved a national policy and strategy for biofuels. In December 2009, the government voided the contract of one of the approved companies, as they failed to comply with their contractual obligations.

4.4 Theoretical framework and methodology

Over the last years, several studies have highlighted the (biophysical) potential of biofuel production on the African continent (Batidzirai et al., 2006; Smeets et al., 2007; Diaz-Chavez and Jamieson, 2008). Mozambique is seen by analysts as one of the most promising African countries for biofuel production, as it has abundant and unexploited land and water resources. These projections have provided strong arguments for the promotion of biofuel production in Mozambique. Although we acknowledge the importance of studies on biophysical potential, we believe there are other drivers that determine how and where biofuel production in Mozambique could be successful. Investment theory explicitly studies the relative importance of specific biophysical, social-economic and legal factors that guide investment location decisions (Davidson, 1980; Wheeler and Mody, 1992). As these factors are sector dependent (Wheeler and Mody, 1992), and biofuels form an emerging sector, it is important to understand and analyse the variables which are dominantly driving the direction of biofuel developments in countries like Mozambique. Moreover, mapping the current biofuel developments *vis-à-vis* long-term policy objectives for promoting biofuels, allows for the timely and adequate development and implementation of policy tools to harmonize investor and government objectives.

The objective of this chapter is to integrate, analyse and visualize knowledge from different disciplines to show how dynamics between biophysical potential, policy and legal frameworks, and social-economic factors need to be understood to explain current biofuel developments in Mozambique (Figure 4.1).



By doing so, we hope to complement existing studies and provide additional insight in the complexities that are driving the direction of biofuel developments in Mozambique. Our efforts to integrate and visualize insights from different disciplines in the form of maps were inspired by the idea that such visualizations could serve as boundary objects (cf. Ewenstein and Whyte, 2009).

Fig. 4.1. Framework to analyse the drivers of biofuel developments in Mozambique.

To reach our objectives, we present various forms of data. Firstly, we conducted a literature study to analyse multiple sources of secondary data; scientific reports and papers on biofuel potential, biofuel-related policy documents, and media reports related to biofuel developments in Mozambique. Secondly, we analysed investment data in collaboration with the Agriculture Promotion Centre (CEPAGRI) of the Ministry of Agriculture of Mozambique. Thirdly, we undertook geographical mapping of biofuel developments in Mozambique. This inventory includes the operational biofuel projects and expressions of interest throughout the country, as well as existing and planned biofuel-related processing and storage facilities. This data was complemented with information collected from ten field visits to both commercial and small-scale biofuel projects, and more than and 50 interviews with policymakers, investors, farmers, NGO representatives and researchers.

4.5 Policy framework for biofuel developments

This section identifies and discusses the (inter)national policies, agreements and legislation related to biofuel production, processing and trade in Mozambique. Subsequently we look at how incentives and restrictions established in these policies could influence the development of the biofuel sector in Mozambique.

4.5.1. Trade agreements

Mozambique is a signatory to several trade agreements that establish the terms and conditions for access of Mozambique's potential biofuel production to key regional and international markets, namely the EU, the US and SADC (cf. Rebello Da Silva and Da Silva Garrilho, 2003 p. 84-85).

Access to the EU market for biofuels is granted under two key agreements: (1) the Cotonou Protocol between the EU and African, Caribbean and Pacific countries, which is in the process of being transformed into a regional Economic Partnership Agreement (EPA) between the EU and SADC and (2) the 'Everything But Arms' arrangement which grants duty-free access to the EU market for all goods (except arms) for least developed countries. As a result, duty-free access is provided for ethanol, biodiesel, and vegetable oil exports from Mozambique to the EU. However, only ethanol and biodiesel produced in compliance with the EC's recently published sustainability criteria will be eligible for the market incentives for biofuels sold on the EU market.

Mozambique also has duty-free access to the US market under the Generalized System of Preferences (GSP) which grants reduced duty or duty-free access to developing countries. This was extended by the African Growth and Opportunity Act (AGOA) in 2000, a United States Trade Act that significantly enhances US market access for (currently) 39 sub-Saharan African countries, including Mozambique.

The SADC Trade Protocol is an agreement between eleven SADC members[17] aimed at promoting regional trade in the bloc. Under this agreement, tariffs on intra-regional trade of certain goods have been eliminated or substantially reduced. Tariffs on so-called 'sensitive goods' are to be eliminated by 2012, although final details remain under discussion, and Mozambique has until 2015 to comply. When fully implemented, the protocol will give Mozambican products duty-free access to a market of over 200 million people with a GDP of US$275 billion, with reciprocal treatment for the goods from the other members (Embassy of the United States, 2006). However, in the case of biofuels, the final size of the regional market, and Mozambique's access to it, will depend on the establishment of harmonized fuel standards and blending mandates or authorization in the other member countries.

4.5.2. Land law

According to the Constitution, all natural resources in Mozambique, including land, belong to the state. Land acquisition procedures are governed by the Land Law (Law No. 19/97 of 1 October 1997) and its Regulation (Decree No. 66/98 of 8 December 1998) and culminate in the attribution of a 50-year renewable lease in the form of a land title or DUAT (*Direito de Uso e Aproveitamento da Terra*). Article 3 of the Land Law states that: "Land is the property of the State and cannot be sold or otherwise alienated, mortgaged or encumbered", and establishes three means of acquiring land:

1. Through existing occupation established by customary norms and practices (Land Law Article 12 and Regulation of the Land Law Article 9). This includes used and

[17] Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

unused (fallow and common) lands that a rural household needs to have access to and control over for a certain period of time;

2. Through existing occupation 'in good faith' (Land Law Article 12 and Regulation of the Land Law Article 10) when people have occupied the land for at least ten years without challenge, which aims to protect the rights of displaced persons that settled in lands during the civil war that were formerly owned by colonial powers, and;
3. Through a formal request to the State (Land Law Article 12 and Regulation of the Land Law Article 11).

Article 13 of the Land Law and Article 27 of the Regulation of the Land Law state that formal requests to the State must be accompanied by a community consultation, which seeks to ensure that community rights are taken into account and provides an opportunity for communities to negotiate some element of compensation or benefit with investors. The Land Law (Article 11) and its Regulation (Article 18) require that foreigners have an approved investment project in order to apply for a DUAT.

Land-requests submitted to the government are evaluated initially by the relevant government departments that oversee the activity at provincial level (Regulation of the Land Law Article 24 (2) and Article 26 (1)). When the area requested is greater than 1,000 ha and therefore no longer the remit of the Provincial Governor alone, evaluations are requested from the relevant government departments at national level, and requests have to be authorized by the Minister of Agriculture (Regulation of the Land Law Article 26 (3)). Where proposals involve areas of more than 10,000 ha or investment values greater than US$100 million, they have to be submitted to the Economic Council (comprising the key Ministries involved in the social and economic sector) and Council of Ministers (Land Law Article 22 (3)) for approval.[18] Provisional DUATs are attributed for two years to foreigners and five years to nationals, after which definitive DUATs are allocated, subject to review by the government that production plans have been fulfilled.

4.5.3. Investment law

The basic legal framework for investment in Mozambique is established by Law No. 3/93 (the Investment Law of 1993). The Regulation, approved by Decree No. 14/93 in 1993 and subsequently altered by Decree No. 36/95 in 1995, defines the procedures for project evaluation. The government's Investment Promotion Centre (CPI) is responsible for implementing the legislation. All investment proposals have to be signed off by the Minister for Planning and Development, which oversees CPI.

Government approval of an investment project is necessary to gain access to certain fiscal benefits provided under the Code of Fiscal Benefits (Law No. 4/2009 of 12 January 2009),

[18] Article 15 of the Regulation of the Investment Law. This article states that agricultural projects of over 5,000 ha and forestry and livestock projects of over 10,000 has should be submitted to the Council of Ministers. However, Article 22 (3) of the Land Law, which stipulates that requests for over 10,000 ha should go to the Council of Ministers seems to have taken precedence.

which altered Decree No. 16/2002 of 27 June 2002, subsequent to the original Code of Fiscal Benefits approved by Decree No. 12/93 of 21 July 1993. The Code of Fiscal Benefits is expressed in a legal agreement between the government and the investor. It establishes incentives for investors to locate production in less-developed provinces. Two location-specific incentives are granted:

- Investment tax credits for five years are provided, equal to 5% of total realized investment in Maputo City province and 10% for other provinces. A greater distinction is made in relation to designated "rapid development zones", which are privy to a tax credit equivalent to 20% of total realized investment. These are geographical areas which have "great natural resource potential but which are lacking in infrastructure and have a weak level of economic activity" (Code of Fiscal Benefits). These include the Zambezi river valley, which covers all districts in Tete province, most districts in Zambezia and Sofala provinces and four districts in Manica province, Niassa province and Nacala district.
- Deduction of expenditure on infrastructure undertaken by the investor, equal to 110% of expenditure for projects located in Maputo City province and 120% of expenditure for projects in other provinces. No additional benefit is granted for the rapid development zones.

In September 2009, the government of Mozambique announced its plans to create special duty-free industrial areas in the city of Nacala-Porto, Nampula province. The objective is to promote social and economic development of some provinces in the centre and north of the country, namely Zambezia, Tete, Niassa and Cabo Delgado (Macauhub, 2009a). This is most relevant for processing activities, which are heavily dependent on the use of imported goods and machinery.

4.5.4. Linking land and investment

Until recently, the process for evaluating land title requests and the evaluation of investment proposals linked to these requests were quite separate. The land title process concentrated mainly on the administrative steps laid down by the Land Law and its Regulation, while investment proposals were evaluated by CPI.

As a consequence of the increase in expressions of interest for large tracts of land, the government made two changes to the project review procedure. Firstly, it tightened the link between the processes for awarding land titles and approving investment proposals. Whereas previously a proposal for a large-scale investment project could be approved by the Council of Ministers independently of the land process, from 2007, investment and land-requests had to be submitted together to the Council of Ministers, with the two processes being launched simultaneously (Circular No. 009/DNTF/07 of 16 October 2007). In addition, the Provincial Governor had to submit an evaluation of both the land request and investment project.

Secondly, at the end of 2008, the Council of Ministers approved the introduction of Investment Guidelines (Resolution 70/2008). These are applied to large-scale projects, defined as more than 10,000 ha, establishing the type of information required for the presentation of projects to the Council of Ministers for their analysis. This now represents the legal basis for the evaluation of large-scale agrarian projects, including many of the biofuels projects submitted to the government.

4.5.5. National Biofuel Policy and Strategy (NBPS)

On 21 May 2009 the Mozambican government published a national biofuels policy and strategy (Resolution 22/2009), partly based on a study on the technical, economic, social and environmental feasibility of biofuel production in Mozambique (Econergy, 2008). The Resolution, approved by the Council of Ministers, aims to contribute to energy security and sustainable socioeconomic development by exploiting agro-energetic resources through stimulating the diversification of the energy matrix, contributing to the well-being of the population and promoting socioeconomic development, particularly in rural areas (Government of Mozambique, 2009 p. 15).

The policy and strategy describes several measures intended to promote biofuel production while limiting potential negative impacts on society and the environment. Some of the important political and strategic pillars are: proposed limits on land allocation to biofuel production on the basis of suitable agro-climatic regions through land zoning; approval of selected feedstocks, namely sugarcane and sweet sorghum for ethanol, and coconut and jatropha for biodiesel; the use of sustainability criteria to select investment projects and allocate land titles; the creation of a domestic market for biofuels via blending mandates, which will be gradually phased in at increasing levels; increase export to create tax revenues and foreign currency; the promotion of regional markets for biofuels; and the establishment of tariffs for the purchase of electricity produced from biomass, particularly cogeneration of electricity as a by-product of the ethanol production process.

While the biofuels policy and strategy provides a general framework and guidelines for the development of the sector, further legislation in the form of Regulations will provide the necessary detail on the pricing mechanism for domestic sales of biofuels; the Biofuels Purchasing Programme, which will probably be based on an auctioning system; the level of fiscal incentives provided to the sector, in the form of substantial discounts on the existing fuel tax; the levels of blending mandates; and the level of tariffs to be established for cogenerated electricity produced from bagasse.

The NBPS states that: "With modest expectations of biofuel expansion to 450,000 ha, combined with compulsory blending of E10 (10% of ethanol with 90% of gasoline) and B5 (5% of biodiesel with 95% of fossil diesel), the biofuel industry is expected to generate substantial macroeconomic benefits, including the reduction of oil imports and the creation of approximately 150,000 direct and indirect new jobs" (Government of Mozambique, 2009 p. 17-18).

4.6 Mozambique's biophysical potential

Mozambique has unexploited natural resources, favourable agricultural conditions and abundant labour that give it enormous economic potential for overcoming the present state of underdevelopment (Rebello Da Silva and Da Silva Garrilho, 2003 p. 65; Diao et al., 2007). The most recent exercise that summarizes Mozambique's biophysical potential on a national scale is the agro-ecological zoning carried out between October 2007 and May 2008. The zoning was coordinated by an inter-ministerial working group in which the National Institute of Agrarian Research (IIAM) identified the agro-climatic suitability of different areas, and the National Directorate for Land and Forestry (DNTF) assessed land availability. The zoning was carried out at a scale of 1:1,000,000, capturing contiguous areas of more than 1,000 ha. Underpinning this exercise are a range of existing studies, including a national forestry inventory, soil and climate data and maps of agro-climatic suitability for different crops, including several potential biofuel feedstocks such as sugarcane and jatropha. Land availability was determined by excluding existing DUATs (community or private), mining areas, projects submitted for approval, and projects 'in the pipeline'.

	Agro-ecological zoning exercise (IIAM and DNTF, 2008)		Annual biomass production potential for 2015 based on Batidzirai et al. (2006 p. 61)	
Province	Total available land (ha)	% of total available land	Annual biomass production potentials (in PJ for 2015)	% of total biomass production potential
Zambezia	1,365,300	19.6%	883	13.2%
Niassa	1,220,400	17.5%	1,176	17.6%
Inhambane	1,071,660	15.4%	113	1.7%
Gaza	866,780	12.4%	234	3.5%
Nampula	709,160	10.2%	1,144	17.2%
Tete	661,730	9.5%	576	8.6%
Sofala	408,650	5.9%	545	8.2%
Manica	381,950	5.5%	642	9.6%
Cabo Delgado	269,400	3.9%	1,286	19.3%
Maputo	11,000	0.2%	71	1.1%
Total:	6,966,030	100.0%	6,670	100.0%

Table 4.1. Available land per province according to the agro-ecological zoning exercise and estimated annual biomass production potentials.

The land zoning exercise identified 6,966,030 ha as being available for large-scale agricultural, forestry and livestock activities (IIAM and DNTF, 2008). Table 4.1 shows the distribution of available land per province (excluding Maputo City province).

Table 4.1 also includes work by Batidzirai et al. (2006) who studied Mozambique's annual biomass production potential for 2015 based on climate and soil characteristics. This study's main conclusion was that Mozambique has an estimated annual biomass production potential for 2015 of 6,670 PJ using surplus land under moderate agricultural technological inputs.

While the land zoning exercise provided an important basis for guiding the government in its land allocation decisions, several concerns exist in relation to its reliability and usefulness:

- The current scale is too large to allow for more than a broad overview of land availability;
- Most of the soil suitability data were out-dated and analysis of agro-climatic suitability was based on rainfall data from the 1980s;
- The zoning only considered water availability from rainfall, excluding opportunities for irrigated agriculture near rivers.

In addition, the accuracy of the land availability data has been called into question. A random locality in Mozambique identified as available based on 1km^2 satellite databases turned out to be extensively utilized and inhabited when viewed at the finer resolution provided by Google Earth™ (Watson, 2008 p. 13). A more accurate land zoning exercise is currently being carried out on a scale of 1:250,000.

4.7 Social and economic factors

This section describes and discusses the social and economic factors that influence biofuel developments in Mozambique. It focuses on the availability and quality of labour force, and access to infrastructure and services.

A rough indicator of potential labour force is population density per province. Mozambique has an average population density of 20.1 people per km^2 (WFP, 2009). In 2000, population rates per km^2 were highest for Nampula, Maputo and Zambezia provinces. Population density was lowest found in Niassa and Tete provinces (Table 4.2).

Quality of labour can be expressed in literacy rates, Net Enrolment Rates (NER), and achievement levels of formal education. According to the Mozambican Household Survey 2002-2003, adult literacy rates are around 50%.[19] There is evidence of large differences in literacy rates between rural households (27%) and urban households (66%) (Castanheira Bilale, 2007 p. 78). Manica, Maputo, and Maputo City province achieved much higher literacy levels than the national average while in most other provinces, adult literacy rates were below the average, with Cabo Delgado and Nampula at the lower end. In rural areas, on average 80.7% of adult residents did not have any formal education (Castanheira Bilale, 2007 p. 82). In Nampula, Zambezia, Cabo Delgado and Tete between 70% and 82% of the population had no formal education, and between 10% and 20% had only achieved primary education. Looking at current school enrolment figures (NER) we found that around 80% of children between 6 and 18 years of age are enrolled at school. The difference between

[19] HDI for 2007 indicated average literacy rates 44.4% for population above 15 years, but of this data specification per province was not available.

provinces was still present, with Maputo, Maputo City, Gaza, Inhambane and Manica provinces amongst the highest, and Nampula, Tete, Sofala, Cabo Delgado, Niassa and Zambezia provinces at the lower end (Table 4.2).

Province	Population density (population per km^2) (CAP 1999-2000 quoted in: Coughlin, 2006 p. 6)	Literacy rates (Castanheira Bilale, 2007 p. 77)	NER (Castanheira Bilale, 2007)
Maputo City	Not included	77%	93%
Nampula	37.8	32%	69%
Maputo	35.6	67%	94%
Zambezia	28.1	40%	77%
Sofala	19.1	47%	71%
Cabo Delgado	16.4	28%	72%
Inhambane	16.4	52%	86%
Manica	15.6	60%	84%
Gaza	14.0	53%	90%
Tete	11.3	45%	70%
Niassa	6.2	49%	74%
Average:	20.1	50%	80%

Table 4.2. Population density, literacy rates and Net Enrolment Rates (NER) per province.

Portuguese colonization and armed conflicts destroyed and uprooted most of Mozambique's social and physical infrastructure (Newitt, 1995 p. 570; Arndt et al., 2000). Cooperatives and unions were systematically destroyed and service provision, such as access to agricultural inputs and extension, disappeared. Despite the sustained recovery since peace was reached in 1992 and efforts to improve infrastructure and distribution networks, access remains poor and patchy between provinces. In 2002, the highest level of communities with access to improved seeds, fertilizers and pesticides were found in Manica, Sofala and Inhambane provinces, while Tete was the lowest (TIA 2002 in Coughlin, 2006 p. 13). Access to extension services was low in every province with an average of 1.3 extension workers per 10,000 inhabitants (MADER 2004 in Coughlin, 2006 p. 32).

Despite recent investments in roads, the density of the road network is the lowest in southern Africa, at only 32 kilometres per km^2 (World Bank, 2006b p. xvi). "Under the Portuguese colonial government, roads and railways were mainly laid to facilitate the exportation of agricultural produce from Malawi, Zambia and Zimbabwe" (Coughlin, 2006 p. 6). The deep-sea ports of Maputo, Beira and Nacala are still used by Mozambique's neighbouring countries to export and import a substantial part of their commodities (Meeuws, 2004 p. 5). These ports have (fuel) storage facilities and are well accessible by road. Poor north-south infrastructure makes transport by road inside the country more costly than exporting from the nearest port (cf. World Bank, 2005 p. 60; Coughlin, 2006 p. 6).

Efforts to provide electricity to rural Mozambique are mainly concentrated around urban centres, such as the Beira and Maputo corridors, and along the coast (OCIN, 2006). There are plans for building of a 1,000 km north-south power line, linking hydroelectric, coal- and gas-fired power stations in central and northern Mozambique with the main consuming areas in the south (EarthTimes, 2009).

4.8 Reality of biofuel developments in Mozambique

This section presents an overview of the developments in the biofuel sector that have taken place in Mozambique since 2006, based on projects formally submitted to the Government of Mozambique, and an inventory of other implemented projects and expressions of interest. Given that individual investment proposals contain sensitive information, we have summarized the data in such a way that confidentiality is assured. Subsequently we have added an overview of the existing and planned biofuel-related infrastructure, such as processing and storage facilities.

We are aware that not all biofuel projects are actually being implemented at this stage. The objective of our inventory is therefore not to be speculative, but merely showing the areas where projects are being developed to provide a basis for further analysis of what is driving biofuel developments in Mozambique.

4.8.1 Formally submitted biofuel projects

Up to December 2008, the Government of Mozambique had officially received 17 biofuel-related investment proposals. Of these projects, 12 were related to biodiesel production and five to bioethanol production. The majority of investors originate in Europe or South Africa, often engaged in partnerships with Mozambican counterparts. The core business of nearly all biodiesel projects is growing jatropha seeds to extract oil for the production of biodiesel. The bioethanol projects mainly focus on sugarcane as a feedstock, with some interest in sweet sorghum and cassava. Some of the projects have ancillary activities, such as production of seedlings or food production. The biodiesel investors requested 179,404 ha of land; the bioethanol investors 66,000 ha.

As Table 4.3 demonstrates, the proposed biodiesel projects amount to a total investment of US$298 million and the bioethanol projects US$1003 million. Average investment per hectare shows that sugarcane production is far more capital intensive than producing jatropha, mainly driven by higher planting density, and costly investments in irrigation systems and ethanol distilleries. Total employment creation is expected to be between 34,018 and 42,220 jobs. The available data shows that the biodiesel projects intend to create between 25,093 and 30,263 employment places (around 73% of total). The bioethanol projects account for between 8,925 and 11,956 jobs (around 27% of the total) mainly depending on whether cane will be harvested manually or mechanically. Average employment per hectare does not differ much between the bioethanol and biodiesel sector. For the whole biofuel sector, the estimated employment potential is between 0.14 and 0.17 jobs ha^{-1}.

	Bioethanol projects		Biodiesel projects		Total
#	5	29%	12	71%	17
Land formally requested (ha)	66,000	27%	179,404	73%	245,404
Investment (US$ million)	1,003	77%	298	23%	1,301
Average investment per requested ha (US$)	15,197		1,663		5,303
Employment (jobs)	Between 8,925 and 11,956	26% – 28%	Between 25,093 and 30,264	72% – 74%	Between 34,018 and 42,220
Employment per requested ha	Between 0.14 and 0.18		Between 0.14 and 0.17		Between 0.14 and 0.17
Main crop	Sugarcane		Jatropha		
Other crops	Sweet Sorghum, Cassava		–		
Estimated yields	113.3 t cane ha^{-1}		2.64 t jatropha oil ha^{-1}		
Market	Mostly EU		Mostly EU		

Table 4.3. Analysis of the 17 biofuel investment proposals based on collaboration with CEPAGRI.

The 12 biodiesel projects aim at an average production of 2.64 t jatropha oil ha^{-1} yr^{-1}. Research shows that yields depend highly on the growing conditions of the crop. Recent studies indicate a maximum of 2.72 t jatropha oil ha^{-1} yr^{-1}, calculated on the basis of full radiation, high temperatures and year-round canopy cover, no limitations due to lack of water or nutrients, and the absence of plagues and diseases (Jongschaap et al., 2007 p. 28). Achieving these yields in practice will be extremely difficult, if not impossible.

The average expected yields by the three biggest sugarcane projects are 113.3 t cane ha^{-1}. By comparison, the best average yield for the Mozambican industry over the past five years was 72 t ha^{-1} and the best average company yield over the same period was 87 t ha^{-1} (CEPAGRI, 2009). Data from the Brazilian sugarcane sector shows averages of 77.6 t ha^{-1} in 2007 for dry-land cane (FAOSTAT, 2009).

Most projects intend to supply the domestic and regional (SADC) markets, as well as targeting the EU and broader international markets. However, since the EU has announced its renewable energy targets for 2020 (20% renewables, 10% blending of biofuels for the transport sector), the European market seems to be the premium market, where the highest prices will be paid. Most interviewed investors and experts confirm that initially: “Most of the ethanol produced in Mozambique will be exported to the EU” (Engineering News/ Reuters, 2009).

Dropping fossil-fuel prices and the financial crises have had their impact on the biofuel sector in Mozambique. In 2009, only five biofuel-related investment proposals have been received, which is much lower as compared to the proposals received in 2008.

	Principle Energy Ltd.	Procana Ltd.	Enerterra SA	Grown Energy Zambeze Ltd.	Total
Province	Manica	Gaza	Sofala	Sofala	
Land (ha)	18,000	30,000	18,920	15,000	81,920
Investment (US$ million)	290	500	53	212	1,055
Investment per ha (US$)	16,111	16,667	2,801	14,133	
Employment (seasonal)	The two projects should generate between 7,000 and 10,000 jobs		5,000		Between 14,163 and 17,163
Employment (permanent)			total: 5,025	total: 2,138	
Mozambican			20	2,104	
Foreign			5	34	
Average jobs per ha	Between 0.15 and 0.21		0.27	0.14	Between 0.17 and 0.21
Main crop	Sugarcane	Sugarcane	Jatropha	Sugarcane	
Production (per year)	212 million litres of ethanol	298 million litres of ethanol	*No data*	100 million litres of ethanol	
Market	Mostly EU	Mostly EU	10% domestically; 90% EU	10% domestically; 90% EU, USA and Japan	

Table 4.4. Analysis of the four formally approved biofuel projects.

Table 4.4 shows the characteristics of the four formally approved biofuel projects (based on: Noticias, 21 August 2009; Allafrica.com, 2007, 2009a; Engineering News/ Reuters, 2009).

In October 2007, the first large-scale bioethanol project was formally approved. Procana Ltd., with a total investment of around US$500 million according to Allafrica.com (2007), is a Mozambican company in which the London-based Bioenergy Africa Ltd. is the main shareholder. Procana obtained a DUAT for 30,000 ha for irrigated sugarcane production southeast of Massingir (Gaza province). In July 2008, Principle Energy Ltd., also a London-based renewables energy company, was granted access to 18,000 ha in Dombe (Manica province). Like Procana, Principle Energy's main objective is to produce irrigated sugarcane for bioethanol production. Both projects intend to build on-site ethanol refineries where the sugarcane can be processed, and should generate between 7,000 and 10,000 jobs, depending on whether cane is harvested manually or mechanically (Allafrica.com, 2009b).

On 6 October 2009 one of the major shareholders in Procana, Bioenergy Africa Ltd., announced an adaptation of investment policy and change of name. Based on a review of a 23 month period ending on 31 March 2009, the Directors believed that: "The global economic climate and current reduced interest in non-carbon related fuel products will make it difficult for the Company to raise the necessary financing required under the Massingir Investment Agreement" (BioEnergy Africa Ltd., 2009a). For the 23 month period under review, BioEnergy Africa is reporting a pre-tax loss of US$7.7 million (BioEnergy Africa Ltd., 2009b). The company intends to suspend further material investment in the Massingir Project. By the end of November 2009, the company's name and website had already been changed to Sable Mining Africa Ltd. In December 2009, the government voided the DUAT of Procana Ltd. because the company failed to comply with its contractual obligations (United Press International, 2009).

In August 2009, the Council of Ministers granted land titles to Enerterra SA and Grown Energy Zambeze Ltd., both in Sofala province. Enerterra SA is a company with Portuguese and Mozambican interests, which has been granted 18,920 ha for the production of jatropha (Allafrica.com, 2009a). Grown Energy Zambeze Ltd., which has Mozambican, Asian and South African shareholders, has been granted 15,000 ha for the cultivation of sugarcane and sweet sorghum for ethanol production and energy generation for the national grid. Grown Energy Zambeze is planning to construct an on-site ethanol distillery. In addition, beans and soya will be grown, in combination with livestock production. The project has budgeted a social fund of US$2.7 million to support education, health, infrastructure and electrification of the area (Noticias, 21 August 2009).

While the 17 investments proposals aim at creating an average of between 0.14 and 0.17 jobs ha^{-1} (Table 4.3), the estimates of the four formally approved projects are slightly higher at an average of between 0.17 and 0.21 jobs ha^{-1}. This is however, still much lower compared to government projections of 150,000 new jobs for 450,000 ha (0.33 new jobs ha^{-1} including self-employment for entrepreneurs) (Government of Mozambique, 2009 p. 18).

The other investment proposals are under consideration prior to potential approval, or are in the process of conducting baseline studies and Environmental and Social Impact Analysis. From interviews we know that one biodiesel project officially withdrew from the application procedure (this project, just like Procana is however included in our analysis of the investment data). We know that some projects are close to formal approval, others face difficulties getting their activities financed or are 'shelved'.

The fact that a project is not formally approved does not mean that no activities are being undertaken. Some of the projects have been granted land rights to start experiments and nurseries. However, fieldwork experiences showed us that some projects have already started bush-clearing, infrastructure, housing and plantation activities. We know of at least one biodiesel project that started operating on land rights transferred from another company. DUATs are transferrable, meaning that the name of the DUAT-holder and assets can be sold without effectively having to get a new DUAT. However, DUATs are linked to specific feedstocks and production plans, such that investors have to receive authorization from the government if land acquired in this way is intended for other use.

Reasons of confidentiality only allowed us to explicitly name the projects that have been formally approved in Figure 4.2. The map contains 18 dots as one project intends to work at two different locations.

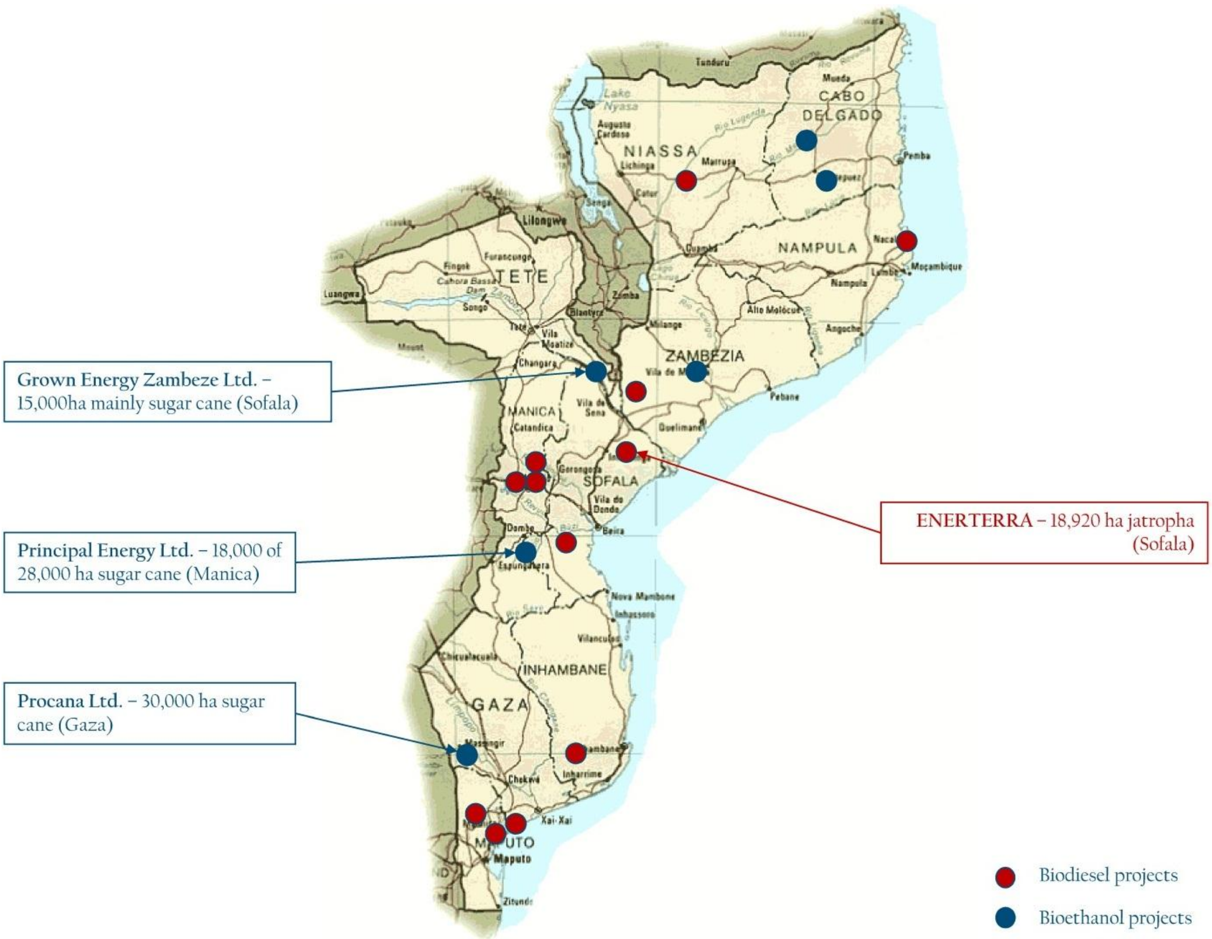


Fig. 4.2. Geographical spread of biofuel projects that formally submitted investment proposals to the Government of Mozambique and the four biofuel projects that have been officially approved at national level.

Province	Agro-ecological zoning exercise (IIAM and DNTF, 2008) Total land availability (ha)	% of total land available	Investment proposals formally submitted for approval to Government of Mozambique Formal land requests (ha)	% of total formal land requested	% of land requested compared to land availability (zoning)
Zambezia	1,365,300	19.6%	72,618	30%	5.3%
Niassa	1,220,400	17.5%	1,300	1%	0.1%
Inhambane	1,071,660	15.4%	11,000	4%	1.0%
Gaza	866,780	12.4%	30,138	12%	3.5%
Nampula	709,160	10.2%	15,050	6%	2.1%
Tete	661,730	9.5%	0	0%	0.0%
Sofala	408,650	5.9%	43,920	18%	10.7%
Manica	381,950	5.5%	57,122	23%	15.0%
Cabo Delgado	269,400	3.9%	2,000	1%	0.7%
Maputo	11,000	0.2%	12,256	5%	111.4%
Total:	6,966,030	100.0%	245,404	100%	3.5%

Table 4.5. Land availability (agro-ecological zoning) versus land-request per province (17 formally submitted investment proposals).

In Table 4.5 we compare land requested by the formally submitted proposals per province with the land availability per province as was identified through the 2008 agro-ecological zoning (scale 1:1,000,000). Except for Maputo province, the requests are still within the amount of land available per province. In total, investors requested for 3.5% of the total available land identified during the agro-ecological zoning of 2008.

Provinces	Agro-ecological land zoning (IIAM and DNTF, 2008) Land identified as available (ha)	% of total land available	Investment proposals formally submitted to Government of Mozambique Requested land (ha)	% of total land requested
Maputo, Gaza, Inhambane, Manica and Sofala	2,740,040	39%	154,436	63%
Tete, Niassa, Cabo Delgado, Zambezia and Nampula	4,225,990	61%	90,968	37%
Total:	6,966,030	100%	245,404	100%

Table 4.6. Land requested compared to land availability per region.

As our analysis shows, the majority of available land can be found in the northern provinces of Mozambique; Zambezia, Niassa, Tete, Nampula and Cabo Delgado, representing 4,225,990 ha or 61% of the total available land. The central and southern provinces - Manica, Sofala, Inhambane, Gaza and Maputo - represent the remaining 2,740,040 ha or 39% of the total 6,966,030 ha. When looking at the formal land-requests by biofuel investors, we find the opposite: 63% or 154,436 ha of the total land requested is located in Manica, Sofala, Inhambane, Gaza and Maputo provinces, and the remaining 90,969 ha (37%) in Zambezia, Niassa, Tete, Nampula and Cabo Delgado provinces (Table 4.6).

4.8.2 Other implemented biofuel projects and expressions of interest

Besides the investment proposals that were formally submitted to the Mozambican government, a wide variety of other biofuel projects are being implemented and explored in Mozambique. These projects are very heterogeneous, ranging from large-scale commercial to smallholder development projects each with their own specific approach, objectives and markets.

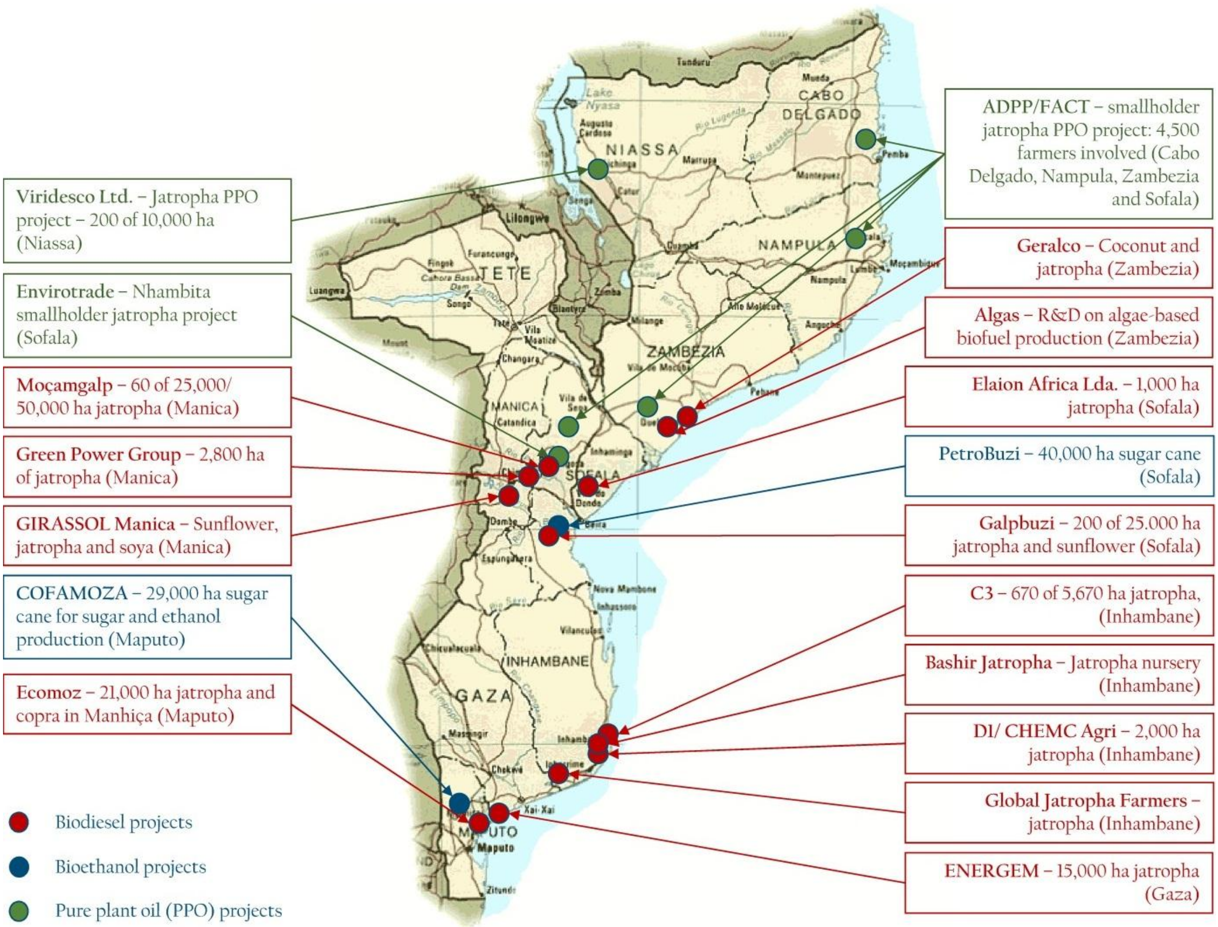


Fig. 4.3. Geographical spread of other implemented biofuel projects and expressions of interest.

Figure 4.3 illustrates the geographical spread of the projects, distinguishing between bioethanol, biodiesel and projects producing pure plant oil (PPO). The PPO-projects mainly focus on producing jatropha oil by smallholders for local energy use. The success of these smallholder projects ranges enormously. Where some projects are already harvesting, collecting, and pressing jatropha seeds, other initiatives have been abandoned by farmers due to bad performing jatropha and lack of agronomic management skills on how to prune, control pests and viruses (Bos et al., 2010).

In line with the formally submitted projects, Figure 4.3 demonstrates a concentration of biofuel activities in the Beira corridor, around Quelimane and along the southern coast between Maputo and Inhambane. The majority of projects focus on jatropha as feedstock, either to produce PPO or biodiesel as end-product.

4.8.3 Existing and planned processing and storage facilities

Mozambique currently has four operating sugar mills; Marromeu and Mafambisse sugar mills (Sofala province), and Xinavane and Maragra sugar mills (Maputo province) (see Figure 4.4). None of these sugar mills are currently producing ethanol, but by showing their location, we seek to indicate which areas potentially provide access to goods and services related to the emerging biofuel sector in Mozambique. One of the sugar producers – Tongaat Hulett (with shareholding in Mafambisse and Xinavane sugar estates and mills) – recently expressed their intention to move into the bioethanol market over the next few years, requiring a mandatory 10% blending regime to kick-start renewable energy programs (BusinessReport, 2009). There is one operating distillery in Mozambique in the Buzi region about 50 km from the Beira port. This distillery, with installed capacity of 3 million l yr^{-1}, produces alcohol for beverages and pharmaceutical applications using molasses as a feedstock (Econergy, 2008 p. 192).

While no biodiesel was produced prior to 2006, Mozambique produces oilseeds and has a small vegetable oil industry. The domestic oilseeds industry is composed of small- and medium-sized companies whose production is monitored by the Ministry of Industry and Commerce (MIC) (Econergy, 2008 p. 130). Eight oil production facilities are registered with the MIC. In general, refined oil is processed from raw copra oil. Raw copra oil has two markets: the domestic soap industry, and export, primarily to South Africa for the cosmetics industry (Econergy, 2008 p. 130). The domestic oil refining industry relies heavily on imported oils to supplement domestic supply.

There exists an embryonic biodiesel sector in Mozambique, using coconut oil, and occasionally palm oil as feedstock (Econergy, 2008 p. 131-132). As the prices of coconut oil went up significantly, the opportunity cost of using the oil for biodiesel rather than sale on the international market was too high. The most prominent biodiesel project is Ecomoz, in which Mozambique's oil company PetroMoc has a 30% share. Ecomoz started operating in 2007, mainly using coconut oil as feedstock. The product is refined in Matola, Maputo province. The refinery has a capacity of 100,000 l day^{-1}, but limited quantity and quality of feedstock is preventing this potential from being achieved. Currently, Ecomoz sells its biodiesel to PetroMoc, using it in their company's cars while awaiting approval of the blending license to sell to the market. Ecomoz is planning to expand production and use 21,000 ha in Manhiça district to produce jatropha and copra (PetroMoc, 2009).

Fig. 4.4. Locations of existing biofuel-related processing facilities.

Besides the existing facilities, the Mozambican government is rehabilitating, expanding and modernizing three PetroMoc storage facilities in Nacala, Beira and Maputo. A new facility of 95,000m^3 is constructed in Beira. Storage facilities which are in study are located in Vandúzi Manica, Beira and Maputo/Porto de Dobela (PetroMoc, 2009). These units are not specifically designed for biofuels but aim to be versatile and accommodate normal fossil-fuel, gas, biofuels and all kind of liquid fuels that will be necessary (personal communication PetroMoc).

Galpbuzi, a consortium made up of Mozambican company *Companhia do Buzi* and Portugal's Galp Energia presented its long term plans to set up a biofuel refinery in the town of Buzi, in Sofala province. Mentioning that the project needed an area of 8,000 ha, the General Manager explained they are planning to invest US$140,000, with part of production expected to be exported and the remainder used for domestic consumption (Macauhub, 2009c). British company Sun Biofuels also announced the construction of a factory to refine biodiesel from jatropha near Chimoio in Manica province aiming at producing around 20,000 l of biodiesel per year (Macauhub, 2009b). Petrobuzi (PetroMoc) intends to construct an on-site ethanol distillery (CPI, 2009), just like Procana, Principle Energy and Grown Energy Zambeze. As Procana's contract was recently voided by the government, it is unclear if this facility will be constructed.

Figure 4.5 presents the location of planned processing and storage facilities. According to our inventory, there is a strong concentration of planned processing and storage facilities around Beira. It must be noted that many issues related to feedstock quantity, economic sustainability and administrative procedures have to be resolved before individual projects can justify establishing processing and storage facilities.

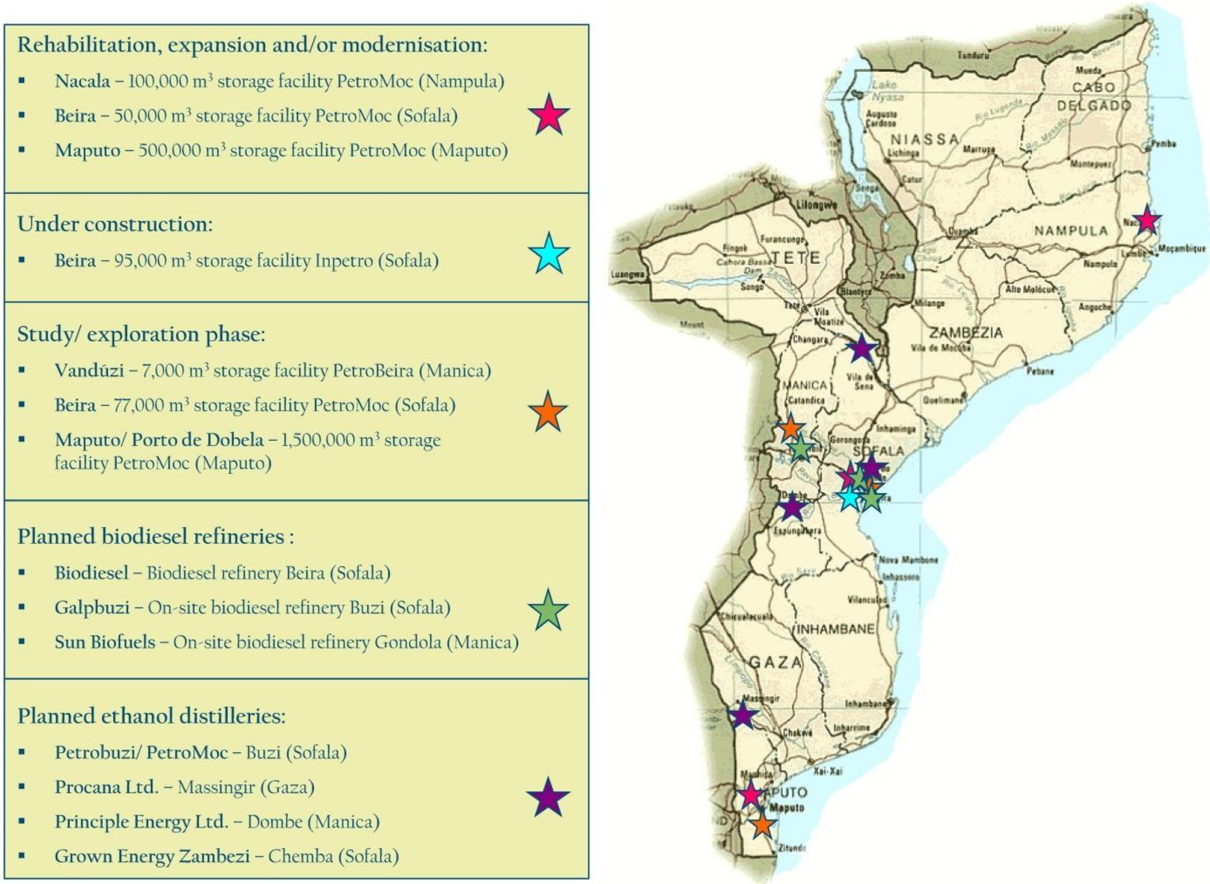


Fig. 4.5. Location of existing and planned processing and storage facilities.

4.8.4 Overview of biofuel developments in Mozambique

Figure 4.6 brings together all implemented biofuel projects and expressions of interest. We added existing and planned biofuel-related processing and storage facilities, and indicated the concentration of activities. It shows that the highest concentration of biofuel activities can be found around Maputo up to Inhambane, and in and around the Beira corridor, followed by the south of Zambezia province around Quelimane and the north of Nampula province and the south of Cabo Delgado province.

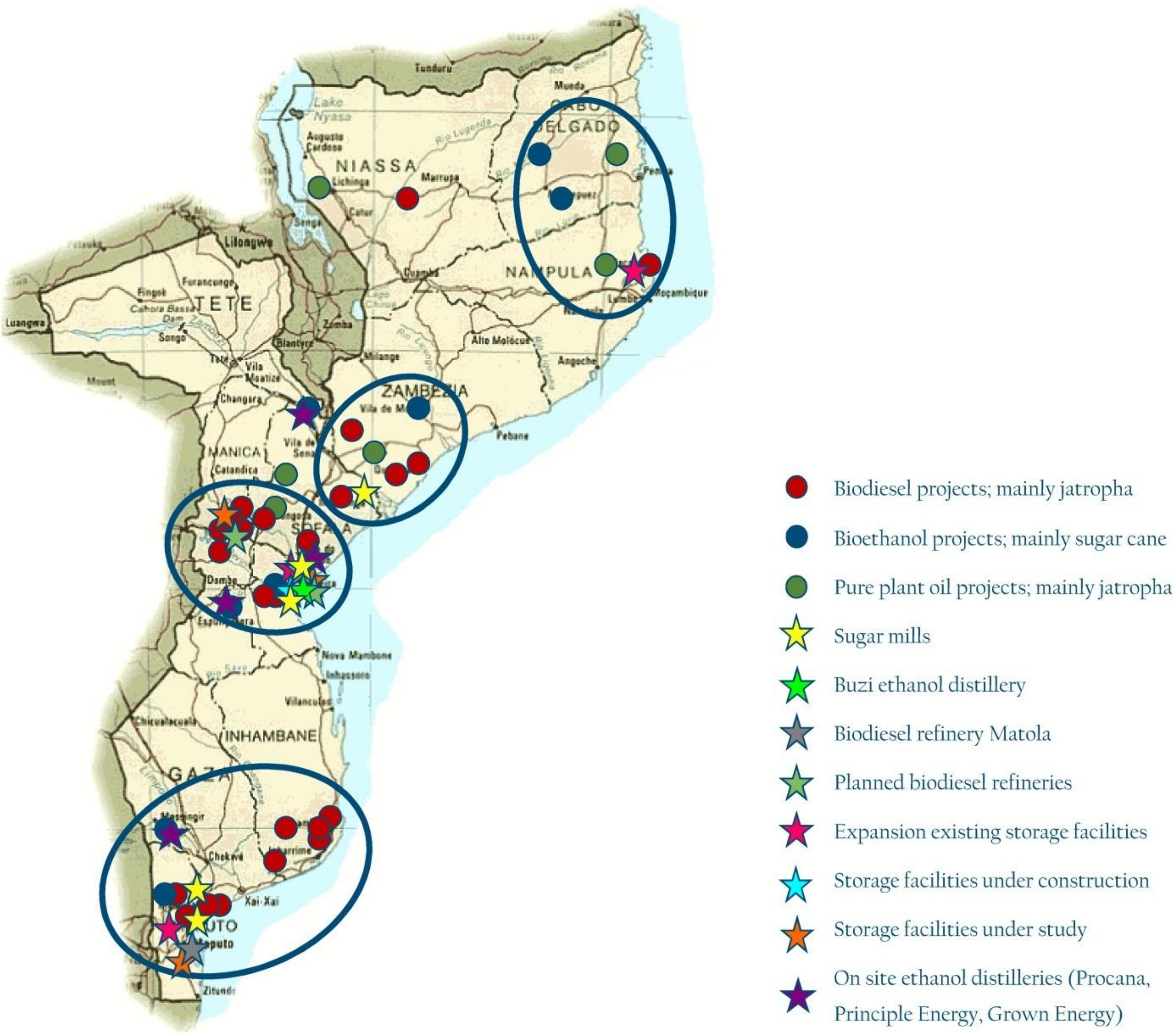


Fig. 4.6. Geographical spread of biofuel developments in Mozambique.

Table 4.7 summarizes the inventory of formally submitted proposals, other implemented biofuel projects, expressions of interest, and existing and planned biofuel-related processing and storage facilities per Mozambican province.

	Bioethanol projects				Biodiesel and PPO projects				Total projects		Processing and storage facilities		Total	
Province:	# formal	# other	# total	%	# formal	# other	# total	%	#	%	# total	%	#	%
Maputo	0	1	1	14%	2	1	3	10%	4	11%	5	24%	9	15.3%
Gaza	1	0	1	14%	1	1	2	6%	3	8%	1	5%	4	6.8%
Inhambane	0	0	0	0%	1	4	5	16%	5	13%	0	0%	5	8.5%
Sofala	1	1	2	29%	2	4	6	19%	8	21%	11	52%	19	32.2%
Manica	1	0	1	14%	3	3	6	19%	7	18%	3	14%	10	16.9%
Tete	0	0	0	0%	0	0	0	0%	0	0%	0	0%	0	0.0%
Zambezia	1	0	1	14%	1	3	4	13%	5	13%	0	0%	5	8.5%
Niassa	0	0	0	0%	1	1	2	6%	2	5%	0	0%	2	3.4%
Nampula	0	0	0	0%	1	1	2	6%	2	5%	1	5%	3	5.1%
Cabo Delgado	1	0	1	14%	0	1	1	3%	2	5%	0	0%	2	3.4%
Total:	5	2	7	100%	12	19	31	100%	38	100%	21	100%	59	100%

Table 4.7. Analysis of biofuel developments per Mozambican province.

As Table 4.7 demonstrates, 71% of biofuel projects (formally submitted and other projects) are located in Maputo, Gaza Inhambane, Sofala and Manica provinces. The remaining 29% of biofuel projects are located in Zambezia, Niassa, Nampula and Cabo Delgado provinces.

Of the existing and planned processing and storage facilities, 90% are located in Maputo, Manica and Sofala provinces. There appears to be a relation between the location of processing and storage facilities and the geographical interest of the projects, as 50% of the implemented biofuel projects and expressions of interest are also located in these provinces. We believe that biofuel projects prefer locations near processing and storage facilities, mainly because this will reduce transport costs.

When combining the geographical data on implemented projects and expressions of interest with data on existing and planned processing and storage facilities, the differences between North and South Mozambique become even more evident: 80% of the total biofuel developments are in Maputo, Gaza and Inhambane, Sofala and Manica provinces, and only 20% in Zambezia, Niassa, Nampula and Cabo Delgado provinces. Tete is the only province where no biofuel developments take place.

4.9 Drivers of biofuel developments in Mozambique

The objective of this chapter was to analyse knowledge from different disciplines to provide an overview of current biofuel developments in Mozambique, exploring to what extent reality matches the country's biophysical potential and government's objectives as described in the NBPS. In our analysis, we have tried to highlight what appear to be the key drivers behind biofuel developments in the country.

4.9.1 Policy drivers

The majority of implemented and planned biofuel projects are outside the areas defined as 'Rapid Development Zones', which are located in regions with poor infrastructure and low levels of human capital. This may reflect the fact that the incentives provided under the Investment Law and Code of Fiscal Benefits consist mainly of reduced payment of corporate taxes once profits have been made, while it is more difficult to make profits in areas which are far from major target markets and poorly serviced by basic infrastructure.

The creation of special duty-free industrial areas near big cities (like Nacala-Porto, Nampula's deep-sea port) might stimulate the agglomeration effect (Wheeler and Mody, 1992). The concentration of biofuel industry in such areas make them increasingly attractive for future biofuel feedstock producers, as these areas provide the necessary infrastructure, access to goods, services and expertise and allow feedstock producers to keep transportation costs low.

In relation to market selection, it is too early to comment conclusively as the NBPS was only recently put in place. Although the government identified establishing the domestic market as priority, blending mandates will take some time to put in place, and other policy instruments designed to create domestic demand are not yet defined. As SADC and other regional markets for trading biofuels are also to be established, investors focus on the EU market where incentives are already in place, such as premium prices and tariff advantages under trade agreements.

4.9.2 Biophysical potential

The general scale of the land zoning exercise (1:1,000,000) does not allow us to draw very firm conclusions about whether or not projects are located in areas where land is most available. However, we can observe that the provinces with highest interest for biofuel projects[20] (71% of the projects are located in Maputo, Gaza, Inhambane, Manica and Sofala) only represent 39% of land available. The rest of the projects (29%) are spread over the northern provinces that represent 61% of the available land (Figure 4.7).

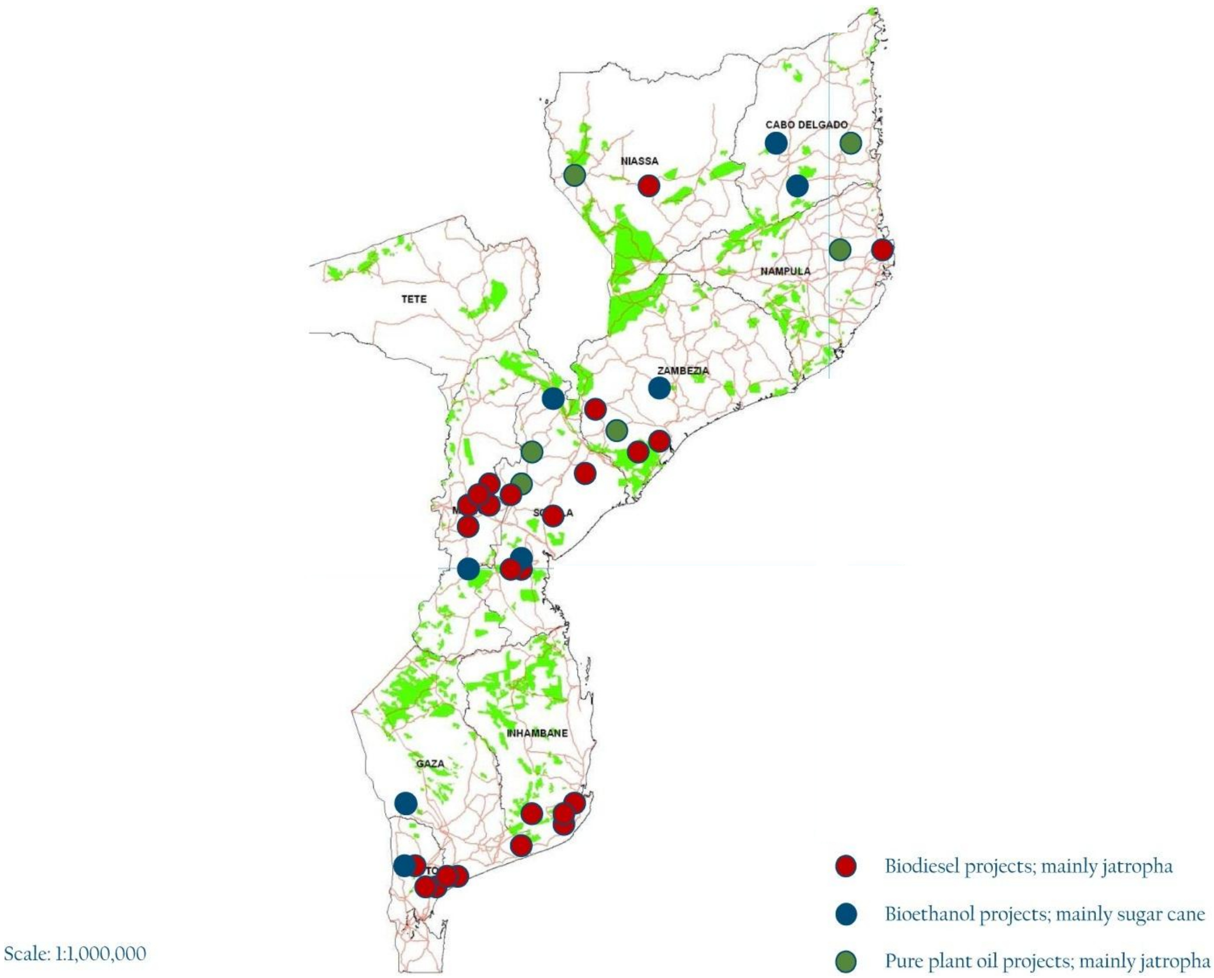


Fig. 4.7. Geographical spread of implemented projects and expressions of interest versus agro-ecological zoning in Mozambique (source map: IIAM and DNTF, 2008).

[20] Note: When referring to 'biofuel projects', this does not include the existing and planned processing and storage facilities.

This difference becomes even more visible if we zoom in on Maputo, Manica and Sofala provinces. 50% of the biofuel projects are located in these provinces, whereas they only represent 11.6% of the 6,966,030 ha identified as available during the zoning. Maputo, for example, only has 11,000 ha of land available, whereas 12,256 ha (111.4%) was requested by investors.

We can draw a similar conclusion if we compare our findings with the projection of provincial biomass annual production potential for 2015 based on climate and soil characteristics (Batidzirai et al., 2006 p. 61-62). We see that 32% of the biofuel projects are located in Maputo, Gaza and Inhambane provinces, whereas these provinces only represent 6.3% of the country's 6,670 PJ total annual biomass production potential (see Table 4.1). Provinces with highest annual biomass production potential such as Niassa, Cabo Delgado and Nampula (54.1% of total annual biomass production potential), are not very popular among investors, as only 16% of the biofuel projects have interest in locating themselves in these provinces. This is likely to be explained by the almost total absence of infrastructure, and the lack of (skilled) labour in these provinces.

4.9.3 Socioeconomic factors

Our analysis revealed an apparent relationship between the spatial availability of (skilled) labour, access to inputs, the availability and quality of infrastructure (roads and ports), and the number of biofuel projects in these areas. Provinces with a combination of low population density, low literacy levels and low net school enrolment rates (NER) such as Tete, Niassa, Nampula and Cabo Delgado were not attractive for biofuel projects. Provinces with relative high population density, highest adult literacy rates and NER such as Maputo, Inhambane and Manica coincided with a high number of implemented and planned biofuel projects. On the contrary, Sofala province does not score very well on population density, literacy levels and NER, but has the highest number of implemented and planned biofuel projects in the country. This high interest in Sofala could be explained by relatively good access to agricultural inputs, existing and planned processing and storage facilities, electricity and infrastructure such as Beira port.

In general, we saw a high concentration of biofuel projects around areas with good infrastructure and access to ports, such as Maputo, Beira, Quelimane, Nacala and Pemba, where existing fuel storage facilities are also present. This is rational, as a significant quantity of biofuels produced in Mozambique will be used to supply external markets.

4.10 Conclusions

Since the initial promotion of biofuels in 2004, much has changed in Mozambique. From promoting biofuel production by smallholders for domestic purposes, the sector is currently dominated by foreign commercial investors whose main intention is supplying external markets. Based on our analysis and geographical mapping, we can conclude that biofuel developments mainly take place in areas near good infrastructure (roads and ports), where there is (skilled) labour available, and access to services and goods, processing and storage facilities; not deviating from the classical variables from investment theory. We also found that current developments appear to be less driven by biophysical potential and incentives provided within prevalent government policy.

As compared to the policy objectives described in the NBPS, our analysis shows that currently only few projects are located in remote, rural areas. Moreover, job creation as proposed by investors seems lower than expected by the government in the NBPS. Nonetheless, although the currently operational biofuel projects are not in the most remote rural areas, they do contribute to socioeconomic development by generating employment, income and more indirect local spin-offs. Most investors – in absence of domestic or regional markets – focus on supplying external markets. Although this is in line with the NBPS to generate tax revenues and foreign currency, it does not contribute to diversifying the country's energy matrix, or decreasing the fossil-fuel dependency Mozambique is facing.

It will be important for the Mozambican government to closely monitor developments in the biofuel sector, to understand the dynamics at play that are driving the direction of biofuel developments, and how these can harmonized with the country's NBPS-objectives. This requires the timely development and implementation of adequate policy tools and instruments to increase the likelihood that biofuel developments in Mozambique will eventually enable the country to benefit its potential.

Lastly we would like to mention that the maps, tables and figures that we used to visualize our findings were extremely useful when sharing our results with policymakers and other stakeholders. Notably, the maps served as tangible boundary objects to which different communities of actors could easily relate (cf. Klerkx et al., 2010). This helped us to position the outcome of this research in the biofuel policy debate.

Acknowledgements

This research is part of the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions,' and is funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation (former Ministry of Agriculture, Nature Conservation and Food Quality). The research is also part of the 'Competing Claims-Competing Models' programme jointly funded by Wageningen University and Research Centre and the Dutch Ministry of Development Cooperation (DGIS).

The authors acknowledge the contributions of colleagues and the two anonymous reviewers who provided constructive feedback on earlier versions of this chapter. Special thanks to CEPAGRI, IIAM, GTZ-ProBEC and all the investors, farmers, extension workers, researchers, NGO representatives and policymakers that collaborated with us and provided data and insights necessary for this study.

CHAPTER 5

Space for innovation for sustainable community-based biofuel production and use

Lessons learned for policy from Nhambita community, Mozambique

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Published as:
Schut, M., A. van Paassen, C. Leeuwis, S. Bos, W. Leonardo and A. Lerner (2011). Space for innovation for sustainable community-based biofuel production and use: lessons learned for policy from Nhambita community, Mozambique. Energy Policy 39(9): 5116-5128.

KEYWORDS

Biofuels

Jatropha

Mozambique

ABSTRACT

This chapter provides insights and recommendations for policy on the opportunities and constrains that influence the space for innovation for sustainable community-based biofuel production and use. Promoted by the Mozambican government, Nhambita community established jatropha trials in 2005. Initial results were promising, but crop failure and the absence of organised markets led to scepticism amongst farmers. We start from the idea that the promotion of community-based biofuel production and use requires taking interactions between social-cultural, biophysical, economic, political and legal subsystems across different scales and levels of analysis through time into account. Our analysis demonstrates that heterogeneous farming strategies and their synergies at community level should be carefully assessed. Furthermore, national and international political and legal developments, such as the development of biofuel sustainability criteria, influence the local space in which community-based biofuel developments take place. We conclude that *ex-ante* integrated assessment and creating an enabling environment can enhance space for sustainable community-based biofuel production and use. It may provide insights into the opportunities and constraints for different types of smallholders, and promote the development of adequate policy mechanisms to prevent biofuels from becoming a threat rather than an opportunity for smallholders.

5.1 Introduction

Biofuels are high on the global political agenda, and many governments are exploring the production, processing and use of biofuels as part of a transition towards a more bio-based economy. Objectives for promoting biofuels vary across political levels and geographical locations. In many developing countries, governments perceive the production and use of biofuels as a pathway out of poverty because it may reduce the dependency on fossil fuel imports, create employment and increase exports. As in many other sub-Saharan African (SSA) countries, the Mozambican government is exploring: "[T]he potential for decentralized and renewable energy options for meeting energy needs" (Jumbe et al., 2009 p. 4982). Mozambique is seen as a promising country for biofuel production (Batidzirai et al., 2006). The recently approved National Biofuel Policy and Strategy (NBPS – Resolution 22/2009) underlines the Mozambican government's commitment to biofuels to improve energy security and to stimulate socioeconomic development, particularly in the rural areas (Government of Mozambique, 2009). The NBPS provides guidelines for the long-term development of the commercial biofuel sector in Mozambique but is also concerned with sustainable smallholder and community-based biofuel production and use. As the pace of rural electrification in Mozambique has been much slower than expected (Arthur et al., 2010 p. 7247), community-based biofuel production and use provides an interesting option to meet energy demands in rural areas that could consequently function as a catalyst for stimulating rural socioeconomic development (Jumbe et al., 2009 p. 4982).

Although the emerging commercial biofuel sector has been analysed and compared with the Mozambican government's policy objectives (cf. Schut et al., 2010c), systemic analyses of existing smallholder or community-based biofuel projects in Mozambique are scarce, but equally crucial for operationalizing and implementing the government's NBPS. Because smallholders in Mozambique and in other African countries are considered to play an important role in the growing of energy crops (Jumbe et al., 2009 p. 4984), understanding the complexity of smallholder farming is essential, as it makes bioenergy policies fundamentally different from other (rural) energy policies. The objective of this chapter is to provide insights into the opportunities and constrains that influence the innovation space for sustainable community-based production and processing of biofuel feedstock for localized use or for local marketing (henceforth referred to as 'community-based biofuel production and use') (cf. Mangoyana and Smith, 2011 p. 1287). In so doing, we hope to sensitize strategic thinking when designing and implementing biofuel policies, and respond to the need for more effective and pro-active policy mechanisms to support responsible and sustainable community-based biofuel production and use; in Mozambique, but also in other SSA countries (cf. Verdonk et al., 2007; van Eijck and Romijn, 2008).

The chapter draws on lessons learned from Nhambita community in Mozambique, one of the first communities that complied with the government's request to produce *Jatropha curcas* Linnaeus (henceforth abbreviated as jatropha), a small tree or shrub that produces toxic grain with a relatively high oil content (between 30 and 35%) (Jongschaap et al., 2007; van Eijck and Romijn, 2008; de Jongh, 2010). The initial government proposal (which dates from 2004) stated that five hectares of jatropha were to be planted in each of Mozambique's 128 districts, using underutilized or empty marginal soils to avoid competition with food production (Schut et al., 2010c p. 5152). Although the majority of the projects were unsuccessful[21], the Mozambican government continues to perceive jatropha as a high potential biofuel crop for community-based biofuel production. Furthermore, jatropha was selected as one of the four officially approved biofuel feedstock in the NBPS[22] (Government of Mozambique, 2009 p. 14). It is important to mention that, as part of operationalizing and implementing its NBPS, the Mozambican government actively supported this research to generate insights on the opportunities and constrains for responsible and sustainable community-based biofuel production and use.

Section 5.2 provides the research approach and methodology, followed by background information on Nhambita community in Section 5.3. Section 5.4 describes and analyses the introduction of jatropha and pigeonpea in Nhambita, followed by Section 5.5 that presents three case study farms to explore farming strategies in the community. Section 5.6 assesses the potential for local processing and marketing of jatropha oil, after which the political and legal developments are described in Section 5.7. Subsequently, the findings are analysed and discussed in Section 5.8, followed by Section 5.9 that provides the main conclusions and recommendations for policy.

[21] Due to the poor quality of distributed jatropha seed and a lack of agronomic knowledge on crop management, many trees died. The few farmers that produced jatropha grain failed to sell it as there were no organised markets and supply chains (Schut et al., 2010c p. 5152).
[22] Selected crops are jatropha and coconut for biodiesel, and sugarcane and sweet sorghum for the production of bioethanol (Government of Mozambique, 2009 p. 14).

5.2 Research approach and methodology

We start from the idea that understanding the introduction and performance of an agricultural innovation like jatropha as part of a community-based biofuel strategy requires integrated assessment or an innovation systems approach. Firstly, this approach acknowledges that agricultural innovation is not just about new technologies, but that space for innovation is embedded in and constituted by dynamics between social-cultural, biophysical, economic, political and legal subsystems (Figure 5.1) (Klerkx et al., 2010; Schut et al., 2010b; Leeuwis and Aarts, 2011). Supporting innovation processes or analysing space for innovation therefore requires cutting across the individual subsystems and providing integrated and holistic analysis of systems (cf. Smits and Kuhlmann, 2004 p. 11).

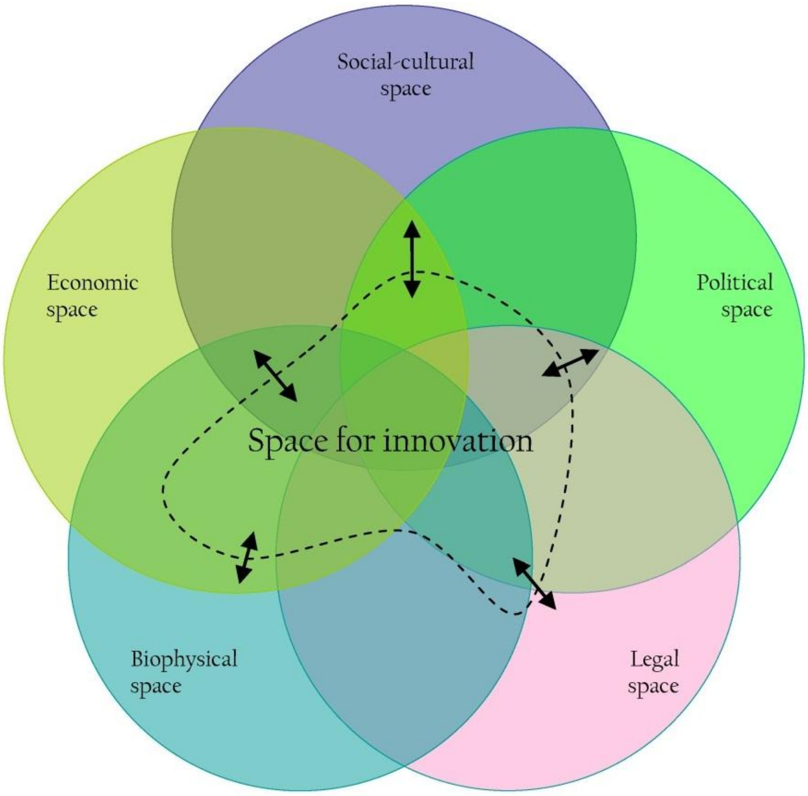

Fig. 5.1. Subsystems that constitute space for innovation.

A second fundamental premise for analysing local space for innovation is to study the interactions of subsystems across different scales and levels of analysis (spatial dynamics) through time (temporal dynamics) (cf. Cash et al., 2006). In terms of designing policy for community-based biofuel production and use, this implies addressing all relevant levels of policy influence that enhance or constrain local space for innovation, from international biofuel sustainability criteria to local customary laws and practices (Giller et al., 2008). Temporal dynamics require that innovations should be approached and studied as dynamic processes (Hekkert et al., 2007 p. 414). Although Figure 5.1 presents a rather static image of space for innovation and suggests that innovations can only be sustainable when all subsystems overlap, this is often not the case. Space for innovation is generally found within one of the subsystems, complemented by or triggering change of space in other subsystems. For example: “[N]ew laws, entry of new actors, and other events change [...] [space for innovation] over time” (Hekkert et al., 2007 p. 417).

In sum, the dynamics and interactions between different subsystems across different scales and levels of analysis through time can both constrain or enhance (local) space for innovations, and in doing so, influence the extent to which innovations can contribute to sustainable and dynamic development (cf. Leeuwis and Aarts, 2011).

Most of the empirical data for this study were gathered from Nhambita community in Gorongosa District, Sofala Province, Mozambique (Figure 5.2). Nhambita was chosen for this study as it is one of the few communities where smallholders still grow jatropha. Moreover, jatropha trials were established with the support of the Envirotrade project (see Section 5.3) and an oil-seed press was provided by the Ministry of Energy, creating a unique enabling environment for community-based biofuel production and use. Nhambita community is part of the Chicare *Regulado* (traditional authority) and accommodates around 85 households.

Fig. 5.2. Nhambita community in Gorongosa District, Sofala Province, Mozambique.

To reach our objectives, we present various forms of data. As innovation trajectories are dynamic and need to be understood through time, we firstly provide background information on the introduction and performance of jatropha in the community. This information is based on field visits, semi-structured interviews with Envirotrade staff, extensionists and farmers from the community, complemented with secondary data analysis of scientific papers, reports, presentations and policy documents. Secondly, we present a combination of data to explore existing farming strategies in Nhambita. To get an idea about the local dynamics and heterogeneity of farming in the community, three highly contrasting case study farms were selected and repeatedly visited and interviewed between July 2009 and July 2010. Only one of the farms grows jatropha; nevertheless, understanding reasons for not allocating resources to biofuel production are equally important when one is analysing space for innovation. In-depth interviews were conducted at the homestead of the households. The questionnaire that guided those interviews can be found in Appendix D and in Bos et al. (2010). GPS was used to plot and measure the farmers' fields where possible. A transect-walk allowed us to better understand the geographical spread of farming activities as compared with the biophysical diversity in the area. We analyse the case study farms by drawing on existing literature on farming strategies and agricultural statistics from Mozambique and other SSA countries. Thirdly, we analyse the potential space for localized use, or for local marketing of biofuels. In line with other studies (cf. van Eijck and Romijn, 2008), we also explore the potential for non-energy applications, such as the use of jatropha oil for local soap production and the potential for organic fertilizer production. Semi-structured interviews were used to collect data on energy consumption by households and the Envirotrade project. Interviews with shopkeepers on local prices and consumption patterns of fuel and oil-based products enabled us to develop scenarios for the local production and use of biofuels. Lastly, two of the authors of this chapter actively participated in the policy debate on biofuel sustainability in Mozambique. Between December 2008 and November 2010 they supported an inter-ministerial working group in developing a biofuel sustainability framework for Mozambique. This work allows us to describe the evolving political and legal environment during this period, which is necessary to comprehend the dynamic context in which biofuel developments in Mozambique take place.

5.3 Setting the scene: Nhambita and Envirotrade

Nhambita community is located in the buffer zone of Gorongosa National Park (NP), one of Mozambique's most biodiverse areas, and a famous tourist destination. The area can be classified as savannah (or miombo) woodland, which is generally found on nutrient poor and acidic soils (Campbell et al., 1996; Frost, 1996) with low organic content (Ryan, 2009). The area is a previous war front, and this has greatly impacted the social structures in the communities. After the war in 1992, the return of displaced people led to a major population increase in the area (University of Edinburgh, 2008 p. 53). Although a peace treaty was signed, the situation for the communities in the area remained difficult. Commercial agricultural production (mainly cotton) had collapsed and there was little or no access to medical services, education, employment, capital or markets. As communities relied heavily on the area for agriculture and charcoal production, this resulted in increased pressure on Gorongosa NP.

The majority of the approximately 1,100 households in the Chicare *Regulado* depend on forest resources and agriculture for their livelihoods. Their main sources of income derive from selling agricultural and animal products, and locally made products such as bricks. Farmers use shifting cultivation and crop rotation to maintain agricultural productivity. Due to the exodus of the local population during the war, most land was left fallow for a long time, resulting in relatively fertile soils when people started to return in the 1990s (University of Edinburgh, 2008 p. 69).

Commonly grown crops in the community are maize, cassava, sorghum, pigeonpea, and various fruits and vegetables. The majority of households own more than one plot (referred to as *machambas* or *dimbas*). *Machambas* are generally located near the homestead or on land further away from the homestead (outfields). Plots located near the various small rivers and streams in the area are called *dimbas*. *Dimbas* are highly valued as they are generally more fertile than *machambas* and allow for production in the dry season. *Dimbas* are often used for high-value cash crops, such as vegetables. Agriculture in the area is predominantly rain-fed, with mean annual rainfall of 850 mm of which 82% falls between November and March (Ryan, 2009 p. 31). Agricultural production follows a seasonal cycle wherein crops such as maize and sorghum are sown after the arrival of the rains (November – December). Agricultural extension provided by government – as in other places in Mozambique – is almost non-existent (Coughlin, 2006 p. 30).

The majority of permanent wage jobs in Nhambita community are provided by the Envirotrade project. Envirotrade is a Mauritius-based company that has developed a business model for selling carbon offsets generated through involving smallholder farmers in conservation management and reforestation activities (www.envirotrade.co.uk). It is one of the few projects in Africa where smallholder farmers receive payments for the conservation of carbon under a voluntary payment scheme. Under the Gorongosa Community Carbon Project, the Envirotrade project offers farmers different agro-forestry contracts, such as planting trees to improve soil quality through nitrogen fixation, the conservation of woodlots and non-burning of fields. In the case of planting trees, the project provides the trees to farmers and monitors their condition twice a year. Farmers receive an annual remuneration, spread over seven years, for maintaining the planted trees.

Besides the agro-forestry contracts, the project supports the establishment of microbusiness associations such as a carpentry and tree nurseries. The project has also established rural community committees, responsible for monitoring the forest management activities. So-called community trust funds are used to initiate and manage community projects.

5.4 Two new cash crops in Nhambita community

One of the principal objectives of the Envirotrade project is to promote sustainable land use practices and provide alternatives to shifting cultivation and the opening up of new *machambas* using the slash-and-burn method. Besides providing income through the different agro-forestry contracts, the project stimulates the production of cash crops for sale on local markets (Envirotrade, 2006 p. 5). For the purpose of this study, we describe the recent introduction of two crops in the community: pigeonpea and jatropha. Both crops were introduced more or less around the same time; allowing for comparative analysis with regard to their relative performance and adoption in the community.

5.4.1 Pigeonpea

Between November 2004 and January 2005, Envirotrade initiated a programme stimulating the intercropping of pigeonpea (*Cajanus cajan* (L.) Millsp.) (Envirotrade, 2006 p. 10). The objective was to reduce the opening up of new *machambas* by regenerating soils of existing *machambas*. This would consequently reduce deforestation and provide farmers with a new cash crop. Each household received five kilograms of seed, to be reimbursed after the first harvest. Pigeonpea is a perennial leguminous multi-purpose crop that can produce grain for human consumption, fodder for supplementary livestock feed and mulch or green manure for soil fertility maintenance (Agyare et al., 2002). The crop has a deep rooting system and can as a result improve soil fertility through more efficient nutrient cycling through leaf litter production and biological nitrogen fixation (Giller, 2001). Pigeonpea is easy to establish from seed and grows well under the combined stresses of drought and poor soil fertility (Agyare et al., 2002 p. 198). Moreover, pigeonpea grain is highly nutritious and can be stored for a long time. During our fieldwork we observed that pigeonpea is used for intercropping by the majority of farmers in Nhambita community. Pigeonpea is used for household consumption and sold as a cash crop.

5.4.2 Jatropha

Following the government's promotion of jatropha, a communal jatropha trial in Nhambita community was established by the end of 2005. Between February and April 2006, the trial increased to around 4 ha. The jatropha grew extremely well during the first growing season, and, between May and July 2006, 250 farmers from the area expressed an interest in planting jatropha. During that time, the first grain was harvested from the jatropha trials (Envirotrade, 2006).

When the first pruning was needed, little agronomic knowledge existed on how and when to prune effectively. From our interviews we learned that during the first pruning all branches were cut off, leaving just the main stem. Subsequently, Envirotrade was advised to do a second pruning, cutting back all plants to knee height. The second pruning was followed by a humid period, after which the majority of plants started rotting and died (Photo 5.1). Samples were sent for analysis to the Forest Faculty of Pietermaritzburg University in South Africa. As the samples did not arrive fresh, they could only be tested for bacterial infections, and they tested negative. The plants could not be tested for viral infections and fungi, which according to Envirotrade's operations manager are likely to have affected the jatropha.

The site where the jatropha trial had been established was left fallow for a long time, and soil quality and fertility status – although we did not have the resources to analyse soil samples – appeared to be reasonable.

Photo 5.1. Mostly dead jatropha plants in the communal jatropha trial in Nhambita community. Photo taken by M. Schut in July 2009.

5.5 Farming strategies in Nhambita community

In Nhambita community, farming strategies are centred on crop production and off-farm activities. Farming strategies are not homogeneous as resource allocation varies between households of different social classes, according to their objectives and factor constraints (Tittonell et al., 2005). Our method for describing the three highly contrasting case study farms and their interdependencies is inspired by farming systems analysis (cf. Tittonell et al., 2005; van Wijk et al., 2009; Giller et al., 2011). As it is not our aim to describe the farming systems in detail, we use a simplified approach to highlight the main features that influence allocation of resources at both farm and community level, and how that may affect community-based biofuel production.

5.5.1 Exploring heterogeneity: three case study farms

The 85 farm households in Nhambita community were roughly divided into three categories; high, medium and low resource endowed.[23] This stratified approach to categorizing farms according to resource endowment is often used in studies on farming systems (Tittonell et al.,

[23] In relation to assets representing classical wealth indicators such as land size and livestock ownership (Tittonell et al., 2009), or labour availability, use of fertilizer and hiring temporary labour (Mather et al., 2008).

2009; van Wijk et al., 2009; Zingore et al., 2009). On the basis of the three categories, Envirotrade's senior extensionist assisted us in identifying five farm households per category. After exploratory visits to farm households from the three categories, one case study farm per category was selected. For the purpose of the study, we chose to select three highly contrasting case study farms. In the group of high resource endowed farm households, a farmer growing jatropha was purposively sampled, which is justifiable considering the nature of this study (cf. Russell Bernard, 2006 p. 189-190). In the groups of the low and medium resource endowed farm households, none of the farmers was growing jatropha.

Household 1: high resource endowed

The male head of this household is a well-known farmer in the community and is involved in many activities. The household consists of twelve members, of which eight provide labour for on- and off-farm activities. The head of the household works as a driver for Envirotrade, and his wives and labourers run the farm. The total farm size is 15.8 ha, divided into 10 fields. The *machambas* are located around the homestead (1.4 ha) and an outfield in Themba (2.4 ha). The household owns eight *dimbas* (12 ha), of which some land was bought. Near the homestead the household grows food and cash crops. On the *dimbas*, fruits and vegetables are produced. Main food crops are maize, cassava, sorghum and pigeonpea, the excess of which (except sorghum) is sold. Important cash crops are beans, sesame and bananas.

To manage soil fertility, crops are rotated, and crop residues are incorporated into the soil during land preparation. During the last growing season, the farmer applied small amounts of synthetic fertilizer (3 kg) to the vegetables. The fertilizer was bought in Chimoio (approximately 150 km from the community). Goat manure is gathered and also applied to the vegetable garden. Seeds used are mainly local varieties, although the farmer bought an improved maize seed variety in Chimoio last year. During the last cropping season, the crops were affected by pests, but no agro-chemicals were applied to manage them.

On the homestead *machamba*, jatropha is intercropped with pigeonpea (0.2 ha jatropha, 0.2 ha pigeonpea). The jatropha was planted in 2005 using seed provided by Envirotrade. The first jatropha grain has been harvested, although limited in quantity (half a bucket). As there is currently no organised market for jatropha grain, the household is still uncertain about what to do with it. One of the household members explained that jatropha was planted as an experiment for a maximum period of five years. If – by that time – there was no market on which to sell the jatropha grain, they would stop investing land and labour in it. In August 2009, the jatropha appeared to be in good condition. It had leaves and fruits, unlike the remaining jatropha in the communal trial (see Photo 1). In July 2010, we observed that the *machamba* had not been actively managed in terms of weeding or pruning, resulting in bad ramification and limited fruit production. We could see that fruits had not been harvested (causing dehiscing), as confirmed by one of the household members.

The household owns a substantial number of goats and poultry but no cattle. The livestock are mainly for home consumption, but occasionally sold. Additional income is derived from agro-forestry contracts with Envirotrade. The head of the household is involved in one of the microbusiness nursery associations and is a shareholder in the maize mill. Occasionally, the household receives remittances in kind, such as rice from family members living in Beira, the capital of Sofala Province. The household's main expenditures are on soap, cooking oil, salt, sugar, fish and school requisites for the children. Moreover, money is being spent on milling, buying mobile phone credits, and occasionally improved seeds and fertilizer. Bush clearing, ploughing, planting, weeding and harvesting are done manually. External labour is hired and paid for both in cash and in kind.

Household 2: medium resource endowed

The male head of the household is a war veteran (for which he receives a monthly government pension) who settled in Nhambita community after Mozambique's armed struggle. The household consists of four members, all contributing labour to the household's activities. The household has three agro-forestry contracts with Envirotrade, and the head of the household works as an Envirotrade employee. His salary is being invested in constructing a stone house, which was almost finished at the time of our visit in July 2010.

On the *machamba* nearest to the homestead, the household grows maize and pigeonpea (1 ha). On the other homestead *machamba* (3 ha), sorghum, pigeonpea and maize are grown. Mangos, sesame, pineapple, cashew, tomatoes and sweet potato are planted around the homestead. Labour constraints, especially for weeding, keep the household from cultivating all available land. The household does not apply fertilizer but keeps residues on the fields. They mainly use local seed varieties, although they used an improved pigeonpea variety that was distributed by Envirotrade. The household owns one *dimba* (estimated at 0.5 ha) which is ploughed first. When production is good, excess sorghum and maize are sold. Mangos are used to pay day labourers who plough and weed the fields.

The household owns about 30 chicken, two ducks and two goats, mainly for home consumption. Manure is not applied to the fields and no agro-chemicals are being used. The major expenses of the household are cooking oil, soap, salt, petroleum for lighting, and milling of maize and sorghum. No remittances are received or sent.

The household does not grow jatropha. The head of the household believes that jatropha does not grow well in the area. He first wants to see jatropha yield well, before he would start growing it.

Household 3: low resource endowed

This household consists of five members, four of whom contribute labour to the household activities. The family owns a *machamba* near the homestead (0.5 ha) and a *dimba* (estimated around 1 ha). The male head of the household is responsible for the work on the *dimba* as it is more clayey and therefore harder to work. His wife mainly works on the homestead *machamba* where they intercrop maize and sorghum. On the *dimba* they grow maize, sorghum and some vegetables. The *dimba* is the most important field for the household. Pigeonpea is planted around and randomly in all fields. They have some mango and papaya trees and brew some beverages for home consumption.

The complete yield is used for household consumption. Two household members work two or three days per week as labourers for other farmers, the rest of their available time they invest in their own fields. The household has one agro-forestry contract with Envirotrade for planting indigenous trees. Last year, one of the household members worked temporarily for Envirotrade as a construction worker.

Improved seed varieties, fertilizers or agro-chemicals are not used, and no livestock is owned at the moment. Main expenditures are on milling, and buying salt and soap. The household does not receive any remittances.

The household has only recently heard about jatropha, when it was planted in the community. They know it can be used as fuel, but that the crop is difficult to grow. If others started growing it, they would also be interested. At the time of our last visit to the community in July 2010, the household had moved from the research area to an unknown location.

5.5.2 Analysis of case study farms

The heterogeneity found in our three case study farms is summarized in Table 5.1. Smallholder agriculture in Nhambita is dominated by rain-fed maize, sorghum, cassava and pigeonpea production. Important cash crops are sweet potato, beans and sesame. Only the high resource endowed household is growing jatropha as an experiment. Amongst the main expenditures for all interviewed households were milling, buying salt and soap.

Household	1	2	3
Resource endowment	High	Medium	Low
Household size	12	4	5
Household members contributing labour to household	8	4	4
Fields (#)	10	3	2
Total farm size[24]	15.8 ha	4.5 ha	1.5 ha
Number, location and size of fields	1 homestead *machamba* (1.4 ha), 1 outfield *machamba* (2.4 ha) and 8 *dimbas* (12 ha)	2 homestead *machambas* (4 ha) and 1 *dimba* (0.5 ha)	1 homestead *machamba* (0.5 ha) and 1 *dimba* (1 ha)
Main food/cash crops	Maize, cassava, pigeonpea, sorghum and sesame	Maize, sorghum, and pigeonpea	Maize, sorghum and pigeonpea
Fruits, vegetables and other crops	Bananas, papaya, cashew, sesame, sweet potato, tomato, beans, onion and cabbage	Mangos, pineapple, cashew, sesame, sweet potato and tomato	Mango and papaya, tomatoes, onion and cabbage
Biofuel crops	Jatropha (0.2 ha)	–	–
Livestock	Goats, ducks, chickens and turkeys	Goats, ducks and chickens	–
Apply synthetic fertilizer	Yes (3 kg to vegetables)	–	–
Apply manure	Yes (to vegetables)	–	–
Use improved seed	Yes (maize)	Rarely	–
Envirotrade agro-forestry contract(s)	Yes	Yes	Yes
Received remittances (money/in kind)	In kind: rice	–	–
Off-farm income			
▪ Day labourer for other farmers			X (2–3 days week^{-1})
▪ Government pension		X	
▪ Envirotrade	X (salaried employment)	X (salaried employment)	X (occasionally as labourer)
Main expenditures	Cooking oil, soap, salt, sugar, milling, mobile phone credit, paying labourers, fertilizer, improved seeds	Cooking oil, soap, salt, milling, petroleum for lighting	Milling, soap and salt

Table 5.1. Summary and comparison of the three case study farms.

As commonly seen in Mozambican smallholder agriculture, there exists a relationship between resource endowment, access to labour, the amount of land owned and cultivated,

[24] Combination of field-size measured using GPS and estimations made together with the farmers.

possession of livestock and wealth (Mather et al., 2008). Such patterns have also been observed in other SSA countries such as Kenya (Tittonell et al., 2005) and Zimbabwe (Zingore et al., 2007). High to medium resource endowed households often have access to permanent sources of off-farm income (e.g. salary or pension) and compensate lack of household labour by hiring in labour which they pay for in cash or in kind. Moreover, high resource endowed households can afford inflows of inputs, such as fertilizers or improved seeds, and use animal manure to enhance agricultural productivity. On the other side of the spectrum, low resource endowed farm households are faced with multiple constraints, which include small farm size, competing demands for labour, and lack of livestock, manure and cash to buy inputs. We must emphasise that smallholders in Mozambique typically do not use, and do not have easy access to, agricultural inputs. According to a national survey conducted in 2007, only 4% of Mozambican farmers use fertilizers (FAO/WFP, 2010 p. 13). The households that do have access to nutrient inputs tend to apply manure or fertilizer to high-value cash crops such as vegetables. Another significant difference between Mozambique and other SSA countries is that household livestock assets are relatively low (Mather et al., 2008 p. 10). Cattle in particular are not to be found in vast parts of the country, and in Nhambita none of the households owns cattle. The main reason is the lack of control of tsetse-fly, tick-borne and foot-and-mouth diseases (FAO/WFP, 2010 p. 17).

Access to land does not seem to be a constraining factor for the expansion of crop production. TIA (*Trabalho de Inquérito Agrícola* – Mozambique Agricultural Survey, 2002) found that: "85% of households declared that it was 'easy to obtain additional land' in their village" (Mather et al., 2008 p. 21). In Nhambita, some scarcity was mentioned for land in the *dimbas*, which are the more fertile and productive soils. *Dimbas* are generally used for the production of cash crops such as vegetables, although the low resource endowed household indicated that they grew food crops in the *dimba*.

In the absence of cattle, and no apparent land scarcity, mobilizing and allocating labour to different on- and off-farm activities – especially during peaks in the labour calendar – seems crucial in Mozambican smallholder agriculture. In the next section, we further explore how this affects the potential for jatropha production within the different case study farms.

5.5.3 Land and labour requirements vis-à-vis jatropha production

As maize is the staple food crop in the community, we calculate maize production and consumption as an indicator of food self-sufficiency within the three case study farms. Food crop yields in Mozambique are low compared with other SSA countries (Tschirley and Weber, 1994). Based on different literature sources we estimate average annual maize yields for *machambas* and *dimbas* in Nhambita community at 500 kg ha^{-1}, using local seeds and no irrigation or nutrient inputs (Tschirley and Weber, 1994; Howard et al., 2003; FAO/WFP, 2010). Assuming post-harvest losses of 12% or 60 kg ha^{-1} (FAO/WFP, 2010 p. 23) and a maize seed requirement of 25 kg ha^{-1} (FAO/WFP, 2010 p. 24), 415 kg ha^{-1} become effectively available to meet household food requirements. On average, annual maize consumption per individual was estimated at 100 kg, on the basis of estimates of actual maize consumed by farmers in a typical diet dominated by maize in sub-Saharan Africa (Zingore et al., 2009; Zingore et al., 2011). We use this figure as an indicator for calculating maize requirements at household level, although we understand that farmers have a more varied diet. In our calculations we did not include additional food sources such as remittances or food aid.

Household	1	2	3
Resource endowment	High	Medium	Low
Household (hh) size (persons)	12	4	5
Contributing labour to household (persons)	8	4	4
Food requirement (kg maize hh^{-1} $year^{-1}$)	1,200	400	500
Land requirements			
Field size needed to achieve maize self-sufficiency (ha)	2.89	0.96	1.20
Total farm size (ha)	15.8	4.5	1.5
Machambas (ha)	3.8	4	0.5
Dimbas (ha)	12	0.5	1
Percentage of total farm size needed to achieve maize self-sufficiency	18%	21%	80%
Percentage of *machamba* needed to achieve maize self-sufficiency	76%	24%	100%
Percentage of *dimba* needed to achieve maize self-sufficiency	0%	0%	70%
Labour requirements			
Land:labour ratio[25]	2.0	1.1	0.4

Table 5.2. Land and labour dynamics versus food self-sufficiency calculated for the three case study farms.

The high and medium resource endowed farmers need around 20% of their total farm size to achieve household maize self-sufficiency (Table 5.2). Production can be achieved within the *machamba* field size, leaving additional space on the *machambas* and the *dimbas* for cash crop production (taking potential labour constraints into account). The low resource endowed farm needs 80% of its total farm size to produce sufficient maize for household consumption. Other than for the high and medium resource endowed household, part of the *dimbas* is needed to achieve maize self-sufficiency; this matches the assertion by the low resource endowed household that maize and sorghum are grown in the *dimba*. TIA data from 2005 moreover indicate that high resource endowed households are more resilient in terms of their household food reserves and have far less difficulty feeding their families throughout the year as compared with low resource endowed households (Mather et al., 2008 p. 19). High and medium resource endowed households are likely to produce excess food crops, used for sale or to pay labourers.

[25] Land:labour ratio calculated as total farm size divided by number of household members contributing labour to household (Zingore et al., 2011).

The land:labour ratio (Table 5.2) can be used as an indicator of the effective cultivation capacity of land per household member contributing labour to the household's activities. The ratio is influenced by the amount of labour available within the household, either increased by hiring in labour, or reduced by hiring out labour, demonstrating important labour synergies at community level. Crop production on wealthy farms is enhanced by labour supplied by poor farmers. Subsequently, poor farmers who struggle to achieve food self-sufficiency benefit from the excess maize production at the community level in return for the labour they sell to wealthy farmers (Zingore et al., 2009). Demands for labour are not equally distributed throughout the year as labour is especially scarce just before the rainy season (land preparation) and during the rainy season (weeding). As many low resource endowed household – during this time of the year – have run out of food reserves from the previous harvest, they are 'forced' to sell some of their labour to meet their food requirements. Consequently, this reduces the area cultivated, crop management and – eventually – yields on their own farm (cf. Zingore et al., 2009 p. 58).

Relating our findings on land and labour requirements to our case study farms and the potential for jatropha production, we conclude that the high and medium resource endowed farm households have *machamba* available for growing jatropha, without negatively affecting food self-sufficiency within the household. Although these households produce excess food crops to pay labourers or to sell on the market, allocating small parts of *machamba* to jatropha is possible, as shown by the high resource endowed case study household. The feasibility of jatropha cultivation within the low resource endowed household is highly questionable as they need all their *machamba* and a large part of their *dimba* to achieve food self-sufficiency.

Demands on labour are high, especially during peaks in the labour calendar. As jatropha is a perennial crop, labour for land preparation and planting is only required preceding the first growing season. Jatropha can be planted shortly before the beginning of the rainy season. Especially after the first growing season, jatropha is fairly drought-tolerant. In the absence of water, the plant goes into dormancy and sheds its leaves, but will grow once water becomes available (Flemming Nielsen, FACT Foundation, personal communication). Labour demands for weeding are similar to weeding of other crops, although increased canopy cover (depending on planting distance and pruning) will decrease labour requirements over time. Jatropha pruning is preferably done during the dry season when labour demands for other crops are low. As jatropha does not drop its fruits, harvesting the jatropha grain can be somewhat postponed until after food crops have been harvested. Leaving the fruits on the trees will reduce water content in the grain, which is preferable when its oil is to be extracted. However, leaving the fruits on the tree too long will result in dehiscing and loss of the grain, as we saw at the case study farm growing jatropha. Under the current conditions, investing labour in jatropha production will be particularly difficult for the low resource endowed household who already face labour constraints. For the high resource endowed household, it is not so much labour constraints as prioritizing the allocation of labour to different crops and activities compared with their relative revenues and benefits.

5.6 Potential for local market development

We focus on analysing the potential for localized use or for local marketing of biofuels, as this seems less sensitive to 'outside' distortions such as fluctuating crude oil prices (cf. Practical Action Consulting, 2009). The fact that the local fuel prices in Nhambita community did not change between September 2009 and July 2010 (US$2.10 l^{-1} for petroleum)[26], *vis-à-vis* a 24% increase in fossil fuel prices during that same period at fuel stations, supports this assumption. Local market development is moreover in line with the Mozambican government's objectives to contribute to local energy security and stimulate socioeconomic development in rural areas.

Analysing the current use of fossil fuels and oil-based products in Nhambita community enabled us to develop three scenarios that provide a basic idea of the scale of jatropha production needed to partly replace fossil fuels with pure plant oil (PPO) or to locally manufacture oil-based products such as soap. As jatropha press-cake and fruit coats are rich in nutrients (Jongschaap et al., 2007 p. 16), we calculated the potential for organic fertilizer production using jatropha press-cake within each of the three scenarios.

5.6.1 Current consumption of fossil fuels and oil-based products

The majority of the 85 households in Nhambita use petroleum lamps for lighting as the community is not connected to the electricity grid. Petroleum can be bought at the local shops for US$0.53 per 250 ml, which is, according to the local shop owners, the average weekly household consumption. The lamps and petroleum form an important commodity for the local shops. However, the locally sold fuel is expensive, amounting to US$2.10 l^{-1} as compared with US$0.88 l^{-1} at the petrol station in September 2009.

The Envirotrade project has a diesel generator to supply their offices with electricity. The average consumption of the generator is 200 l diesel week^{-1}. The generator is also used by the carpentry association (25 l diesel week^{-1}). The maize mill microbusiness association uses a diesel engine (10 l diesel week^{-1}) to power their mill (Table 5.3). We decided not to include the fuel usage by Envirotrade's vehicles and motor cycles. Diesel for the generators is bought in Chimoio for US$0.88 l^{-1}.

[26] To convert prices from the Mozambican Metical (MZN) to US Dollar (US$), we have used the average exchange rate during the time the research was conducted (between 1 July 2009 and 30 June 2010). According to www.oanda.com, the average exchange rate during this period was MZN1 to US$0.035.

Household level	Potential for PPO use	Average consumption
Households (n=85)	Lighting	21.3 l petroleum week^{-1}
Envirotrade and microbusiness associations		
Envirotrade project	Generator	200 l diesel week^{-1}
Carpentry association	Generator	25 l diesel week^{-1}
Maize mill association	Maize mill	10 l diesel week^{-1}

Table 5.3. Overview of fossil fuel usage in Nhambita community by households and the Envirotrade project.

The analysis of the three case study farms (Table 5.1) revealed another potential application of PPO as all interviewed households indicated that buying soap is amongst their main expenditures. An average household of five persons uses two bars of soap per month, corresponding to US$1.05 (US$0.53 per bar[27]). As jatropha-based PPO is suitable for manufacturing soap, there is potential for local soap production in Nhambita community. Furthermore, local soap production could be seen as an opportunity to establish a new microbusiness association.

5.6.2 Scenarios for local use of jatropha PPO and organic fertilizer production

To keep our scenarios as realistic as possible, we have used data from FACT Foundation, gathered at a community-based jatropha project in Cabo Delgado Province, Mozambique. The data show that approximately 5 kg of jatropha grain are needed to produce locally 1 l of PPO (similar findings were found by van Eijck and Romijn, 2008 p. 314). Such a ratio more or less corresponds with a jatropha grain oil content of 30% and a press efficiency of 60%, using a specific gravity of 0.92 kg l^{-1} for jatropha oil.[28] On the basis of average rainfall data from the Nhambita region (850 mm yr^{-1}) and medium soil fertility status, jatropha grain yields were modestly estimated at 1,250 kg ha^{-1} yr^{-1} (de Jongh, 2010). Within each scenario, we compare the value of the jatropha per hectare if processed and used locally *vis-à-vis* the value of the jatropha grain per hectare if sold for US$0.11 kg^{-1} on the market (Flemming Nielsen, FACT Foundation, personal communication). Table 5.4 summarizes and compares the scenarios.

[27] Due to the conversion of prices from MZN to US$ and rounding off of numbers, small inconsistencies may occur.

[28] Using these percentages and specific gravity showed that 5.11 kg jatropha grain are needed to produce 1 l PPO; this is the figure that we used in our calculations. Corresponding author can be contacted for more detailed formulas.

Scenarios	Scenario 1: Provide 85 households with 250 ml PPO weekly	Scenario 2: Provide 85 households with two soap bars monthly	Scenario 3: Replace 50% of the annual diesel consumed by Envirotrade, the carpentry and the maize mill with PPO
Required amount of PPO (l yr^{-1})	1,105	1,020	6,110
Required amount of jatropha grain (kg yr^{-1})	5,648	5,213	31,229
Required land for jatropha production (ha yr^{-1})	4.5	4.2	25.0
Total value if sold for US$0.11 kg^{-1}	593	547	3,279
Value ha^{-1} if sold (US$)	131	131	131
Total value if used locally (US$)	2,321	1,071	5,346
Value ha^{-1} if used locally (US$)	514	257	214
Organic fertilizer production per scenario			
Seed-cake organic fertilizer (kg yr^{-1})	4,631	4,275	25,608
Seed-cake organic fertilizer per household (hh) (kg hh yr^{-1})	54.5	50.3	301

Table 5.4. Different scenarios for community-based jatropha production, use of PPO and the production of organic fertilizer.

Scenario 1: PPO for lighting

Jatropha grain contains viscous oil with few other components than oil, fats and carbohydrates, which makes it well suited for burning (Jongschaap et al., 2007 p. 15). To supply all households in our study area (n=85) with 250 ml petroleum $week^{-1}$, 1105 l PPO yr^{-1} would be needed annually.[29] Producing this quantity would require 5,648 kg jatropha grain yr^{-1}, equivalent to 4.5 ha based on a jatropha grain production of 1,250 kg ha^{-1} yr^{-1}. This equals a value of US$2321 yr^{-1} if the equivalent of petroleum is bought at local shops for US$2.10 l^{-1}. If the PPO is used locally for lighting, the value of the jatropha would be US$514 ha^{-1}.

However, there are some technical issues to bear in mind. Jatropha oil will not burn easily in regular oil lanterns because of its high viscosity and low capillary effect. Low-tech lamps such as the *Binga Lamp* could serve this purpose better (Flemming Nielsen, FACT Foundation, personal communication). Further research is needed to investigate whether indoor burning of jatropha PPO is actually healthier than using petroleum or other fossil fuels for lighting.

Scenario 2: soap production from PPO

To produce 1.27 kg of soap, one litre PPO, 0.35 l water and 150 gr caustic soda are needed (de Jongh, 2010 p. 77). One bar of soap weighs around 0.45 kg,[30] roughly indicating that at least

[29] We assume here that 1 l PPO has the same energy content as 1 l petroleum. In the literature, we could find was that the energy content of PPO is about 4–5% less per volume as compared with fossil diesel (de Jongh, 2010 p. 62).

[30] Soap bars weighed by FACT Foundation in Bilibiza, Cabo Delgado.

two bars of soap can be manufactured from 1 l PPO. Providing all households (n=85) with two bars of soap per month would require 1,020 l PPO yr^{-1}. The required 5213 kg jatropha grain yr^{-1} can be produced on 4.2 ha. The produced soap represents a total value of US$1071 yr^{-1} compared with soap sold locally for US$0.53 per bar. If used locally, the value of the jatropha per hectare would be US$257.

The social-cultural acceptance of buying and using locally produced soap (e.g. smell, colour and foam) requires attention, although jatropha soap is generally whiter – and therefore considered of a higher quality – than the brown soap bars locally available (Flemming Nielsen, FACT Foundation, personal communication). Another point of attention is that the local availability of caustic soda could be problematic.

Scenario 3: PPO application in generators

The conversion of diesel engines to (partly) run on jatropha PPO is only attractive when regular and sufficient PPO production can be guaranteed. To generate power for Envirotrade, the carpentry and the maize mill, 12,220 l diesel yr^{-1} is needed.[31] If 50% of the consumed diesel (6,110 l yr^{-1}) was replaced by PPO, 31,229 kg jatropha grain yr^{-1} would be needed, and this requires growing 25 ha of jatropha. Compared with diesel bought for US$0.88 l^{-1} at the petrol station, 6,110 l PPO equals a total value of US$5,346 yr^{-1}. In this scenario, the value of the jatropha per hectare would be US$214.

Production of organic fertilizer

The by-products of jatropha such as fruit coats and press-cake can be used as organic fertilizer. The press-cake in particular is nutrient rich and therefore very suitable as a fertilizer (Jongschaap et al., 2007 p. 16, 28).

One kilogram of jatropha fruit (dry weight) can roughly be divided in 0.7 kg grain and 0.3 kg fruit coat (Jongschaap et al., 2007 p. 14). With an oil content of 30% and a press efficiency of 60%, 1 kg of jatropha grain would provide 0.18 kg PPO or 0.20 l PPO (PPO weighs 0.92 kg l^{-1}). The remaining 0.82 kg press-cake can be used as organic fertilizer (Jongschaap et al., 2007 p. 16). One ton of press-cake contains approximately 51 kg of nitrogen (N), 18 kg of phosphorus (P) and 13 kg of potassium (K) (de Jongh, 2010 p. 84). The equivalent of synthetic fertilizer can be calculated on the basis of the press-cake nutrients. However, as nutrients in synthetic fertilizer are much more available for crops than nutrients in jatropha press-cake, this does not allow for a fair comparison.

As fertilizers are not commonly used or available in Nhambita community, applying organic fertilizer could boost crop production. Moreover, applying the fruit coats and other residues on the fields will increase the organic matter in the soil and induce higher retention of water and nutrients, and reduce the growth of weeds and consequently labour demands for weeding.

[31] Calculations based on five working days per week and 52 working weeks per year.

5.6.3 Analysis of the potential for local market development

Table 5.4 provides an overview of the potential local market for PPO use in Nhambita and the amount of land needed to fulfil each scenario. Based on available knowledge and experiences, we think we have been quite conservative in determining jatropha grain yields, oil content (30%) and press efficiency (60%). We want to emphasise that the 'total values' and 'values ha^{-1} in US$' in Table 5.4 should not be interpreted as 'revenues.' Calculating revenues would require the analysis of the total amount of labour, land and inputs needed to produce and process jatropha as compared with e.g. buying petroleum or industrial soap locally, and allocating the same labour, land and inputs to other on- or off-farm activities. Although jatropha is known to produce grain in the first and second year, yields of 1,250 kg ha^{-1} yr^{-1} will most probably be achieved from the third or fourth growing season onwards. Furthermore, whether such yields can be considered realistic depends on biophysical conditions and crop management. If not used, processed and marketed locally, the market price paid for jatropha grain – at the time of the research – was approximately US$0.11 kg^{-1}. This price will fluctuate, as it is highly dependent on fossil fuel prices and regional demand and supply (Flemming Nielsen, FACT Foundation, personal communication). When using the market price of US$0.11 kg^{-1} in our scenarios, the value of jatropha grain per hectare equals US$131, most likely from the third growing season onwards, when yields of 1,250 kg ha^{-1} yr^{-1} can be expected. How this relates to revenues from producing other cash crops that can be harvested annually, using a similar amount of land, labour and inputs, requires further research.

Of the three scenarios, the production of PPO for lighting or local soap manufacture seems the most realistic option in the short term. It requires the smallest amount of land for jatropha production and, besides testing oil lamps and developing soap-making techniques, no costly investments are required as an oil-press is already available to the community. Moreover, the potential (added) value per hectare is relatively high as compared with selling the grain for a market price of US$0.11 kg^{-1}. Within the PPO for lighting scenario in particular, the value per hectare is almost four times higher, mainly because of the high local prices for petroleum. Combined, scenarios 1 and 2 produce around 100 kg organic fertilizer hh^{-1} yr^{-1}. This could increase agricultural productivity as currently no fertilizers are used by the majority of farmers in Nhambita.

If the production of jatropha grain and PPO exceed the absorption capacity of the local market for lighting and soap, the more ambitious third scenario could be explored. However, it requires large amounts of land and labour to produce sufficient quantities of PPO. However, the scenario of replacing 50% of the diesel with PPO could initially also start by replacing 5% or 10%. Most likely, a higher capacity oil press and storage capacity are needed to ensure year-round availability of PPO, as well as investments in the conversion of engines. Nevertheless, this scenario could provide guaranteed off-take of jatropha grain and thus reduce uncertainty and risks for smallholders producing jatropha. It would also lead to large quantities of organic fertilizer that could increase agricultural productivity in the area.

One may argue that many other scenarios could be included. The literature describes the use of jatropha oil for cooking, jatropha oil extracts as insecticide or fungicide, or using press-cake as animal fodder (cf. Jongschaap et al., 2007; de Jongh, 2010; FAO, 2010). On the assumption that 5.11 kg jatropha grain is needed to produce 1 l PPO, it is likely that the energy content in the remaining press-cake is actually higher than in the PPO itself. In that case, biogas production from the press-cake is an attractive option that adds extra value to the crop. On many of these applications, further research is needed.

5.7 Political and legal developments

The jatropha trials in Nhambita initially received considerable attention from high-level politicians and the media, who described the project as the first successful jatropha plantation in Mozambique, highlighting the potential for community-based biofuel production and use. Subsequently, the Ministry of Energy provided Envirotrade with an oil-seed press to produce PPO. Jatropha was presented in the NBPS as an "officially approved biofuel feedstock," that has: "[T]he firm commitment of the high-level leadership of national policy, on behalf of His Excellency, the President of the Republic of Mozambique, who has personally launched the campaign for *Jatropha curcas* farming in the country, one of the main raw materials for biodiesel production" (Government of Mozambique, 2009 p. 14).

Since then, much has changed. Scepticism about jatropha as a competitive biofuel feedstock has been growing in Mozambique and elsewhere. Crop failure due to the lack of agronomic knowledge about crop management, pests and diseases, and low productivity on so-called marginal soils have tempered the initial enthusiasm about jatropha. Moreover, uncertainty about the GHG and energy balance of jatropha biofuels, potential competition with food crop production and the bankruptcy of several jatropha plantations in Mozambique has reduced political interest in promoting jatropha. On the other hand, the Mozambican government is showing an interest in gathering lessons learned and using them to further operationalize and implement the country's NBPS.

Following international discussions on the sustainability of biofuels, the Mozambican government defined the necessary steps to develop a national biofuel sustainability framework. In 2010, Version 1 of the framework – including biofuel sustainability principles and criteria, and a guide for implementation – has been presented and discussed during stakeholder consultation workshops in Maputo, Nampula and Beira. The proposed framework has been designed to be integrated in the government's Project Application and Land Acquisition Process (Circular No. 009/DNTF/07),[32] which exempts smallholder biofuel producers or community-based projects from having to demonstrate compliance with the criteria. Moreover, the framework proposes incentive structures that could stimulate collaboration between commercial biofuel operators and smallholders producers, e.g. by stimulating technology transfer and knowledge sharing to enhance productivity. However, if

[32] This procedure links the processes for awarding land titles and approving investment proposals of large-scale commercial agricultural projects (Schut et al., 2010c p. 5154).

smallholders produce for commercial biofuel operators (e.g. as outgrowers), compliance with the sustainability criteria is required. In the case of Nhambita, this could be problematic as the community is located in the buffer zone of Gorongosa NP, and one of the criteria specifically mentions that biofuel production shall avoid negative impacts on biodiversity, ecosystem functions and services, and land with high conservation value.

Government regulation for biofuel licensing is currently being developed. One of the proposed thresholds for requiring a government licence is the annual amount of biofuels produced. At the moment, this threshold is established at 5,000 l yr^{-1}, which would mean that a biofuel licence would be required only in the case of the third scenario (Table 5.4). A possible advantage is that the regulation proposes that biofuels produced by smallholder cooperatives or association are exempt from paying taxes.

Another interesting development is the attempt to receive carbon credits for planting jatropha. Several projects are exploring this opportunity. If such an attempt was successful, it could provide an incentive for Envirotrade to include jatropha production as one of the agro-forestry contracts where farmers receive payments for carbon conservation.

5.8 Analysis and discussion

The objective of this chapter was to provide insights into the opportunities and constrains that influence the innovation space for sustainable community-based production and processing of biofuel feedstock for localized use or for local marketing. Although we consider this chapter to be exploratory in nature and we could not fully grasp the complexity of, e.g. resource allocation in the community and biophysical conditions for growing jatropha, it does provide a starting point for more systematic and strategic thinking about community-based biofuel production and use. Moreover, lessons learned from existing community-based jatropha projects (in Mozambique and other SSA countries) are scarce but essential to sensitize policymakers and other stakeholders on the complexities of community-based biofuel production and use. In the following sections, we further analyse and discuss our data, focusing on demonstrating how the dynamics and interactions between social-cultural, biophysical, economic, political and legal subsystems across different scales and levels of analysis through time influence the space for innovation for community-based biofuel production and use.

5.8.1 Integrated assessment of subsystems that constitute space for innovation

Although our analysis of biophysical conditions was not supported by e.g. laboratory analysis of soil samples, it seems that factors such as temperature, soil quality and fertility status, and water availability do not make jatropha production in the area impossible. Mean rainfall in the region (850 mm yr^{-1}) and its distribution (82% of the rain falls in five months) does not create optimal growing conditions for jatropha production, although the crop is known to produce grain with a minimum water availability of 500 to 600 mm yr^{-1} (Euler and Gorriz, 2004). Data from South Africa underline the production potential of jatropha under dry conditions, as non-irrigated, unfertilized 4-year-old jatropha (741 trees ha^{-1}) yielded 1,286 kg dry grain ha^{-1} in a growing season of 8.5 months with 652 mm rainfall (Jongschaap et al., 2009). Furthermore, data from interviews and observations in relation to the successful first growing season of the trials, the good condition of jatropha on the *machamba* of the high resource endowed farm in September 2009 and the fact that jatropha in the communal trial died after the first pruning make us conclude that there is acceptable biophysical space to produce jatropha in Nhambita community. Pest, disease and crop management in general seem to have hampered the production potential of jatropha in the community.

The analysis of the economic space demonstrated the potential for local use and marketing of biofuels and other applications of PPO. The majority of households buy petroleum for lighting, and one of the main expenditures of households is soap purchase. Moreover, the Envirotrade project uses large quantities of diesel that could partly be replaced by PPO. Within all scenarios, organic fertilizer can be produced, which could increase agricultural productivity as currently only a very small percentage of farmers apply fertilizer. The high added value of jatropha when processed and used locally may allow for higher jatropha grain prices for farmers compared with selling unprocessed jatropha grain for a market price of US$0.11 kg^{-1}. Moreover, supplying the local market is less sensitive to outside distortions such as highly fluctuating fossil fuel prices. Whether estimated grain yields (1,250 kg ha^{-1} yr^{-1}) are realistic and allow for competitive production as compared with producing other cash crops, Envirotrade's agro-forestry contracts or allocating labour to off-farm activities requires further research.

How the performance of a crop, and political and legal space can be interrelated is nicely demonstrated in the Nhambita case. Initially, the project received considerable attention from politicians, and the project was used to underline the government's political commitment to the emerging biofuel sector and the potential for biofuel – and more specifically jatropha – production in Mozambique. On the basis of the initial success of projects like Nhambita, jatropha was officially approved by the government as biofuel feedstock, and this created the legal basis for the expansion of commercial and community-based jatropha production in Mozambique. However, discussions on competition between biofuels and food production, crop failure and growing criticism of jatropha as a 'miracle crop' have reduced the political space for jatropha in Mozambique. Government officials have acknowledged that the initial promotion of jatropha was mainly based on wishful thinking, lacking profound analysis and a clear strategy. There is a willingness to learn from existing experiences however, and to use these experiences in developing and implementing more realistic and sustainable biofuel policies.

Despite the potential biophysical and economic space for community-based biofuel production and use, the initial political commitment and legal space for jatropha production in Mozambique, our study has demonstrated that different farm households have different reasons for allocating or not allocating resources to producing jatropha. We must conclude that farmers are not reluctant to adopt agricultural innovations. The success of pigeonpea cultivation in Nhambita shows that the introduction of new (cash) crops can be sustainable if some critical conditions are met. Farmers carefully allocate their labour and land to crops and activities that provide resilience in terms of meeting their demands for food and income. Our data show that labour availability, its allocation and labour synergies at the community level are crucial for understanding these trade-offs at farm level. The low resource endowed household faces multiple constraints in terms of achieving food self-sufficiency given their current household and farm size, and the amount of labour they can invest in the own farm. The risks associated with allocating resources to a single-purpose, non-food crop such as jatropha, of which they have little knowledge and that only gives profitable yields after three to four years, are too high under the current conditions. High and medium resource endowed households have land and labour available, and – in the case of the high resource endowed farm – experience some sort of space to experiment. Nevertheless, our data demonstrate that also the high resource endowed household decided to allocate available resources (in this case labour) to activities other than producing jatropha. The main reason for this can be found in a lack of trust in the crop, driven by the failure of the communal jatropha trials, lack of agronomic knowledge about the crop, and the absence of organised markets and supply chains.

Our data demonstrate the complex dynamics of community-based biofuel production and use, and how interactions between different subsystems influence the extent to which an agricultural innovation (such as jatropha or another biofuel crop) can contribute to sustainable development. Especially in the case of community-based biofuel production and use, understand the context specific and multiple realities of smallholder farming and its synergies at community level is crucial, as it is the farmers who eventually determine whether community-based biofuel production and use is perceived as an opportunity or a threat.

5.8.2 Spatial and temporal dynamics that influence space for innovation

In the previous section, we addressed some of the interactions between scales and levels of analysis e.g. how trade-offs at farm level influence labour dynamics at community level, and how changes in political or legal space at the national level affect local space for innovation. Another example can be found in the proposed Mozambican biofuel sustainability framework, which includes criteria that seek to avoid biofuel production and processing near nature conservation areas and areas that are highly biodiverse. If implemented, this criterion would affect the possibility for farmers from Nhambita (being located in the buffer zone of Gorongosa NP) to work as outgrowers, producing jatropha grain for a commercial biofuel operator. As the development of the biofuel sustainability framework emerged from international debates on the sustainability of biofuels, this illustrates how dynamics across different scales and levels affect the local space for innovation. On the other hand, the Mozambican biofuel sustainability framework also provides opportunities for smallholder communities, as it includes criteria that promote collaboration between commercial and smallholder biofuel producers in terms of knowledge and technology transfer to enhance agricultural productivity.

Depending on the volume of biofuel production, a government licence might be required. Studies have shown that smallholders or smallholder communities often lack the financial, administrative and organisational capacity to meet such requirements (Schut et al., 2010a). This underlines the need for adequate support mechanisms that can create an enabling environment for community-based biofuel projects, rather than create additional obstacles. A good example of how a legal space at the national level can enhance local space for innovation is the government's intention to integrate biofuel sustainability criteria in the existing Project Application and Land Acquisition Process, which exempts smallholder biofuel producers from having to demonstrate compliance with the biofuel sustainability criteria if the biofuels are produced, processed and used locally.

The Nhambita case provides some clear examples of how space for innovation changes through time. Initially, the prospects for biofuel production and use in Nhambita community were promising. Envirotrade supported the development of jatropha trials, the jatropha was growing well, an influential farmer planted jatropha on his *machamba*, farmers from the area expressed an interest in growing jatropha and an oil-seed press was provided to the community. However, the lack of agronomic knowledge about crop management eventually heralded the failure of jatropha in the community, and farmers lost their trust in the crop. Furthermore, the disappointing results of community-based and commercial jatropha projects have reduced political interest in promoting jatropha. However, the analysis of these (mainly disappointing) experiences may contribute to more realistic prospects for jatropha biofuels in Mozambique and other SSA countries. Recent studies have created widespread awareness that the performance of jatropha – like any other crop – depends on specific biophysical conditions such as nutrient and water availability, and adequate crop management. The sharing of research data and experiences with regard to crop management, harvesting, seed and grain storage, oil pressing, using PPO for domestic lighting, local production of soap, but also project and social organisation, is essential for the development of policy that provides a more enabling environment for existing and future community-based biofuel projects. Although it is unlikely that farmers' trust in jatropha can be easily restored in Nhambita community, the case provides an incentive for more strategic thinking in the design and implementation of biofuel policy, and for the development of adaptive capacity in policy to respond to the uncertainties of community-based biofuel production and use in Mozambique (cf. Verdonk et al., 2007).

5.9 Conclusions and recommendations for policy

This study shows that the design and implementation of biofuel policy concerned with sustainable community-based biofuel production and use requires integrated assessment of social-cultural, biophysical, economic, political and legal subsystems within which innovations like jatropha are expected to contribute to sustainable and dynamic rural development. Moreover, interactions across different scales and levels of analysis (farm level, community level, country level, as well as internationally) and temporal dynamics influence the extent to which local space for innovation for community-based biofuel production and use can be created and sustained.

The way jatropha production in Nhambita was promoted by the Mozambican government caused disappointing results that have negatively affected farmers' trust in the biofuel crop. Agricultural innovations, such as the introduction of biofuel crops in smallholder farming systems, are unsuitable for 'silver bullet' solutions or linear trajectories (van Mierlo et al., 2010; Giller et al., 2011). It implies that community-based biofuel policies must be targeted to the specific context in which farming takes place, taking into account the complexity of different farming strategies and their synergies at community level. This makes the design and implementation of biofuel policies concerned with community-based biofuel production and use fundamentally different from other rural energy policies. It does not mean that no policy strategies can be developed however. There exist *ex-ante* integrated assessment tools (see e.g. the NUANCES-framework – http://www.africanuances.nl) that can contribute to more strategic policy development regarding agricultural innovations and interventions, before they are promoted amongst smallholder farmers (Giller et al., 2011).

Moreover, policies that promote community-based biofuel production and use should focus on creating an enabling environment. Such an environment should provide safe space for experimentation and institutional support in terms of capacity building, sharing knowledge and experiences, and market development. An enabling environment could enhance local space for innovation by continuously adapting to local demands and the changing context in which biofuel developments take place, preventing biofuels from becoming a threat rather than an opportunity for smallholders (Verdonk et al., 2007). Envirotrade has several mechanisms in place that could support community-based biofuel production and use. Examples include the annual remuneration for planting and maintaining trees that reduces risks and results in short-term, financial benefits for smallholders. Furthermore, the microbusiness associations and rural community committees and trust funds could facilitate the social organisation of community-based biofuel activities, as well as the distribution of benefits.

Acknowledgements

The authors thank the Mozambican Ministry of Energy, National Directorate for Renewable Energy (DNER) and GTZ-ProBEC for supporting this research. This study contributes to the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions,' funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation (former Ministry of Agriculture, Nature Conservation and Food Quality). The research also formed part of the 'Competing Claims-Competing Models' programme jointly funded by Wageningen University and Research Centre and the Dutch Ministry of Foreign Affairs (DGIS).

We express our gratitude to the Envirotrade project staff for facilitating our stay in Nhambita community. We are grateful to Nhambita community for welcoming us and giving us permission to do our fieldwork. The authors acknowledge the valuable contributions of colleagues, especially Raymond Jongschaap, Shamie Zingore, Flemming Nielsen and Ken

Giller, and the journal's anonymous reviewer who provided constructive feedback on earlier versions of this chapter.

CHAPTER 6

Ex-ante scale dynamics analysis in the policy debate on biofuel sustainability in Mozambique

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Resubmitted with revisions for publication in Ecology and Society.

KEYWORDS

Scale dynamics analysis

Action-oriented research

Policy processes

Biofuels

Mozambique

Sustainability

ABSTRACT

The objective of this chapter is to explore how *ex-ante* scale dynamics analysis can contribute to better understanding of interactions between scales and levels and how they influence solution space in policy processes. In so doing, we address opportunities and challenges of conducting *ex-ante* scale dynamics analysis as part of an action-oriented social science research approach that seeks to enhance its contribution to more scale- and level-sensitive policy development. The policy debate on biofuel sustainability in Mozambique provides the empirical context in which we describe and explain how research on interactions between multiple scales and levels influences the space within which stakeholders can explore and design policy solutions.

On the basis of our analysis, we conclude that *ex-ante* scale dynamics analysis can contribute to (1) increasing awareness of interactions between scales and levels, and their implications for policy, (2) identifying immediate and potential matches and mismatches between scales and levels and developing (adaptive) capacity to address them, and (3) identifying stakeholders and their scale- and level-related interests that can provide the basis for collaborative multi-stakeholder learning. In so doing, *ex-ante* scale dynamics analysis can provide an important contribution to balancing and harmonising interactions between different scales and the levels on those scales, from which innovative and scale- and level-sensitive policy responses can emerge. However, attention needs to be paid to processes of scale and level inclusion and exclusion when conducting *ex-ante* scale dynamics analysis in multi-stakeholder policy contexts.

6.1 Introduction

In the context of globalisation, there is increased awareness of the need to explore sustainable policy solutions by crossing the boundaries not only of countries and continents, but also of institutions, administrations and disciplinary approaches to research (Cumming et al., 2006; Smith et al., 2010). Climate change is a classic example that illustrates how global phenomena are rooted in a complex mix of local processes, and *vice versa*. Similarly, the extent to which biofuels can contribute to solving the global energy crisis and reducing greenhouse gasses (GHG) emissions will be determined by: "[I]nteractions among environmental, social and economic factors that are unique to particular bioregions, cultures, and economies" (Atwell et al., 2011 p. 1).

Studying such interactions across multiple scales and levels forms an essential part of what Cash et al. (2006) described as scale dynamics analysis. Although the body of literature on scale dynamics analysis and its implications for policymaking and other forms of governance is growing rapidly,[33] Kok and Veldkamp (2011 p. 7) identified a need for: "[M]ore case study papers that explicitly make use of the conceptual literature while providing experimental insights in the value of these concepts."

One of the conceptual discussions on scale dynamics in policy processes is whether scales and levels should be seen as "real entities" or "socially constructed" (Buizer et al., 2011 p. 3, 8).[34] The former approach in which scales and levels are perceived real entities is at the core of many natural science disciplines (e.g. landscape ecology). Within such disciplines, *ex-ante*[35] scale dynamics analysis often provides the basis for developing models or scenarios to inform policymakers about how changes or actions at one scale or level may constrain or provide opportunities at other scales or levels (Cash and Moser, 2000). In the social sciences, both 'real' and 'constructivist' approaches to scales and levels are applied. A fundamental difference from its application in the natural sciences is, however, that scale dynamics analysis in the social sciences is mainly used as an analytical tool to reconstruct or evaluate policy processes *ex-post* (see e.g. the work of Bunce et al., 2010; Mandemaker et al., 2011; van der Veen and Tagel, 2011; van Lieshout et al., 2011). In line with Manson (2008 p. 778), we take the position that it is particularly "useful to understand how the range of [...] viewpoints[,] [...] definition[s] and use of scale concepts in research" can contribute to more scale-sensitive policy development. Although many scholars have described the need for this type of research (cf. McNie, 2007; Giller et al., 2008; Termeer et al., 2010; Veldkamp et al., 2011), few case studies exist that explore the potential of *ex-ante* scale dynamics analysis as part of a social science, action-oriented research approach in support of more scale-sensitive policy development; i.e. policy that takes into account interactions between different scales and levels.

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[33] See for example the Special Feature on Scale and Governance in Ecology and Society.

[34] See also Turnhout and Boonman-Berson (2011).

[35] *Ex-ante* = foregoing or before; *ex-durante* = during; and *ex-post* = afterwards or after.

The next section provides a theoretical exploration of scales, levels and the different types of scale dynamics and scale dynamics analyses. This is followed by a section that describes how interactions between scales and levels can create challenges that affect solution space in policy processes. Subsequently, we provide a background on the policy debate on biofuel sustainability in Mozambique that provides the empirical context of this chapter. From these sections, we derive the research objective, research approach and the methodology. Three empirical sections describe different forms of scale dynamics analyses. These are followed by the analysis that describes how *ex-ante* scale dynamics analysis can contribute to more scale-sensitive policy development, and a discussion on the opportunities and challenges of *ex-ante* scale dynamics analysis as part of action-oriented research. We close the chapter with the main conclusions.

6.2 Scales, levels and scale dynamics

In line with Gibson et al. (2000 p. 218), we define scales as: "The spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon." Termeer et al. (2010 p. 1) describe levels as: "[T]he units of analysis that are located at different positions on a scale." To illustrate, the spatial scale is an example of a scale, whereas local, subnational, national, regional and global are the units of analysis or levels on the spatial scale. The literature provides a wide variety of examples of scales. The spatial and temporal scales are among the classics (Termeer et al., 2010), but scales can also be administrative or institutional (Cash et al., 2006). As indicated above, spatial scales include levels relating to geographical space that form the basis for disciplines such as geography and ecology. Temporal scales can be divided in perceptions of time, for example short-term, middle-term or long-term, or slow and fast (Cash et al., 2006). The administrative scale contains levels of decision making that can range from the supranational level to, for example, village level. The levels on the institutional scale, ranging from formal declarations, conventions, laws and regulation, to more informal institutions such as norms, attitudes and practices, are closely related to the administrative scale. Other disciplines use scale-like approaches to explore different modes of knowledge production or research (cf. Gibbons et al., 1994), for example by differentiating between knowledge produced in the context of abstraction (generalised and global) and knowledge produced in the context of application (contextualised with local relevance) (cf. Cash et al., 2006). Such a categorisation can also be applied to the concept of sustainability, which can be conceptualised as a process of standardisation, or as something that is locally grounded and contextual. Figure 6.1 illustrates the examples.

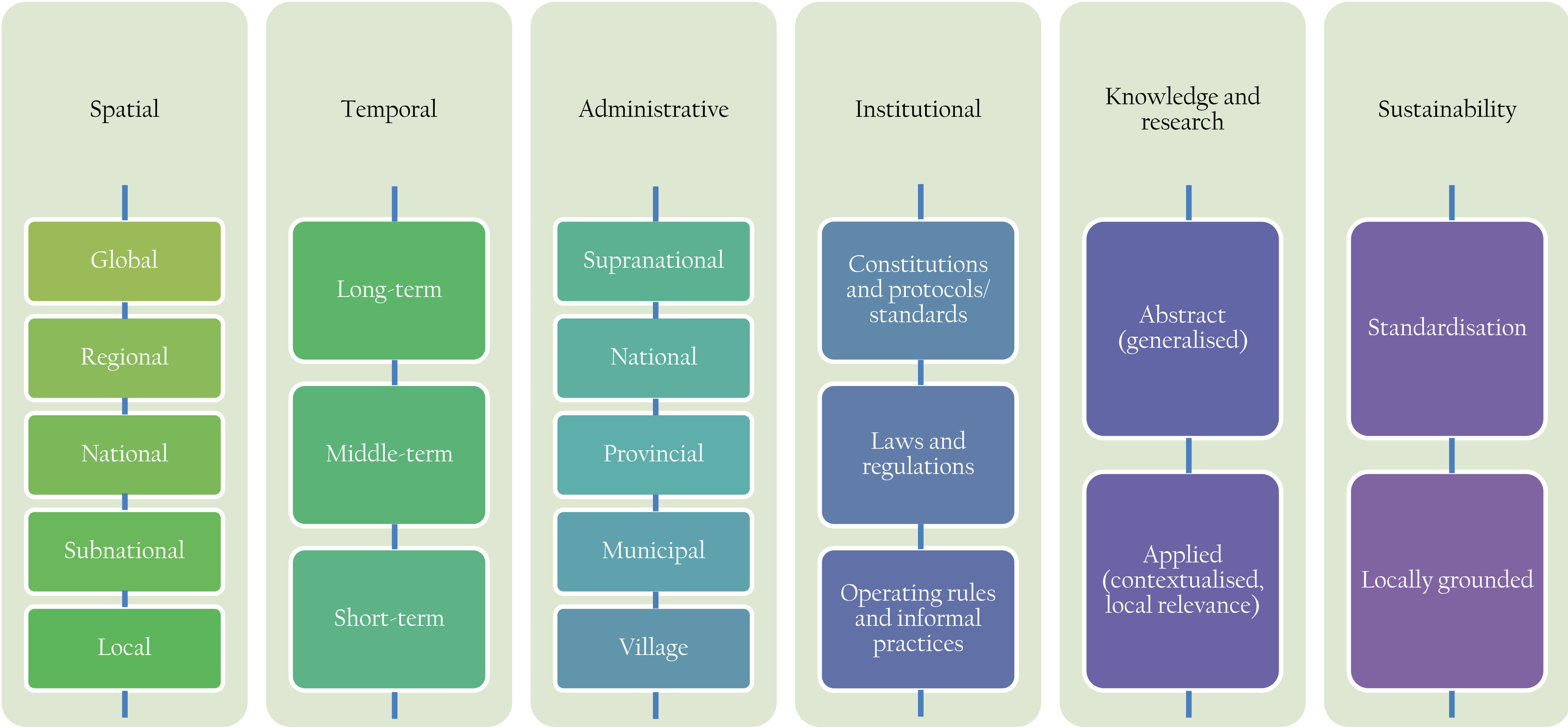

Fig. 6.1. Examples of scales and levels (based on: Gibbons et al., 1994; Cash and Moser, 2000; Gibson et al., 2000; Cash et al., 2006; Termeer et al., 2010; Veldkamp et al., 2011).

Cash et al. (2006 p. 2) describe cross-scale dynamics as: "[I]nteractions across different scales," for example between levels of the spatial and temporal scales. They define cross-level dynamics as: "[I]nteractions among levels within a scale [...]"; such as between the global and the local level on the spatial scale. In a similar fashion, Cash et al. (2006 p. 2-4 emphasis changed) clarify that: "'Multilevel' is used to indicate the presence of more than one level, and 'multiscale' the presence of more than one scale, but without implying that there are important cross-level or cross-scale interactions." For this chapter, scale dynamics should be interpreted as cross-scale, cross-level, multiscale or multilevel interactions through time, and the various combinations between them (e.g. multiscale and cross-level). Accordingly, scale dynamics analysis refers to the process of describing and explaining such interactions.

6.3 Scale dynamics analysis and solution space in policy processes

According to Giller et al. (2008), feasible policy solutions may emerge from balancing interests and bridging perceptions on sustainability across different scales and levels. This implies that *ex-ante* scale dynamics analysis can provide an important contribution to describing and explaining such interests and perceptions across different scales and levels, and – in so doing – shape the space within which scale-sensitive policy solutions can be explored and designed. Solution space in policy processes is determined by interactions between social-cultural, biophysical, economic, political and legal scales and levels that influence the course and outcome of policy processes (Giller et al., 2008; Schut et al., 2010b). Solution space concerns both the policy content, as well as the way the policy process is organised (Dovers, 1995).

Cash et al. (2006) have identified three categories of challenges related to interactions between scales and levels that can affect solution space in policy processes. The first challenge is that of 'ignorance,' referring to the: "[U]nknown cross-level and cross-scale interactions that take place" (Veldkamp et al., 2011), often resulting from a lack of scale or level sensitivity, and resulting in unforeseen or unintended policy responses (cf. Buizer et al., 2011). The second challenge is that of different types of 'mismatches' between scales and levels. Mismatches may occur when different scales or levels do not correspond, for example when seeking to address a transfrontier or international problem at the national administrative or decision-making level (Cumming et al., 2006; Veldkamp et al., 2011). "When the spatial scales of management and the spatial scales of ecosystem processes do not align appropriately", Cumming et al. (2006 p. 3) refer to this as spatial mismatches. Temporal mismatches may emerge when slow bureaucratic procedures and processes are unable to respond to urgent policy issues (Cumming et al., 2006; Termeer et al., 2010). Mismatches can also be more functional, for example, when research or knowledge has little relevance to policymakers at a certain level (Cash et al., 2006; McNie, 2007). The third challenge, 'plurality,' refers to the representation and participation of stakeholders and their scale- and level-related interests in policy processes (Cash et al., 2006). With regard to this challenge, it is important to stress that the framing of policy problems by stakeholders at a certain scale or level should be considered strategic and political acts, as responding to scale challenges may imply the (re-)distribution of resources, responsibilities and power (Adger et al., 2005; Lebel et al., 2005; Dewulf et al., 2006; Lebel, 2006; Termeer et al., 2010).

In line with that, neither the process of scale and level inclusion and exclusion by stakeholders and researchers, nor the scale dynamics analysis and the solution space it shapes should be perceived as something that is neutral or 'out there' (Turnhout and Boonman-Berson, 2011). Carlsson et al. (2002 p. 239) say about this: "There is no reason to hide that the delineation [of scales and levels or system's boundaries] may often be somewhat arbitrary and partly based on informed [choices] [...][36] by the researcher." In addition, policy processes are dynamic by nature as stakeholder perceptions and the policy context are likely to change over time. Especially in action-oriented research approaches, this dynamic and changing nature of the policy context often requires the ongoing inclusion and exclusion of scales and/or levels in the analysis as the policy process unfolds over time.

6.4 Policy debate on biofuel sustainability in Mozambique

In December 2007, the Mozambican government organised a workshop to discuss the proposed European Union Directive 2009/28/EC[37] (EU, 2009), which includes the EU's biofuel sustainability criteria. It was concluded that the EU should consider its biofuel policy in the light of its development agenda for Africa, and the criteria on GHG emissions and the effects of indirect land-use change were perceived as "too ambitious," and could "scare away potential investors" (Schut et al., 2010a p. 18). It was decided that a national policy framework for biofuel sustainability should be developed.

To implement the country's National Biofuel Policy and Strategy (NBPS – Resolution 22/2009), the Mozambican government established four subgroups, overseen by a National Biofuel Taskforce. One of the subgroups – the Subgroup Sustainability Criteria (henceforth abbreviated as 'subgroup') – was given de responsibility to: (1) analyse the development of sustainability criteria by different platforms and markets, and develop capacity so Mozambique can influence the international debate and can cooperate with countries in similar positions; (2) develop a national system for sustainable biofuel production that reflects the Mozambican reality and long-term requirements of the major markets; (3) support the investment subgroup to develop criteria for selecting biofuel investment projects; and (4) support the legal framework subgroup in modifying Mozambican legislation to promote a sustainable biofuel sector.

[36] The original quote by Carlsson et al. speaks of "guesses"; we prefer to use "choices".

[37] European Commission (EC), which originates European Union (EU) laws. Directive 2009/28/EC endorses a mandatory 10% minimum target to be achieved by all member states for the share of renewable energy (including biofuels) in transport-related petrol and diesel consumption by 2020. Only biofuels produced in compliance with the EU's sustainability criteria may count as part of the 10% minimum target and will be eligible for the market incentives for biofuels sold on the EU market (Schut et al., 2010c p. 5153).

Between December 2008 and November 2010, the lead author of this chapter conducted action-oriented research in Mozambique. During this period, the author formed part of a Technical Secretariat, responsible for conducting research and supporting the subgroup in developing a policy framework for biofuel sustainability. The initiator of the subgroup, the Mozambican government, had formalised the participation of private sector and civil society stakeholders in the policy process in the country's NBPS; envisioning the subgroup to be a multi-stakeholder policy platform.

6.5 Research objective, approach and methodology

The objective of this chapter is to explore how *ex-ante* scale dynamics analysis can contribute to better understanding of interactions between scales and levels and how they influence solution space in policy processes. In so doing, we address opportunities and challenges of conducting *ex-ante* scale dynamics analysis as part of an action-oriented social science research approach that seeks to enhance its contribution to more scale-sensitive policy development.

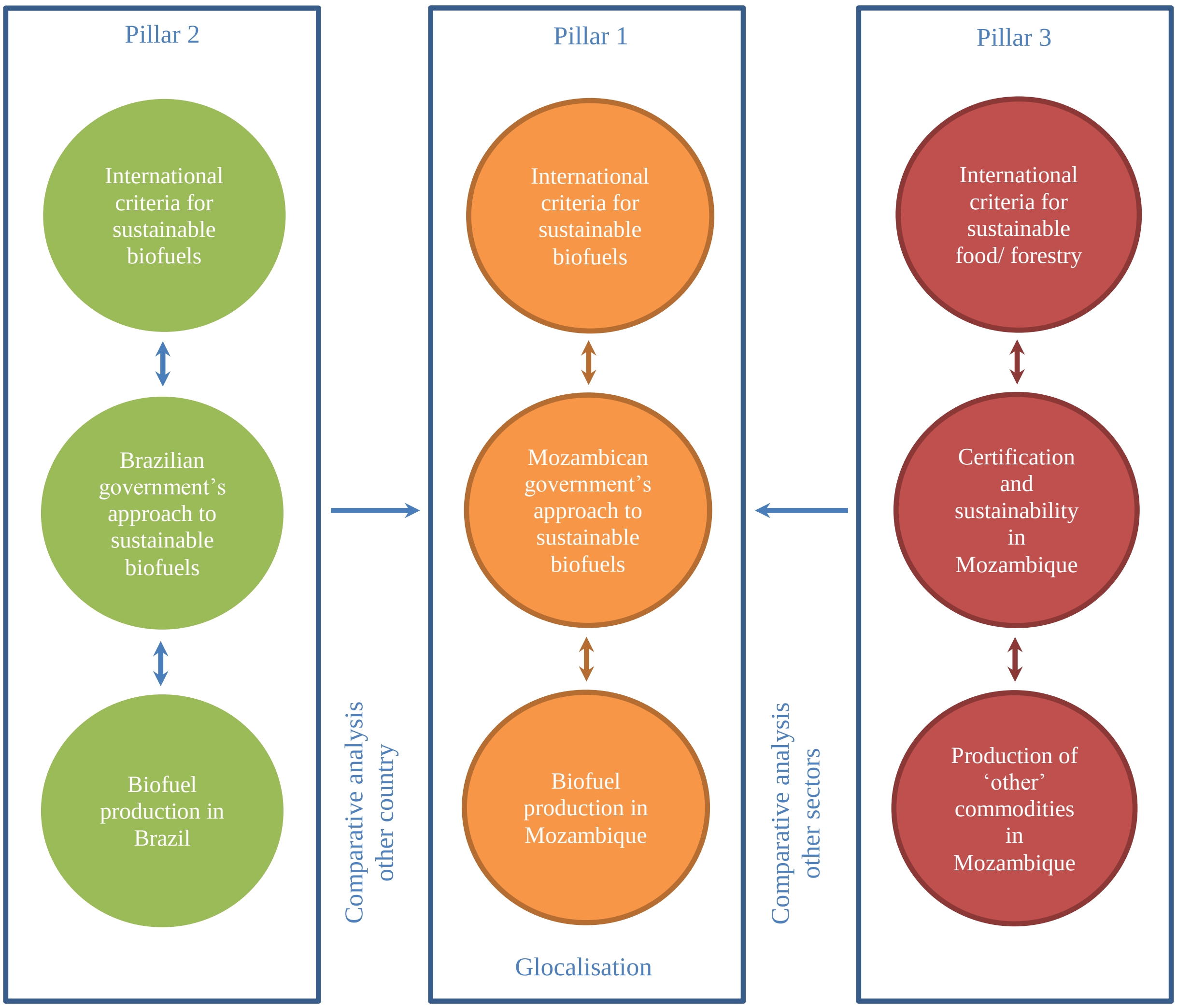

Fig. 6.2. Research approach.

Upon arrival in Mozambique in December 2008, we elaborated the research approach in collaboration with the Mozambican government. One of the first challenges was making choices about what scales and levels to include and exclude in the research, and what types of scale dynamics analyses (cross-scale, cross-level, multiscale, multilevel) would be most relevant. As the multi-stakeholder subgroup was not active (terms of reference were in the process of being developed), we proposed a threefold research approach to the Mozambican government, focusing on different types of scale dynamics analyses (Figure 6.2). The approach was based on the objectives of the subgroup as formulated in NBPS (see previous section).

The first research pillar focuses on 'glocalising' the biofuel sustainability debate in Mozambique; a perspective that: "[R]aises the question of the extent to which forces operating at the global level influence economic, social and political processes taking place at the [national or] local level or *vice versa*" (Ramutsindela, 2004 p. 61 italics changed). The analysis of interactions between different scales and levels in this pillar is twofold. Firstly, we describe and compare existing biofuel sustainability frameworks developed at different administrative levels, and identify matches and mismatches with the biofuel policy objectives of the Mozambican government. Part of this first step is the analysis of existing institutional agreements at the interface of different levels on the administrative scale, such as trade agreements between the EU and Mozambique. Secondly, we describe and analyse how the policy objectives of the Mozambican government relate to the reality of the emerging biofuel sector in Mozambique. Again, we elaborate the existing institutional framework that governs agreements between the Mozambican government and biofuel investors, such as the investment guidelines and the land acquisition process.

Because of the relative newness of biofuels in Mozambique (as well as in other sub-Saharan African countries), we decided to analyse similar interactions across scales and levels in Brazil, a country with a long history in producing, processing, trading and using biofuels (Pillar 2). The objective of this type of comparative analysis is to generate insights about how the Brazilian government (positioned at a similar level on the administrative scale) has dealt with scale and level interactions in promoting and regulating the sustainability of its biofuel sector, how the Brazilian government has positioned itself in the global debate on biofuel sustainability over time.

To learn more about scale dynamics related to certification and sustainability in Mozambique, we conduct comparative analysis of scale and level interactions in other sectors in Mozambique that produce commodities under certification or sustainability schemes (Pillar 3). This research pillar provides insights into the formal and informal institutional dynamics to which a biofuel sustainability framework is likely to be exposed in practice. Again, we describe and analyse how such interactions between scales and levels have evolved over time and how different types of challenges related to interactions between scales and levels have been addressed.

The data presented in this chapter originate from a variety of quantitative and qualitative research methods. Specific data collection techniques are elaborated in the sections that describe the three research pillars. With regard to analysing the opportunities and challenges of ex-ante scale dynamics in action-oriented research, we mainly draw on participatory observations that were gathered during the two years of fieldwork in Mozambique when the lead author worked as policy advisor in the Technical Secretariat.

6.6 Three research pillars for scale dynamics analysis

Below the three research pillars are elaborated. Each section concludes with a short summary of how the analysis of scale and level interactions provided lessons learned for the policy debate on biofuel sustainability in Mozambique.

6.6.1 Pillar 1: Glocalising biofuel sustainability

In line with the subgroup's first objective, we started by analysing and comparing four – at that time leading – biofuel sustainability frameworks: (1) the Dutch Cramer Criteria; (2) the UK Renewable Transport Fuels Obligation (RTFO); (3) the EU Directive for sustainable biomass production (Directive 2009/28/EC); and (4) Version 0 of the Roundtable on Sustainable Biofuels (RSB) of which an overview is provided in Appendix F. The implementability of the UK and Dutch frameworks was at that time questionable, as some criteria were potentially conflicting with EU laws and World Trade Organization (WTO) treaties. For example, the WTO's 'national treatment principle' requires that products from other countries should be treated the same way as products manufactured in the importing country, and that regulations and standards should not create unnecessary trade obstacles (Bauen et al., 2005; van Dam et al., 2008). However, the categorisation of products using GHG emission reduction, biodiversity or environmental criteria is possible (Woods and Diaz-Chavez, 2007); this explains the EU's "(narrow) focus on climate and biodiversity" and lack of detailed social and economic criteria (Di Lucia, 2010 p. 7400).

At the national level, we analysed the government's NBPS, which promotes the production of biofuels in order to: "Make use of agro-energy resources to diversify the range of energy sources, benefit the population and enhance socio-economic development, especially of the population of rural areas" (Government of Mozambique, 2009 p. 11). The NBPS describes several measures intended to promote biofuel production while limiting potential negative impacts on society and the environment. Some of the measures are: proposed limits on land allocation based on agro-ecological land zoning; preventing negative impacts on food security; approval of selected feedstocks;[38] the use of sustainability criteria to select investment projects and allocate land titles; the creation of a domestic market for biofuels via blending mandates; increasing exports to create tax revenues and foreign currency; and the promotion of regional markets for biofuels. Analysis of other biofuel-related legislation revealed that data requirements under the government's existing Project Application and Land Acquisition

[38] Sugarcane and sweet sorghum for ethanol, and coconut and jatropha for biodiesel.

Process – governed by the Mozambican investment law and land law, and their regulatory frameworks (Figure 6.3) – could potentially be adapted to assess the sustainability of biofuel operations in Mozambique. The assessment of companies after two years provides the Mozambican government a legal instrument to void land titles of companies that do not comply with Mozambican legislation[39] (see also: Schut et al., 2010c p. 5153-5155).

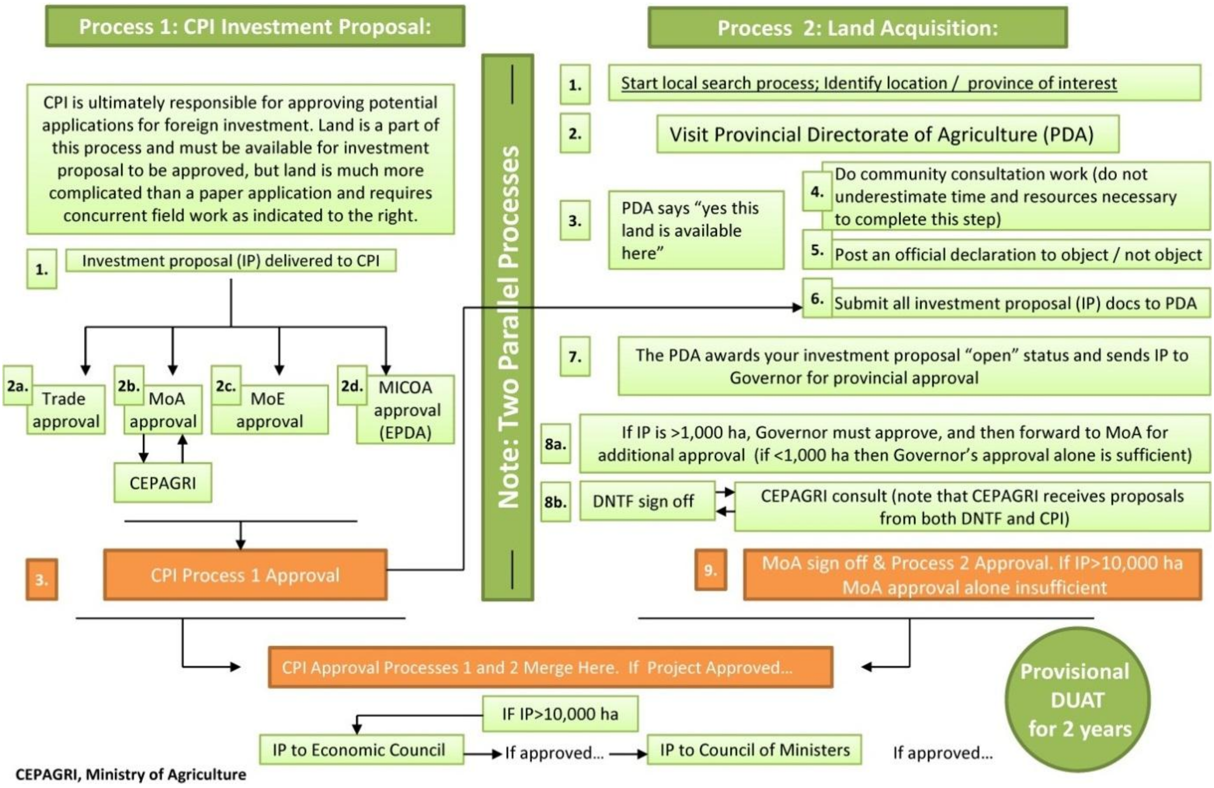

Fig. 6.3. Project Application and Land Acquisition Process (Albino, 2010).

Subsequently, we analysed existing (trade) agreements between Mozambique and other individual countries and supranational bodies. Duty-free access for ethanol, biodiesel and vegetable oil exports from Mozambique to the EU is granted under two key agreements: (1) the Cotonou Protocol between the EU and African, Caribbean and Pacific countries, which is in the process of being transformed into a regional economic partnership agreement (EPA) between the EU and SADC,[40] and (2) the 'Everything But Arms' arrangement, which grants duty-free access to the EU market for all goods (except arms) for least developed countries. The SADC Trade Protocol provides duty-free access for Mozambican products to ten other SADC countries[41] and is aimed at promoting regional trade (Schut et al., 2010c p. 5153). In terms of promoting the sustainability of the emerging biofuel sector in the country,

[39] The power of the procedure was demonstrated in December 2009, when the government voided the contract of a large sugarcane-for-ethanol project, as the company failed to comply with their contractual obligations (Schut et al., 2010c p. 5152).
[40] Southern African Development Community.
[41] Botswana, Lesotho, Malawi, Mauritius, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Mozambique is signatory to international agreements on sustainability, such as the Kyoto Protocol, and experiences a degree of political pressure to demonstrate: "'[G]oodwill' to international donors and powerful trade partners in consideration of the large share of donations contributing to the national budget" (Di Lucia, 2010 p. 7401).

To better understand the reality of biofuel developments in Mozambique at the local level, we analysed 10 existing biofuel projects, ranging from commercial, large-scale projects, to community-based biofuel projects, and interviewed close to 50 stakeholders, including policymakers and representatives of private sector and civil society organisations. This enabled us to develop a more locally grounded image of the direction and sustainability of the emerging biofuel sector in Mozambique. Furthermore, it allowed us to identify different stakeholder groups and their perceptions on biofuel sustainability, as well as pathways for how the policy process and stakeholder representation could be organised. We complemented these findings by analysing investment data and mapped the geographical spread of implemented and planned biofuel projects in Mozambique. In relation to the government's NBPS, the analysis showed that the majority of commercial biofuel projects have no interest in establishing themselves in remote rural areas and do not focus on areas identified under the agro-ecological land zoning, and employment creation as proposed by investors seems much lower than expected by the government. Moreover, biofuel investors intend to export their produce to overseas markets such as the EU, where incentives are already in place. Although export creates tax benefits and foreign currency for the Mozambican state, it does not solve the energy dependency problem the country is facing (Schut et al., 2010c). One community-based biofuel project was analysed in more detail (Bos et al., 2010; Schut et al., 2011b). The study showed that discriminating between commercial and community-based biofuel production is important, as compliance with sustainability criteria can easily result in reduced market access for smallholder producers. It created awareness that sustainable community-based biofuel production and use requires a different set of policy measures than those needed to sustainably develop the commercial sector (Schut et al., 2011b).

During a later phase in the research, we additionally analysed biofuel sustainability frameworks developed by the Better Sugarcane Initiative (Version 2, see: BSI, 2009), Global Bioenergy Partnership (GBEP, 2010), and the SADC framework for sustainable biofuels (SADC, 2010, see Appendix G). Especially the SADC framework implied the inclusion of an additional (regional) level in the analysis. Due to the worsening global financial climate, these frameworks proposed stricter criteria to regulate the financial sustainability of the biofuel sector. As several biofuel operators in Mozambique faced bankruptcy, such criteria were highly relevant for the Mozambican biofuel sector. We concluded that the SADC framework in particular included principles that were more in line with the objective of the Mozambican government as described in the NBPS; notably those on energy security, economic development and food security. Moreover, aligning with the SADC biofuel sustainability principles would facilitate access to the regional SADC market, one of the objectives of the Mozambican government.

Summarising, the first research pillar contributed to improved understanding of definitions of biofuel sustainability developed at different levels by different administrations, organisations and the stakeholders representing them. It enabled us to identify cross-level matches and mismatches in thinking about biofuel sustainability and their (potential) consequences such as access of Mozambican biofuels to the EU biofuel markets. The analysis also created insight into the extent to which the existing – mainly formal – institutional arrangements that govern the interfaces of different administrative levels provide opportunities in terms of aligning the Mozambican policy framework with existing regional (SADC) and international markets and taking the requirements for accessing these markets into account. Mismatches may result from developing a biofuel sustainability framework that is insufficiently capable of addressing ongoing developments and dynamics in the emerging biofuel sector, such as the worsening financial situation of many biofuel projects. This demonstrates the need for flexibility and adaptive capacity in the policy process. Functional mismatches can emerge if no exceptions are made for smallholder producers or community-based biofuel projects, consequently leading to undesirable obstacles for smallholder or community-based biofuel production and use. With regard to the plurality of involved stakeholders and their scale- and level-related interests, the analysis demonstrated that solution space could be optimised by exploring policy scenarios that could harmonise stakeholder interests. An example is the proposal to modify the existing Project Application and Land Acquisition Process to promote or regulate the sustainability of the commercial biofuel sector. This strategy can reduce additional administrative and financial burdens for both government and the private sector, and exempts smallholders and communities as they do not have to comply with the procedure.

6.6.2 Pillar 2: Learning from interactions between scales and levels in Brazil

We conducted a desk study and analysed secondary data to identify some of the sustainability challenges of the Brazilian biofuel sector, how the Brazilian government promotes the sustainable production of biofuels throughout the value chain, how Brazil has positioned itself in the international debate on the sustainability of biofuels, and how the stakeholder debate on biofuel sustainability has evolved over time. Below, we summarise the main findings; a full account is described in Schut et al. (2010a p. 26-41).

With regard to the sustainability of the Brazilian biofuel sector, a study by Smeets et al. (2008) on the sustainability of Brazilian bioethanol shows that concerns relate mainly to competition with food production, disputes over land rights, impacts on biodiversity, water pollution, soil erosion, GHG emissions and energy balance,[42] working conditions and worker rights, and child labour. We highlight one example to illustrate how ideas about sustainability are closely related to making trade-offs between social, environmental and

[42] Ethanol produced from sugarcane is more efficient with respect to the replacement of fossil energy and the reduction of GHG emissions when expressed per unit of land and when compared with other bioenergy options. However, emissions resulting from fossil fuel use in agricultural operations, biofuel processing and biofuel transportation negatively affect GHG emissions and energy balance (Smeets et al., 2008 p. 791).

economic objectives at the country level through time. During the early 1990s, the Brazilian government started promoting mechanised sugarcane harvesting to decrease GHG emissions and other types of air pollution resulting from cane burning; which is necessary to facilitate manual harvesting (van Dam et al., 2008 p. 755). Cane burning is moreover regarded as unsustainable because it damages the ecosystem and soil structure and is hazardous to the health of cane cutters. However, as a result of the introduction of mechanised harvesting, employment in the Brazilian sugarcane sector dropped by almost 50% between 1992 and 2003, causing social and economic problems for cane cutters and their families (Schut et al., 2010a p. 28). It shows the duality and trade-offs related to thinking about sustainability and how ideas about sustainability are likely to change over time.

The rapid expansion of the biofuel sector in Brazil and its negative impact on biodiversity have resulted in criticism from the EU, with proposals to restrict the import of biofuels from Brazil that have damaged the environment (Keeney and Nanninga, 2008). As a response to global political pressure, Brazil developed several policy mechanisms that regulate the sustainability in the biofuel sector, including stimulating partnerships between commercial and smallholder producers, improving the financial sustainability of the sector, and promoting investments in research and development to continuously improve the productivity, efficiency and overall sustainability of the biofuel sector. Many of these challenges are similar to current and potential future challenges in the Mozambican biofuel sector.

Furthermore, the analysis demonstrated that no additional sustainability or certification schemes are necessary if a country's legal framework deals with the (negative) social, economic and environmental impacts of biofuel production, processing, trade and use. Embedding biofuel sustainability criteria into national policy as a 'licence to produce' would be in line with the objectives of the Mozambican subgroup and the government's NBPS and can reduce the additional administrative and financial burden for both the government and the private sector. It must be said that law enforcement in Brazil is generally weak and consequently many biofuel operators fail to comply with existing legislation. Smeets et al. (2008 p. 797) therefore add that: "Existing legislation and law enforcement strategies can be used to formulate criteria and indicators [for biofuel sustainability], whereby compliance with existing legislation must be a key issue."

Although the analysis of interactions between scales and levels in Brazil did not capture the full complexity of the Brazilian biofuel sector and its sustainability, it did create awareness that no additional certification or sustainability frameworks are necessary if a country's legal framework can be adapted to regulate the sustainability of biofuel production, processing, trade and use. However, the study also demonstrated that the local impact of national policy may be disappointing if law enforcement is not in place. The analysis also highlighted how conceptions on biofuel sustainability are often context specific, based on trade-offs made at a certain level and prone to change over time. This demonstrates the need for adaptive capacity in policymaking to respond to the changing policy context and changing stakeholders' perspectives and needs at different levels through time. In terms of solution space in the policy debate on biofuel sustainability in Mozambique, the analysis highlighted potential solutions to current and potential mismatches, but also the pros and cons of different types of policy scenarios.

6.6.3 Pillar 3: Learning from interactions between scales and levels in other sectors in Mozambique

As part of the research strategy, we analysed interactions between scales and level in other Mozambican sectors in which commodities are produced under certification or sustainability criteria, such as FSC, GlobalGAP and Fairtrade (Appendix H provides a brief overview). Data were collected by analysing secondary data, by conducting field visits to companies and projects and by interviewing policymakers and representatives from companies, certification institutes and civil society organisations.

The analysis demonstrated that mainstream certification can easily result in the exclusion of smallholder producers from markets. Few smallholders have the human or financial resources to comply with sustainability or certification schemes. The need for capacity building, alternative procedures and group certification for smallholders is thus crucial. Also within the commercial sector it is very important to address the heterogeneity of biofuel producers. Both FSC and Fairtrade have developed gradual systems that seek to respect producers in their local context. FSC, for example, allows starting companies to comply with basic standards, whereas more 'mature' companies can expect higher standards and stricter audits.

Only a very small segment of the Mozambican market is supplied by commodities produced under voluntary sustainability schemes. Certified products are mainly produced for overseas markets, as the higher production costs relating to certification do not allow for competitive production for the domestic market. In particular, analysis of the forestry sector in Mozambique revealed that the vast majority of timber is produced and extracted unsustainably and even illegally, mainly because of the lack of enforcement of laws, regulations and standards; a significant challenge in Mozambique (World Bank, 2009). Moreover, there are few companies that perform audits, and there is a general lack of facilities (such as laboratories) that can provide standardisation or certification services (Awasthi, 2005). In response, some public and private stakeholders have established organisational structures and institutional arrangements that can facilitate FSC certification in Mozambique. In December 2010, the Association for Responsible Forestry in Mozambique (AGREF) was founded. AGREF's main objective is to establish an FSC National Office and to develop a national standard for FSC forest certification in Mozambique that will make it easier and cheaper to become FSC certified (FSC, 2010; AGREF, 2011).

In sum, the comparative analysis of dynamics between scales and levels in other sectors provided insights into the potential challenges to which a biofuel sustainability framework in Mozambique would be exposed in practice. It showed that a mandatory, government-led approach to sustainability in the form of a licence to produce is most likely to contribute to achieving the Mozambican government's biofuel-related objectives, although the general lack of enforcement of laws, regulations and standards is worrying. An important lesson that can be learned from other certification or sustainability schemes is that the heterogeneity of producers requires a diversified and flexible approach that distinguishes between commercial and smallholder producers, and evaluates their sustainability in the local context, at the local level. Such a locally grounded approach to sustainability differs from global standardisation approaches such as developed for biofuels by the EU. Consequently, the analysis revealed that in order to contextualise or nationalise global sustainability standards new organisational structures (such as AGREF) and institutional arrangements may be needed to reduce the costs of compliance, facilitate the development of feasible and realistic sustainability criteria, and – eventually – adequately monitor compliance with the certification or sustainability scheme. This research pillar provided additional insights and perspectives on different policy scenarios, and their advantages and disadvantages.

6.7 Ex-ante scale dynamics analysis and solution space in the policy debate on biofuel sustainability in Mozambique

Combined, the threefold research approach provided better understanding of a variety of scale- and level-related dynamics in which the policy debate on biofuel sustainability in Mozambique is embedded. Additionally, the analyses of interactions between scales and levels in Brazil and in other Mozambican sectors provided insights how such dynamics could be addressed. The research findings were continuously shared and discussed with representatives of the key stakeholder groups; government, civil society and private sector. Due to leadership changes in the Mozambican government, the subgroup never became a multi-stakeholder platform for policy debate, but remained an inter-ministerial working group.

In line with the objectives of this chapter, we below analyse how *ex-ante* scale dynamics analysis was used to identify different types of challenges related to interactions between scales and levels and how this shaped solution space in the policy debate on biofuel sustainability in Mozambique.

6.7.1 Reduce ignorance and create awareness of dynamics between scales and levels

The Mozambican government's feedback on EU Directive 2009/28/EC and the objectives of the subgroup (influence the international debate and reflect requirements of major markets) demonstrate some sort of awareness about cross-level political and legal dynamics on the part of the Mozambican government. However, there was very little information on how these dynamics could affect biofuel developments in Mozambique and how it would influence the solution space within which a national framework for biofuel sustainability could be developed. A fundamental first step was therefore to describe and analyse perceptions on, and politics of biofuel sustainability across different policy and administrative levels, the existing institutional agreements at the interfaces of such levels, and how they function in practice.

The analysis of investment proposals revealed that the majority of biofuel investors primarily focus on exporting biofuels to EU markets. Comparing leading biofuel sustainability frameworks provided insights into the long-term requirements of these markets. It also demonstrated how definitions of biofuel sustainability are shaped by multiple objectives, priorities and trade-offs made at different levels or in different spatial contexts (cf. van Dam et al., 2008). Moreover, describing the institutional agreements at the interfaces of administrative levels revealed that definitions of biofuel sustainability are also influenced by legal realities (e.g. WTO's national treatment principle) and by political pressure to demonstrate goodwill.

The analysis of existing biofuel developments in Mozambique raised awareness about the diversity of biofuel projects and how existing projects relate to the biofuel objectives of the Mozambican government. The analysis demonstrated the need for the timely development of policy tools to provide a more secure framework for biofuel investments. One of the underlying questions that the analysis exposed was how a biofuel sustainability framework could differentiate between commercial and smallholder producers in the sector, as well as address plurality within the commercial sector. The analysis of such dynamics in other sectors showed how certification and sustainability schemes can easily result in the exclusion of smallholder producers from markets, but also how schemes such as FSC responded to such challenges over time by developing alternative and gradual procedures to address the heterogeneity of producers. In doing so, the analysis highlighted current and potential mismatches and possible solutions based on learning from scale dynamics in other countries and sectors. Describing the existing institutional and legal framework for biofuel investors in Mozambique provided insights into how existing policy instruments operate in practice, and how the legal framework could be adapted to overcome mismatches and to assess the sustainability of biofuel production in a way that is mutually beneficial for government and investors in Mozambique.

In terms of the subgroup's objectives, the analysis shaped the solution space for exploring a national biofuel sustainability framework that could reflect (1) the long-term requirements of the major markets, and by doing so facilitate the export and market access for biofuels produced in Mozambique and demonstrate political goodwill, and (2) the Mozambican reality by developing a more locally grounded idea about biofuel sustainability and by taking into account the political and legal realities in which a national biofuel sustainability framework would be implemented.

6.7.2 Scale and level matches and mismatches and adaptive capacity in policy development

Identifying matches and mismatches between different levels on the administrative and institutional scales resulted from describing and explaining perceptions and policies on biofuel sustainability at different levels, and the institutional structures and agreements at the interfaces of these levels. The analysis revealed both current and potential mismatches, but also matches.

Mismatches mainly emerged between levels on the administrative and institutional scales, resulting from different perceptions on biofuel sustainability, and different ideas about how biofuels should contribute to sustainable development and how this should be regulated. More specifically, the EU's focus on climate and biodiversity did not reflect the social-economic objectives of the Mozambican government. The most eminent temporal mismatch was the absence of an adequate policy framework to guide biofuel developments in Mozambique, resulting in a biofuel sector that does not reflect the Mozambican government's objectives for promoting biofuel production. Potential functional mismatches to which biofuel sustainability may be exposed in practice emerged mainly from the comparative analysis of scale and level interactions in Brazil and in other Mozambican sectors. These mismatches particularly relate to challenges of law enforcement and the potential exclusion of smallholder farmers or community-based projects from producing biofuels as a result of biofuel sustainability criteria.

Potential matches across levels on the institutional scale were also identified. For example, integrating the biofuel sustainability criteria in the existing legal framework governing project approval and access to land could create win-win situations for investors and the Mozambican government, while at the same time not negatively affect smallholder or community-based production of biofuels. Furthermore, the analysis demonstrated the advantages of collaborating with countries in the region, as SADC member states have adopted regional biofuel sustainability principles, and the existing SADC Trade Protocol provides duty-free access for Mozambican biofuels to the majority of SADC countries. Aligning with the SADC framework was moreover politically desirable, as it could (1) increase the legitimacy of the Mozambican framework, (2) strengthen the position of Mozambique in the international debate on biofuel sustainability and (3) facilitate cooperation with countries in similar positions: key objectives for the Mozambican government.

Definitions of biofuel sustainability are prone to change over time, as was illustrated by the increased attention given to the financial and economic sustainability of the biofuel sector as a result of the global financial and economic crisis. Moreover, the analysis of Brazil and other Mozambican sectors demonstrated how perceptions and policies on sustainability evolve over time and change as a result of new information and experiences, and changing (policy) contexts; demonstrated by the example of mechanised harvesting in Brazil. In order to deal with such dynamics and develop approaches to address both immediate and potential mismatches in a changing policy context the development of adaptive capacity in policy processes is crucial, but also very challenging (cf. Gunderson and Holling, 2002; Cumming et al., 2006; Olsson et al., 2007; Allen and Holling, 2010; Termeer et al., 2010). The analysis of scale dynamics in other countries and sectors provided different scenarios on how a policy framework could address current, or respond to future scale and level mismatches.

6.7.3 Plurality and collaborative stakeholder learning

Scale dynamics analysis contributed substantially to identifying key-stakeholder networks (government, civil society organisations and the private sector) across different policy levels and their objectives, expectations and (power) relationships. It captured not only the different (and competing) stakeholder perceptions concerning the policy content (definition of biofuel sustainability and what sustainability criteria should be included in the framework), but also concerning their expectations about how the policy process should be organised, and their role, rights and responsibility in that process. Furthermore, it demonstrated the need for a platform to facilitate multi-stakeholder interaction, negotiation and learning, and that the limited activity of the subgroup as multi-stakeholder platform became problematic. Creating space for collaborative stakeholder learning could contribute to optimising the policy solution space, and: "[D]eal with change and uncertainty, and making linkages and promoting collaboration across different actors and scales as a way to make policy and management more responsive to the needs of diverse stakeholders [...]" (Bunce et al., 2010 p. 494).

The analyses resulting from the second and third research pillars provided various examples of how collaboration between stakeholders is essential to develop a dynamic and legitimate sustainability framework that reflects the key interests and objectives of different stakeholder groups. It stressed the importance of having a platform in which such collaborative stakeholder learning could take place and that multi-stakeholder dialogue was hampered by limited subgroup activity. Moreover, the analyses created awareness that multiple approaches may be needed to promote biofuel sustainability in Mozambique, for example by distinguishing between smallholder or community-based biofuel production and commercial biofuel production, as both need different types of enabling environments. This triggered thinking about the feasibility of different policy scenarios and their scale-sensitivity in terms of respecting the plurality of stakeholders, their objectives and needs.

6.8 Ex-ante scale dynamics analysis in action-oriented research: opportunities and challenges

Based on the experiences as described in the previous sections, we argue that *ex-ante* scale dynamics analysis as part of an action-oriented social science research approach has a high potential in terms of its contribution to more scale-sensitive policy development. It allows for challenges related to scale and level interactions (and also potential solutions) to be identified during an early stage in the policy process. From a more methodological viewpoint, the comparative analyses of interactions between scales and levels in other countries and other sectors proved valuable for conducting *ex-ante* scale dynamics analysis, especially given the relative newness of, and limited experience with, (sustainable) biofuel production in Mozambique. With regard to exploring policy scenarios to implement the biofuel sustainability framework, the analyses of scale- and level related dynamics in Brazil and other sectors in Mozambique broadened the space within which policy solutions could be explored. Furthermore, the analyses were used to emphasise the advantages and disadvantages of

different policy scenarios during the policy debate, taking into account the multiple objectives of stakeholders and the reality of biofuel developments in Mozambique.
To give the reader an idea of what this led to, the research findings that resulted from the *ex-ante* scale dynamics analysis provided the basis for drafting biofuel sustainability principles and criteria for Mozambique and developing a guide for policy implementation. This process was executed by the inter-ministerial subgroup and the Technical Secretariat. The proposed biofuel sustainability framework was discussed during three stakeholder consultation workshops in which over 150 representatives from government, the private sector and civil society organisations participated. During the workshops, stakeholders negotiated about the formulation of the criteria and discussed the proposal to integrate the framework with the government's existing Project Application and Land Acquisition Process. By the end of 2010, the framework was approved by the subgroup and the National Biofuel Taskforce, making Mozambique the first African country to develop a national policy framework for biofuel sustainability. Currently, the framework is in the process of being operationalised and implemented.

In addition, we conclude that *ex-ante* scale dynamics analysis should form an essential part of action-oriented, social science research that seeks to enhance its contribution to more scale-sensitive policy development. The action-oriented research approach enabled us to continuously include and/ or exclude scales and levels from the analysis. This made the research dynamic and made it possible to respond to the changing policy context, changing stakeholder perceptions and demands, and – consequently – enhance the practical relevance of the *ex-ante* scale dynamics analysis in support of the policy process. However, the approach also poses challenges. Any analysis of complex problems will necessarily include processes of delineation (cf. Carlsson et al., 2002; Smith et al., 2010). As the subgroup did not function as multi-stakeholder platform, choices about what scales and levels to include and exclude could not easily be made in collaboration with the different stakeholder groups. They were often based on choices made by the researcher, which can be questioned as decisions about what scales and levels to include or exclude in the analysis influence the type of scale awareness that the research creates, the matches and mismatches that are identified, and the perceived appropriateness of different stakeholders to participate in the policy process. Here, we touch upon more deeply rooted discussions about the roles for researchers in policy processes (Schut et al., 2011a) and the division of tasks and responsibilities between research and stakeholders in policy processes (cf. Jasanoff, 1990; Hoppe, 2005). In line with Kok and Veldkamp (2011) we conclude that on processes of scale and level inclusion and exclusion as well as on other applications of scale concepts in practice further empirical research is urgently needed.

6.9 Conclusions

This chapter has explored how *ex-ante* scale dynamics analysis as part of a social science research approach can contribute to better understanding of interactions between scales and levels and how they influence solution space in policy processes. Based on our findings, we conclude that *ex-ante* scale dynamics analysis can effectively contribute to transforming challenges resulting from interactions between scales and levels into opportunities by (1) creating awareness about these interactions between scales and levels, (2) identify scale and level matches and mismatches and develop adaptive capacity to deal with them, and (3) identify key stakeholders and their scale- and level- related interests that can provide the basis for collaborative stakeholder learning. In so doing, *ex-ante* scale dynamics analysis can enhance the contribution of research to more scale-sensitive policy development; i.e. policy that takes into account interactions between different scales and levels.

A second objective of this chapter was to identify opportunities and challenges of conducting *ex-ante* scale dynamics analysis as part of an action-oriented social science research approach. Processes of scale and level inclusion and exclusion form an essential part of scale dynamics analysis in action-oriented research. These processes of inclusion and exclusion keep the research flexible, enables the researcher to respond to changing policy context and stakeholder needs, and – consequently – increases the likelihood that the research can meaningfully contribute to scale-sensitive policy development. However, processes of scale and level inclusion and exclusion are not neutral or value free, and it is not always practically feasible to make such choices in collaboration with all stakeholders in the process. More empirical research on scale and level delineation in action-oriented research is therefore needed, as such choices influence the type of awareness the research creates, the type of matches and mismatches that are identified, and the perceived appropriateness of stakeholder groups to participate in exploring and designing policy solutions.

Acknowledgements

This study contributes to the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions,' funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation (former Ministry of Agriculture, Nature Conservation and Food Quality). The research also formed part of the 'Competing Claims-Competing Models' programme jointly funded by Wageningen University and Research Centre and the Dutch Ministry of Foreign Affairs (DGIS).

The authors acknowledge the valuable contributions of colleagues, especially Kasper Kok, and the journal's anonymous reviewers who provided constructive feedback on earlier versions of this chapter. Special thanks to all investors, farmers, extension workers, researchers, NGO representatives and policymakers that collaborated with us and provided data and insights necessary for this study.

CHAPTER 7

Knowledge and innovation management in the policy debate on biofuel sustainability in Mozambique: what roles for researchers?

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Published as:
Schut, M., C. Leeuwis, A. van Paassen and A. Lerner (2011). Knowledge and innovation management in the policy debate on biofuel sustainability in Mozambique: what roles for researchers? Knowledge Management for Development Journal 7(1): 45-64.

KEYWORDS

Researchers' roles

Knowledge management

Innovation management

Policy processes

Biofuels

Mozambique

ABSTRACT

This chapter explores the relationship between knowledge management (KM) and innovation management (IM) in policy processes. By describing and analysing the roles of researchers as knowledge and innovation managers in policy processes we also contribute to the debate on how researchers can enhance their effective contribution to policy processes. Empirical data were gathered between December 2008 and November 2010. During that period, two of this chapter's authors conducted action-oriented research whilst supporting the Mozambican inter-ministerial Subgroup Sustainability Criteria in developing a sustainability framework for biofuel production in Mozambique.

We conclude that KM and IM are mutually reinforcing and inextricably bound: KM can provide the basis for engaging in IM activities or roles, which may – consequently – create an enabling environment for more effective KM in policy processes. The active embedding of researchers in policy processes, an action-oriented research approach and systematic reflection can enable researchers to continuously determine what (combination of) KM and IM strategies or roles can enhance the actionability of research in, and the quality of the policy process. To do so successfully, a process-oriented research approach and strategic management of the boundary between research and policy are key.

7.1 Introduction

In recent years, the interest in researchers' roles in, and their contribution to, policy processes has increased considerably (Jasanoff, 1990; Steel et al., 2004; Pielke Jr., 2007; Boaz et al., 2009; Sterk et al., 2009). In the light of the growing complexity of social, economic and environmental challenges, many have argued that it is time for researchers to abandon their traditional roles as producers of authoritative, objective and value free knowledge (Gibbons et al., 1994; In 't Veld, 2000; Hoppe, 2005) and engage more actively in research that is embedded in interaction with societal stakeholders to collaboratively describe and explain problems, and to explore and design sustainable solutions (Giller et al., 2008 p. 8).

There exists a lively debate about how far researchers can or should go in mobilizing their research findings in policy processes. The Knowledge Management (KM) approach, where researchers focus on producing and managing credible, legitimate and relevant knowledge through processes of multi-stakeholder learning, has become increasingly popular and is widely promoted in the field of international development. However, some claim that the KM approach is too narrow, and that researchers should go beyond their focus on knowledge and knowledge management by also anticipating the more structural formal and informal institutional processes, and relational and power dynamics that determine how knowledge is mobilised and used in practice. This approach is often referred to as Innovation Systems Management or Innovation Management (IM).

This chapter seeks to contribute to sharpen the debate on the relationship between KM and IM in policy processes. We present a case study on the contribution of action-oriented researchers[43] to developing a biofuel sustainability framework for Mozambique. The case describes the roles of researchers as knowledge and innovation managers in the policy process and is used to analyse the relationship between different KM and IM roles, how KM and IM shaped the policy process and *vice versa*. Such insights on knowledge and innovation management in policy processes are important for researchers, but also for policymakers and development practitioners who want to improve their responsiveness to development challenges (Ferguson et al., 2010 p. 1797).

The next section provides a brief overview of the literature on KM and IM to date, followed by an exploration of the roles of researchers as knowledge and innovation managers in policy processes. Subsequently, the research objectives and methodological approach are presented. In the section thereafter, we describe and analyse our roles as knowledge and innovation managers in the policy debate on biofuel sustainability in Mozambique. Finally, we analyse our findings, and follow this up with the main conclusions of the chapter.

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[43] In the original research article (Schut et al., 2011a p. 45, 49, 50 and 59) we refer to "participatory action research". Based on progressive insights, we decided that 'action-oriented research' is more appropriate (see Section 1.5.1).

7.2 Knowledge and innovation management

Terms such as 'knowledge', 'knowledge management' or 'innovation management' are in themselves not easy to define (Amalia and Nugroho, 2011 p. 72). Definitions on KM and IM abound (Swan et al., 1999 p. 264), are prone to multiple interpretations and evoke questions about whether knowledge or innovation can be managed in the first place (cf. Snowden, 2002 p. 101). We acknowledge that any description of KM or IM is contested, and that the boundaries between the approaches are often blurred. On top of that, both approaches – especially KM – are conceptualized in a "variety of ways" (Alvesson and Kärreman, 2001 p. 1004). However, in order to study the roles of researchers as knowledge or innovation managers in policy processes, we cannot escape from at least providing a broad description of KM and IM.

7.2.1 Knowledge management (KM)

A meta-review of literature on knowledge management for development by Ferguson et al. (2008) identifies different types of KM, for example, "engineering and emergent KM approaches" (van den Hooff and Huysman, 2009), or "rationalist and post-rationalist KM approaches" (Ferguson et al., 2010). The engineering or rationalist KM approaches perceive knowledge as: "[A] 'thing' (object) which is amenable to being 'managed' – by a 'subject' (a manager)" (Quintas et al., 1997 p. 389). The main purpose of this form of KM is to produce objective and value free knowledge, and transfer that to end-users, such as policymakers (Hartwich et al., 2007; Ferguson et al., 2010). In this chapter, we refer to KM as the emergent or post-rationalist approaches that have a much stronger emphasis on learning and are rooted in the idea that knowledge is contextual and co-constructed by stakeholders (van den Hooff and Huysman, 2009). The knowledge production process itself (develop relevant research questions, decide on research methods, gather data, and analyse and interpret the findings) is organised in close collaboration with the stakeholders. Doing so can facilitate processes of joint learning and develop shared understanding of the nature of the issue at stake, as well as about the space within which solutions can be explored and designed. One of the challenges of joint knowledge production and multi-stakeholder learning is that stakeholders often act strategically, rather than collaboratively or communicatively (Leeuwis, 2000). KM may therefore not be able to address the more fundamental power or relational dynamics that shape the outcome of multi-stakeholder processes (Pohl et al., 2010 p. 271).

7.2.2 Innovation management (IM)

In this chapter we approach IM from an innovation systems perspective, implying that: "[I]nnovation is considered the result of a process of networking and interactive learning among a heterogeneous set of actors" (Klerkx et al., 2010 p. 390). Within the perspective, knowledge creation, exchange and use form important – but not always central – functions of innovation (World Bank, 2006a p. 89; Klerkx et al., 2009). IM goes beyond KM by also focusing on: "[E]nabling and constraining factors other than knowledge, [...] such as informal norms and practices, and formal rules embedded in legislation and policy" (Klerkx, 2008 p.

12). In doing so, KM is a sub-function of IM. IM seeks to bring together insights related to the social-cultural, biophysical and economic nature of a problem, but also related to the political and legal dimensions across different levels and scales of analysis that influence the space within which solutions can be explored (Giller et al., 2008 p. 7). Such an holistic and systemic approach can provide the basis for promoting more strategic institutional learning, and addressing relationship dynamics between stakeholders and stakeholder networks (Hall et al., 2003 p. 223). Consequently, it can also enhance the actionability of knowledge and research in policy processes (cf. Kristjanson et al., 2009).

7.3 Researchers as knowledge and innovation managers in policy processes

Policy processes are often characterized by fundamental uncertainties and the involvement of many stakeholders, thus making them unsuitable for linear pathways (Funtowicz et al., 1999 p. 7). In line with Giller et al. (2008), we perceive policy processes as dynamic negotiation processes in which research – but also other resources – are used selectively and strategically by stakeholders to influence the course and outcome of the policy process (Hoppe, 2005 p. 203). Such an approach acknowledges that research and researchers can support certain stakeholder perspectives or facilitate negotiations, but is also itself subject to negotiation (cf. Leeuwis, 2000; Giller et al., 2008). As a policy process evolves, numerous contextual factors determine when, how and in what role researchers can contribute to opening up or closing down negotiation space in policy processes, and for whom (Schut et al., 2010b p. 625).

Below, we discuss some typical roles for researchers as knowledge or innovation managers in policy processes. We want to emphasise that the KM and IM roles do not exclude each other. KM should rather be seen as a sub-function of, or being embedded in IM (see Figure 7.1).

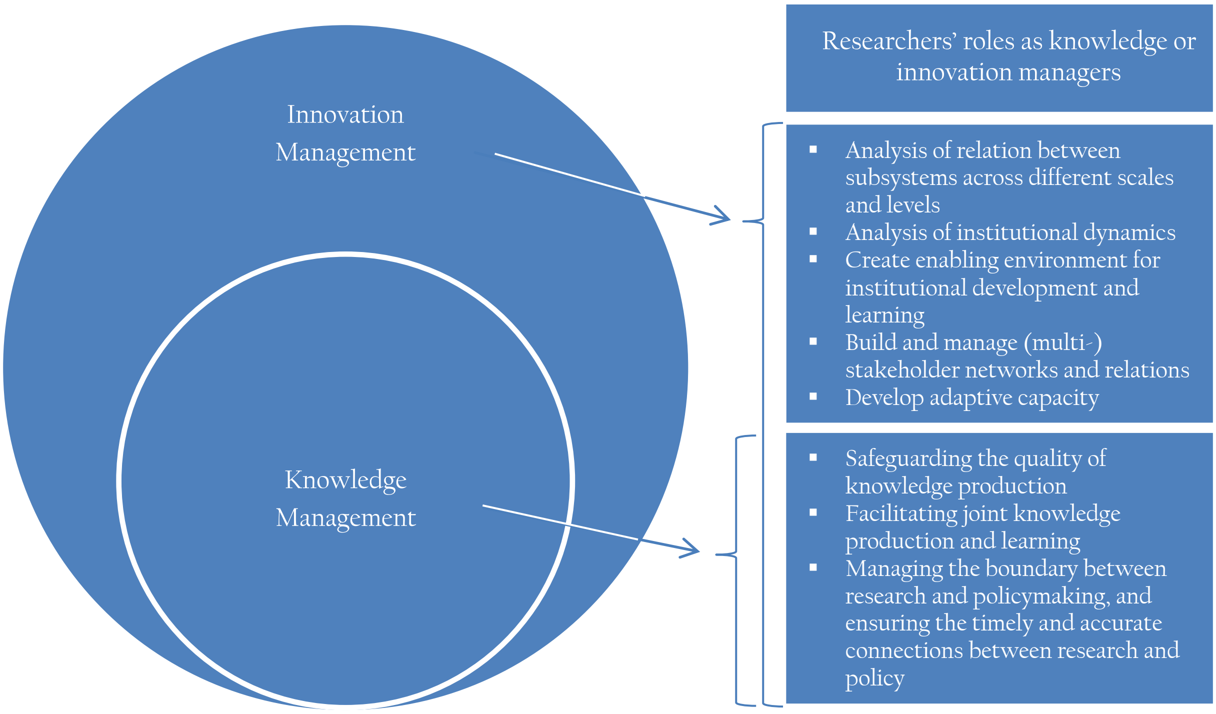

Fig. 7.1. Illustration of the embeddedness of KM in IM, and examples of researchers' roles as knowledge or innovation managers in policy processes.

7.3.1 Researchers as knowledge managers in policy processes

In line with van Buuren et al. (2004), we have identified three important KM strategies or roles for researchers in policy processes.[44] A first role is safeguarding the quality of knowledge production. Knowledge production can imply generating new knowledge and insights, but also documenting and mobilising existing knowledge. According to Cash et al. (2003 p. 8086), research is likely to be perceived as effective by stakeholders if it is not only independent and credible, but also relevant and legitimate to stakeholder claims and interests. A second KM role emphasises the importance of facilitating joint knowledge production and learning when problems are being described and explained, and solutions are being explored and designed (Giller et al., 2008). It may lead to a degree of shared understanding (Cash et al., 2003) that can form the basis for bringing together different stakeholders and their interests (van Buuren et al., 2004 p. 15). Moreover, researchers may contribute to contextualizing knowledge and embedding it in the social context of stakeholders (van den Hooff and Huysman, 2009 p. 2). The close collaboration with multiple stakeholders also enables the researcher to identify, articulate and respond to (changing) knowledge demands throughout

[44] Van Buuren et al. (2004 p. 14) describe four KM strategies. We chose to combine "boundary work" and making "timely and accurate connections between research process and policy negotiations".

the different phases of the policy process, and this may enhance the relevance of the research. A third KM role relates to managing the boundary between research and policymaking, and ensuring the: "[T]imely and accurate connections between [the] research process and policy negotiations" (van Buuren et al., 2004 p. 14). It underlines: "[T]he importance of a good process architecture (Edelenbos et al., 2003 p. 9) of the research process itself, but also of the relation between research and [the stakeholders in the] policy processes" (van Buuren et al., 2004 p. 23).

7.3.2 Researchers as innovation managers in policy processes

In line with our definition of IM, we also approach researchers' roles as innovation managers from an innovation systems perspective.[45] A first fundamental premise of IM in policy processes is to approach the policy process in itself (but also the research process) as a subsystem or part of a larger complex system, in which the problem it seeks to address is another subsystem (Funtowicz et al., 1999 p. 7; Smits and Kuhlmann, 2004 p. 14). Knowledge production should therefore focus on describing and explaining how interactions between social-cultural, biophysical, economic, political and legal subsystems across different scales and levels (cf. Cash et al., 2006) influence the space within which stakeholders can explore and design sustainable policy solutions (Schut et al., 2010b p. 625). A second distinct feature of IM is its focus on the analysis of formal institutions (legislation and policy) and informal institutions (norms and practices), and how they enable or constrain learning, development or change. Thirdly – although closely related to the previous point – the innovation manager seeks to create conducive conditions (Klerkx et al., 2010) or an enabling environment (World Bank, 2006a) to facilitate continuous stakeholder and institutional learning. Although the creation, exchange and mobilisation of knowledge is important to create such conditions or environment, several other functions – such as ensuring the availability of financial resources, market formation, vision development, create an enabling legal or political environment – are just as decisive for innovation (Klerkx et al., 2009 p. 411). A fourth role for researchers as innovation managers is to actively build and manage stakeholder networks (Swan et al., 1999) and relationship dynamics (Hall et al., 2003 p. 223). In order to do so, researchers need profound insight into stakeholders' positions and their mutual relationships. This may include addressing power asymmetries and deep-rooted conflicts (Leeuwis, 2004 p. 54). The fifth and last element of IM is developing strategic intelligence (Smits and Kuhlmann, 2004 p. 12) or adaptive capacity (Hall and Clark, 2010) in stakeholder networks to respond to the uncertainty and the unpredictability of policy processes.

For researchers to fulfil the above-described IM roles, their structural embedding and active involvement in the policy process is essential. Such embedding can enable researchers to enhance their actionability in policy processes, for example by penetrating political agendas, create (stakeholder) coalitions, or engage in political lobbying or issue advocacy (Hekkert et al., 2007; Pielke Jr., 2007). However, such actions or roles are also likely to result in discussions about what is politically desirable, and how that affects ideas about the independence and credibility of researchers in society (Hoppe, 2005). It implies that

[45] The innovation systems literature mainly refers to 'innovation brokers' (cf. Klerkx et al., 2009).

researchers need to think carefully about, on the one hand, who their clients are, and on the other hand, how to remain credible and relevant to other stakeholders in the policy process (Giller et al., 2005).

7.4 Research objectives and methodological approach

The key objective of this chapter is to explore the relationship between KM and IM in policy processes by describing and analysing the roles of researchers as knowledge and innovation managers. We pay special attention to how the different knowledge and innovation management activities and roles influence the policy process and *vice versa*. In doing so, the chapter contributes to sharpening the debate on the value, differences and synergies of KM and IM in policy processes, but also to the debate on how, in what roles and under what conditions researchers can enhance their effective contribution to policy processes, which forms the second objective of this chapter.

Empirical data for this study were gathered between December 2008 and November 2010. During that period, two of this chapter's authors conducted action-oriented research whilst supporting a Mozambican inter-ministerial Subgroup Sustainability Criteria ('subgroup') in developing a sustainability framework for biofuel production in Mozambique. The subgroup sustainability criteria is one of four inter-ministerial subgroups that were developed to operationalize and implement the Mozambican government's National Biofuel Policy and Strategy (NBPS – Resolution 22/2009). The four subgroups are coordinated by a National Biofuel Taskforce (NBT).

Central to the action-oriented research approach are acting, observing, reflecting and revising "in a cyclical process" (Pleijte et al., 2011 p. 224). The iterative character enables the researcher to adapt – on the basis of active reflection – the research strategy during the research process, which may include fulfilling different roles in the policy process. Action-oriented research positions the researcher in a more active role that implies closer contact with practice (Ottosson, 2003). "The active involvement of the researcher should […] not necessarily be considered as a 'threat' to the validity of the research conducted, but […] as a dimension that can produce more insight" (Trondsen and Sandaunet, 2009 p. 18). The embeddedness of a researcher in policy processes may lead to better understanding of the dynamics that influence when and in what form research can contribute to exploring, designing and implementing sustainable policy solutions (Schut et al., 2010b).

Hoppe (2005 p. 202) argues that researchers who seek to optimize the interdependence between research and policy often use: "[M]ultiple research methods in a context of argumentation, public debate and political struggle in order to create, evaluate and communicate policy-relevant knowledge." The empirical data presented in this chapter results from a variety of quantitative and qualitative research methods and data collecting techniques. In addition to this, action-oriented research concerns active reflection upon the research process and the role of the researcher. These reflections among the researchers in the form of meetings, notes and personal memos allowed us to document, reconstruct and analyse the roles we played as knowledge and innovation managers in the policy process.

7.5 Knowledge and innovation management in the policy debate on biofuel sustainability in Mozambique

Before we describe and analyse our roles as knowledge and innovation managers, it is important to briefly elaborate on the institutional embedding of the research, and our intentions as researchers in the policy process. Our work in Mozambique formed part of the research programme 'Competing Claims – Competing Models'; a partnership between DGIS, CEPAGRI and WUR.[46] We developed our research proposal in collaboration with CEPAGRI, focusing on: "Getting more grip on different stakeholders' perceptions on sustainability", that could provide: "The basis for establishing a national set of biofuel sustainability criteria or a certification scheme." Although it was our intention to study and support the policy process by actively participating in it, we did not have a clear strategy in terms of what concrete KM or IM activities or roles we wanted or were allowed to fulfil, nor did we have a formal mandate to participate in the policy process.

The following sections provide an overview of the main roles and activities we fulfilled as knowledge and innovation managers. Figure 7.2 provides a timeline of the process, and positions the most important phases and activities.

[46] Dutch Ministry of Foreign Affairs (DGIS), the Mozambican Centre for the Promotion of Agricultural Investment (CEPAGRI), which is part of the Mozambican Ministry of Agricultural (MINAG), and Wageningen University and Research Centre (WUR).

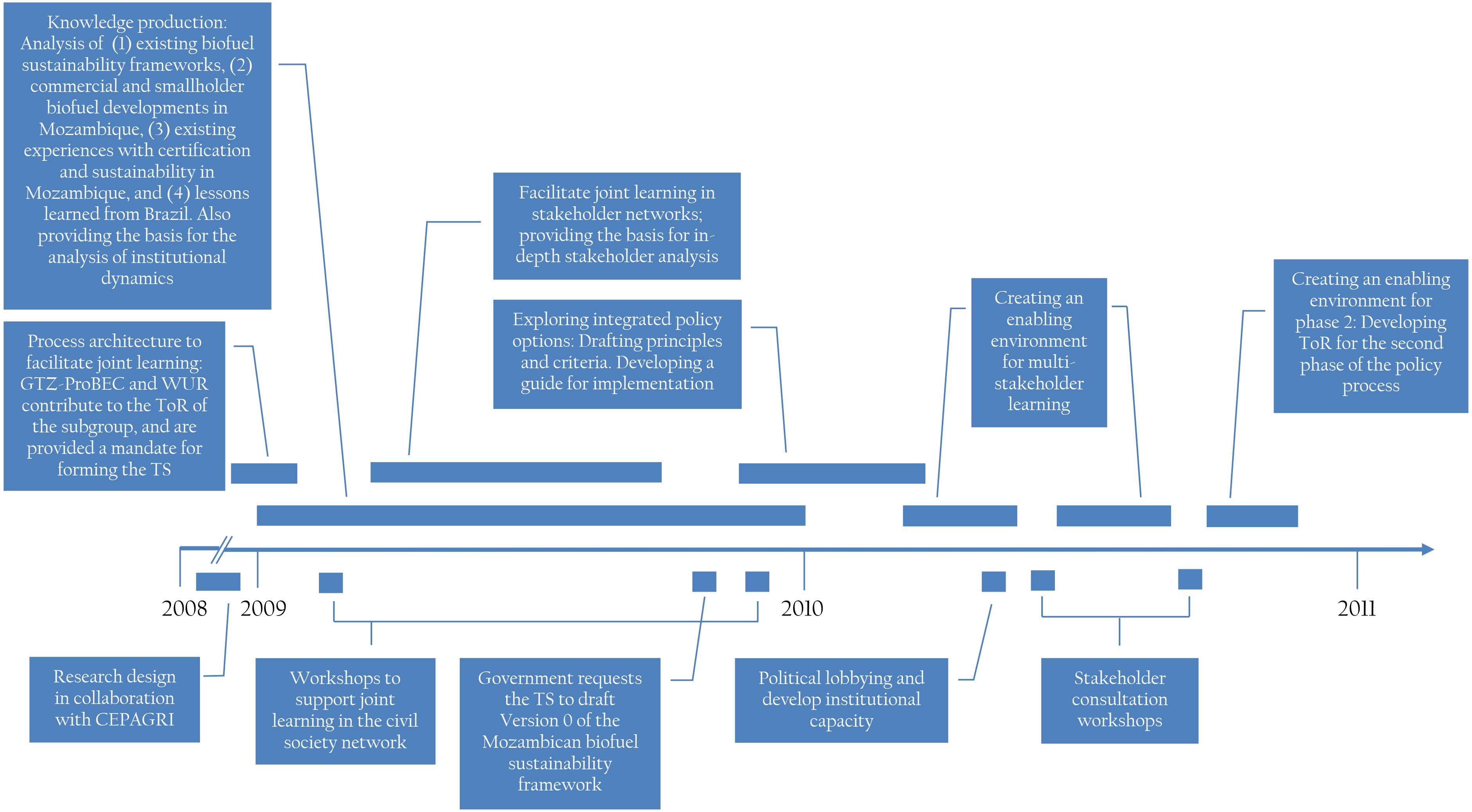

Fig. 7.2. Timeline of the policy process and the most important research phases and activities.

7.5.1 Process architecture to facilitate joint learning

Upon our arrival in Mozambique in December 2008, terms of reference (ToR) for the subgroup were in the process of being developed by CEPAGRI and CONDES,[47] the latter of which was formally assigned to coordinate the subgroup. As part of our collaboration with CEPAGRI, we[48] were invited to develop an action plan for the subgroup. On the basis of our research interest in identifying and bringing together different stakeholder perspectives, we proposed an action plan based on the principles of social learning.[49] We adapted and translated Woodhill's (2004) social learning roadmap to the context of the Mozambican biofuel debate, of which a slimmed down version was included in the final ToR of the subgroup. The ToR moreover stated that the subgroup would be composed of government officials and representatives of private sector and civil society organisations.

On the basis of our contribution to the ToR we were formally provided a mandate to form a technical secretariat (TS). The TS was responsible for doing research to support the subgroup in designing a realistic and implementable biofuel sustainability framework that would reflect both the Mozambican reality and the long-term requirements of major biofuel markets. For us, it emphasised the need to approach our research holistically and from an interdisciplinary perspective, taking into account different levels of policy influence and the perspectives of the three main stakeholder groups (government, private sector and civil society organisations). Our contribution to the ToR had moreover enabled us to sharpen and increase the relevance of our research questions.

7.5.2 Knowledge production

In January 2009, we started elaborating our research strategy. As the ToR of the subgroup had not yet been formally approved, and its representative members still had to be selected, we began by summarizing and comparing seven leading international biofuel sustainability frameworks.[50] Harmonizing the Mozambican framework with these existing international

[47] National Council for Sustainable Development (CONDES), part of the Mozambican Ministry for Coordination of Environmental Affairs (MICOA).

[48] 'We' refers to the researcher from Wageningen University and a Technical Advisor from GTZ-ProBEC; the Programme for Basic Energy and Conservation (ProBEC) of the German Technical Cooperation (GTZ) – http://www.probec.org. GTZ-ProBEC provided technical support to the SADC Energy Sector and SADC Biofuel Taskforce.

[49] Woodhill (2004 p. 47) defines social learning as: "[B]ringing together different stakeholders (actors) who have an interest in a problem situation and engaging them in processes of dialogue and collective learning that can improve innovation, decision-making and action."

[50] We first compared frameworks by the Roundtable of Sustainable Biofuels (RSB), the EU policy framework for sustainable biomass production, the Dutch Cramer Criteria and the UK's Renewable Transport Fuels Obligation (RTFO) (see: Schut et al., 2010a p. 16). As the EU and RSB frameworks were in the process of being developed, we studied the policy proposal by the Counsel of the European Union (17086/08 of 11 December 2008), and Version 0 of the RSB. During a later phase in the research, we also studied biofuel sustainability frameworks developed by the Better Sugarcane Initiative (BSI), the Global Bioenergy Partnership (GBEP) and SADC.

frameworks could facilitate the export of biofuels from Mozambique to other countries (one of the government's objectives), but would also be important in terms of demonstrating political "'[G]oodwill' to international donors and powerful trade partners" (Di Lucia, 2010 p. 7401).

With regard to the Mozambican biofuel reality, on discovering that there was no comprehensive overview of biofuel developments in Mozambique, we consequently decided to develop one ourselves. We analysed existing biofuel-related policies and legislation, and our partnership with CEPAGRI provided access to biofuel investment proposals that – under strict conditions – could be analysed. We mobilised the CEPAGRI and GTZ-ProBEC networks to contact and visit commercial and smallholder biofuel projects in different parts of the country. Our analysis demonstrated the environmental, social and economic opportunities and challenges in the emerging biofuel sector. It also revealed potential mismatches between the government's biofuel objectives and those of biofuel investors (Schut et al., 2010c). With regard to smallholder biofuel projects in Mozambique, we concluded that lack of knowledge on crop management had resulted in crop failure, and we stressed the need for an enabling environment to support smallholder farmers (Bos et al., 2010). Furthermore, we emphasised the potentially negative impacts if smallholders were to comply with biofuel sustainability criteria (Schut et al., 2011b).

Parallel to this research, we studied other commodities produced in Mozambique under certification or sustainability criteria. Our analysis demonstrated that certification can easily result in trade barriers for, and exclusion of, smallholder producers, and that certified products supply only a very small segment of the Mozambican market, as they are mainly produced for overseas markets. The more structural institutional problem of the enforcement of laws, regulation and standards presents a challenge in Mozambique.

We also explored how other biofuel producing countries position themselves in the international biofuel sustainability debate, in particular Brazil. The most important lesson learned from Brazil was that additional biofuel certification or sustainability frameworks are not necessary when the country's legal framework regulates the social, economic and environmental sustainability of biofuel production, processing, blending and use. Furthermore, we believed that a framework developed by a Brazilian civil society platform (see: Moret et al., 2006 p. 10-11), in which biofuel sustainability criteria are accompanied by examples of what each criterion seeks to promote and prevent, could serve as a good discussion-support tool that could be useful later in the policy process in Mozambique.

7.5.3 Analysis of institutional dynamics

The first phase of the research (which roughly took from January to October 2009) did not only result in insights into the factors that are driving the direction of biofuel developments in the country, and opportunities and challenges with regard to the sustainability of the emerging biofuel sector in Mozambique, but also provided the basis for more profound insights into institutional dynamics – both formal rules (e.g. legislation and auditing) and informal practices (e.g. the enforcement of legislation) – to which a biofuel sustainability framework would be exposed in practice. For example, the analysis of existing biofuel-related policies and legislation demonstrated that data requirements under the existing Project Application and Land Acquisition Process[51] could potentially be adapted to assess the sustainability of biofuel operations in Mozambique.

The analysis of leading international biofuel sustainability frameworks provided valuable insights on how the Mozambican government could strategically position itself in the international biofuel sustainability debate to facilitate the export of biofuels to e.g. EU member states and demonstrate political goodwill, but at the same time develop a sustainability framework that reflects the Mozambican reality. Such understanding would become important during later phases of the policy process, as it shaped the political and legal space within which policy options could be explored and designed.

7.5.4 Facilitating joint learning in stakeholder networks

To better understand our data, we conducted interdisciplinary analysis in collaboration with other researchers and a policymaker from CEPAGRI. Our attempt to explain our findings from social-cultural, biophysical, economic, political and legal perspectives provided a holistic image of what was driving biofuel developments in Mozambique. This exercise initiated a joint learning process between researchers and policymakers that was mutually beneficial; it strengthened the relationship between the researchers and the policymakers, and improved the quality of the data analysis. The researchers and policymakers concluded that the subgroup should explore policy options that focus on harmonising different stakeholders' objectives. The joint analysis resulted in a research report (Schut et al., 2010a) and a joint research paper that was published in a peer-reviewed scientific journal (Schut et al., 2010c).

The fact that CEPAGRI acknowledged our research findings was important for our position in the debate. We found that it increased our credibility as researchers (at least within the government network but also within other stakeholder networks), and that this facilitated access to information and people. Increasingly, we were invited to civil society and private sector platforms to present, defend and get feedback on our research findings. We found that especially the maps, tables, scenarios and figures that we used to visualize our findings (e.g. Figure 7.3) were perceived as credible and relevant by stakeholders. As there was no other research that provided a comprehensive overview of biofuel developments in Mozambique, our study provided a degree of shared understanding of what was driving the direction of the emerging biofuel sector in the country (Schut et al., 2010c).

[51] This procedure links the processes for awarding land titles and approving investment proposals of large-scale commercial agricultural projects (Schut et al., 2010c p. 5154).

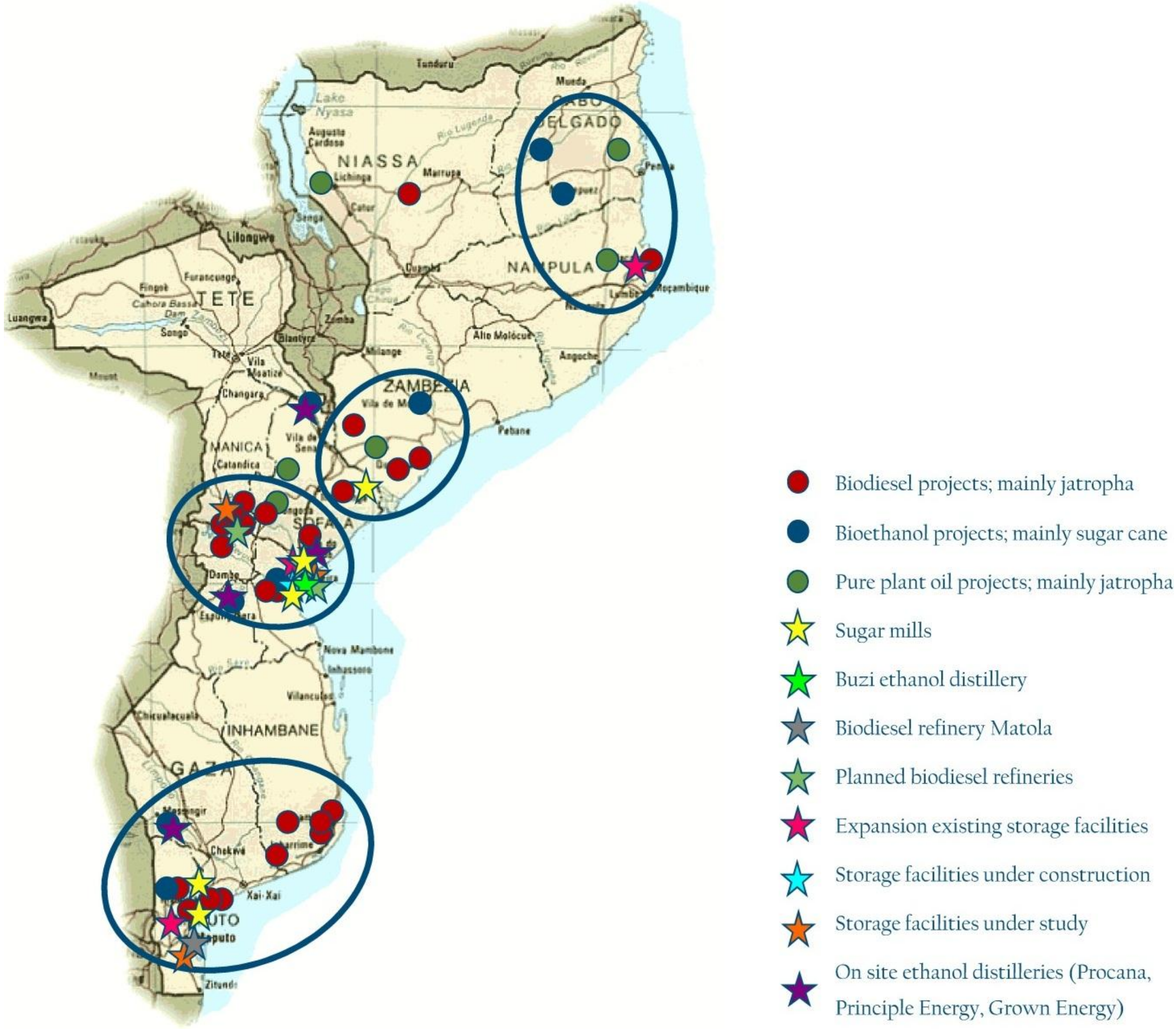

Fig. 7.3. Overview of biofuel developments in Mozambique (Schut et al., 2010c p. 5162).

7.5.5 Building and managing stakeholder networks and relationships

In March and November 2009, we contributed to organizing two workshops to support civil society organisations to better position themselves in the biofuel debate. The objective of the workshops was to develop a joint vision and strengthen the civil society network. We presented our research findings and contributed to facilitating the workshops. On many occasions, we also tried to convince private sector stakeholders to develop such a joint vision, but although some individual project managers and investors were enthusiastic, they did not manage to organise themselves.

Our access to different stakeholder networks allowed for the development of a mutually dependent relationship between the researchers and the three stakeholder groups (government, civil society organisations and private sector). On the one hand, it provided us with better insights into the positions of different stakeholders in the biofuel debate, and their positions *vis-à-vis* each other. This enabled us to conduct in-depth stakeholder analysis, which had been central in our original research proposal. On the other hand, we could provide access to knowledge and information, connect different stakeholders and stakeholder networks, and update them on the policy process. This relationship should not be romanticized however. As we formed part of the TS that supported governmental activities, our mandate and credibility were repeatedly questioned (especially by civil society organisations), both directly and behind the scenes. Critical questions were asked about the TS's legitimacy to fulfil such a role, the transparency of the policy process, and the limited space for civil society organisations and the private sector to participate in the subgroup. However, we also received support, as we had developed a constructive relationship with the Dutch Embassy in Maputo and one of their programme officers, who formed part of a more 'informal network' that actively facilitated our work from behind the scenes.

Although we actively built, managed and connected different stakeholder networks, we had growing concerns about the limited space for multi-stakeholder debate and negotiation, and the growing distrust of civil society organisations and private sector towards the Mozambican government, which also affected our position as researchers and how we were perceived by stakeholders.

7.5.6 Exploring integrated policy options

By October 2009, the position of the subgroup had weakened considerably. Due to changes in leadership within the government, the initial commitment to the subgroup had decreased. This had resulted in a subgroup with few permanent members, who were moreover all government representatives.[52] During a meeting intended to reanimate the subgroup, the chair of the NBT proposed that the TS should draft the biofuel sustainability framework, before involving civil society and private sector stakeholders. The request completely changed our role as researchers in the policy process. Until then, we had mainly focused on producing knowledge and engaging in joint learning with different stakeholder networks. Despite some critique, this had enabled us to remain rather neutral in the process, by not engaging too much in the political debate.

In our deliberations, we discussed that not taking the assignment would somehow undermine the mandate that was given to us by the Mozambican government. Furthermore, we realized that the request provided a unique possibility to mobilise our research findings and translate them into tangible policy recommendations; this made us decide to accept the assignment. In collaboration with the subgroup (at that time consisting of the three government officials), we started developing a draft Version 0 of the Mozambican biofuel sustainability framework. As we were aware of our vulnerable position, we put extra emphasis on ensuring that the developed sustainability principles and criteria were firmly rooted in our research findings. In that way, we could legitimize and defend our choices, thereby enabling us to remain credible to the different stakeholders in the process. Another

[52] The original terms of references stated that civil society organisations and the private sector would be part of the subgroup. It is also important to notice that the NBPS stressed the government's intention to actively collaborate with civil society organisations and private sector in the development of biofuel sustainability criteria.

guiding principle was to ensure that civil society and private sector stakeholders would recognize their key interests in the draft sustainability framework. Our active participation in different stakeholder networks had enabled us to gain in-depth understanding of their positions in the debate, their priorities and their positions *vis-à-vis* each other. Due to their limited participation in the process until then, addressing their interests would be crucial for the credibility and acceptance of the framework. We sought to formulate principles and criteria that could bridge and harmonize different stakeholder interests and objectives. In line with that, and following the example of the Brazilian civil society platform, we developed a discussion-support tool in which each criterion was linked to examples of what the criterion sought to promote or prevent. The underlying idea was that the tool would stimulate multi-stakeholder learning, debate and negotiation later in the policy process.

Once the biofuel sustainability principles and criteria were drafted, the focus shifted towards developing a guide for implementation. On the basis of our research findings from Brazil and experiences with other certification/sustainability schemes in Mozambique, we proposed a government-led, mandatory framework that was to be integrated into the existing Mozambican legislation. This proposal was quite sensitive, as our study had also shown that enforcement of laws and legislation is generally weak in Mozambique. From our (institutional) analysis of biofuel-related legislation, we concluded that – instead of developing separate legislation – data requirements under the existing Project Application and Land Acquisition Process could potentially be adapted to assess the sustainability of biofuel operations in Mozambique. This procedure was generally perceived as effective and powerful, as was demonstrated when the Mozambican government used it to void the contract of a biofuel company that failed to comply with their contractual obligations. Another advantage of the procedure was that it allowed for discrimination between commercial and smallholder producers, as the smallholders do not have to comply with the procedure.

7.5.7 Political lobbying and develop institutional capacity

When the draft sustainability framework was nearly finished in February 2010, CONDES proposed that the TS and subgroup should continue directly with the development of sustainability indicators, before consulting civil society and private sector stakeholders. Informally, we heard that a high government official had questioned the level of detail in the draft Version 0 (principles and criteria) and had concluded that a framework without indicators was not worth discussing with other stakeholders.

We faced a dilemma: continue to work on the indicators and – most likely – lose the support of civil society and private sector stakeholders, or, refuse to develop the indicators, which most probably would have resulted in the end of the TS. We discussed the situation with people in our informal network and colleagues, resulting in an internal memo including strategies to constructively criticize the government's proposal and find ways to penetrate the political agenda. Our main argument was that stakeholder participation was formalized in the NBPS and that not consulting stakeholders would endanger the credibility, legitimacy, acceptability – and consequently – the implementability of the biofuel sustainability framework. Moreover, multi-stakeholder participation was described in the ToR and could create consensus on the principles and criteria (phase 1), before continuing with the development of indicators (phase 2). The memo was discussed during a meeting with the chair of the NBT and proved to be convincing, as it was decided that a first of in total three stakeholder consultation workshops should be organised as soon as possible. As the planned research period was coming to an end (the original proposal stated that the research would take till February 2010), we contacted our managers at the university with the request to extend the research period; which was granted.

The event created awareness that more structural institutional problems needed to be addressed. The TS proposed to expand the subgroup by including representatives from different government departments that would be affected by the implementation of the biofuel sustainability framework (departments that played a role in the Project Application and Land Acquisition Process). A number of meetings were organised in which the TS and the 'new' subgroup discussed the original ToR, the research that had been conducted, and how the drafted criteria and principles as well as the guide for implementation and discussion-support tool had evolved from that. The joint learning process between researchers and policymakers that emerged was useful. It resulted in changes in the sustainability framework, which – as a result – lost some of its research-based character. However, the overall quality of the framework improved, and within the subgroup ownership of the framework increased substantially.

7.5.8 Creating an enabling environment for multi-stakeholder learning

For the stakeholder consultation workshops, the TS proposed an interactive workshop methodology to optimize multi-stakeholder debate. As there had been a general lack of multi-stakeholder learning and negotiation so far, we proposed to spend as much time as possible in small, heterogeneous stakeholder groups to discuss the principles, criteria and guide for implementation. The discussion-support tool was proposed as a way to stimulate discussion and debate during the workshops.

In March 2010, the TS and subgroup presented the workshop methodology to the chair of the NBT. Although we had to defend the proposed workshop methodology to work in small groups, rather than organizing a – more common – plenary workshop, the approach was approved. As the majority of subgroup members were not familiar with facilitating group work and observing discussions, the TS organised a training session in which we did role-plays and practiced observing and note-taking. We moreover lobbied to organise financial resources for the workshops, amongst other things by mobilizing our formal and informal networks. After several rounds of discussions, three organisations provided funds to support the three stakeholder consultation workshops in Maputo, Nampula and Beira.

7.5.9 Facilitating joint learning and multi-stakeholder negotiation

The first stakeholder consultation workshop was organised in Maputo in May 2010. The 70 participants included government officials, private sector and civil society stakeholders, researchers, and representatives from embassies and development organisations. We were somewhat surprised about the relative enthusiasm on the part of the private sector and civil society about the framework.

After the first workshop, the TS facilitated a meeting to analyse and process the feedback and written comments we had received through both regular mail and e-mail. The subgroup also received support from a senior consultant working with the Roundtable for Sustainable Biofuels, who had been hired to support member states of the Southern African Development Community (SADC) in formulating national biofuel policies and strategies. The TS played a crucial role in facilitating the communication between the consultant (who did not speak or read Portuguese) and the subgroup, which eventually resulted in draft Version 1 of the Mozambican biofuel sustainability framework.

This draft Version 1 was discussed in workshops in Nampula and Beira in October 2010, attended by 85 participants. A substantial difference from the Maputo workshop was that members of the subgroup (and not the TS) presented the framework, thus underlining the increased ownership over the framework within the subgroup.

7.5.10 Creating an enabling environment for phase 2

After the workshops, the TS and the subgroup members analysed and processed the feedback, which resulted in the final Version 1 of the biofuel sustainability framework. Some criteria were added, removed or modified, but the overall structure of the framework and the guide for implementation were accepted by the stakeholders, making Mozambique the first African country with a national biofuel sustainability framework. Together with some members of the subgroup, we reflected on phase 1, of which the most important lessons learned were presented to representatives of other SADC member states during a SADC Biofuel Taskforce workshop.[53]

Towards the end of phase 1, we actively supported the subgroup in developing ToR for phase 2, in which the need for a new TS and the continuation of the multi-stakeholder debate were formalized. Together with the Dutch Embassy and colleagues at Wageningen University, we explored how and in what form a TS for phase 2 could be organised and funded. Proactively, we initiated exploratory research focusing on how existing biofuel sustainability indicators could be used or modified to fit the Mozambican framework, and conducted additional institutional analysis on how the existing Project Application and Land Acquisition Process could be upgraded to effectively assess the sustainability of biofuel projects in Mozambique.

[53] Note that the presentation at the SADC Biofuel Taskforce workshop took place in August 2010, shortly before the stakeholder consultation workshops in Nampula and Beira.

7.6 Analysis and discussion: Knowledge and innovation management in policy processes

Below, we analyse and discuss our empirical data in accordance with the two main objectives of this chapter. Both sections provide examples from our research to illustrate: (1) the relationship between KM and IM in policy processes, and (2) how, in what roles and under what conditions researchers (be it as knowledge or innovation managers) can enhance their effective contribution to policy processes.

7.6.1 Relationship between KM and IM in policy processes

Upon our arrival in Mozambique, the conditions for multi-stakeholder learning and KM were not optimal. Although the Mozambican government had intended to work together with civil society organisations and private sector in developing a biofuel sustainability framework, these stakeholder groups were not organised, and decreased government commitment had resulted in a weak position of the subgroup. Consequently, the subgroup did not get off the ground, let alone providing a platform for multi-stakeholder learning. In terms of KM, it did not provide a situation in which we could jointly develop research questions, and design the research in close collaboration with the stakeholders. Although this example does not really illustrate the relationship between KM and IM, it did create awareness for us as researchers that we had to engage in other activities before we could contribute meaningfully to multi-stakeholder learning, as some of the fundamental preconditions for effective KM were absent.

Based on our contribution the subgroup's ToR, we decided to describe and explain biofuel developments in Mozambique from an interdisciplinary perspective, taking into account different levels of policy influence. Our holistic research approach 'forced' us to collaborate with different groups of stakeholders, which did not only result in data about the sustainability or unsustainability of the emerging biofuel sector, but it also exposed potential mismatches between the stakeholder's objectives, as well as the legal and political space within which policy solutions could be explored. We put a lot of efforts on safeguarding the credibility, but also the relevance and legitimacy of our study to different stakeholder groups. In the case of the government, this was strengthened by the joint analysis of our research findings with a policymaker from CEPAGRI. However, also within other stakeholder networks our research findings (notably the maps that we used to visualize our findings; e.g. Figure 7.3) were perceived as credible and relevant, and facilitated a degree of shared understanding of what was driving the direction of the emerging biofuel sector in the country. In doing so, the process of knowledge production provided the basis for intensifying the interaction and collaboration with the different stakeholder groups. In the case of the civil society, for example, we actively contributed to network and vision development, which strengthened their position in the policy debate. It shows how effective KM (the holistic research approach, safeguarding the credibility, relevance and legitimacy of the research) provided the basis for IM activities (build and support stakeholder networks and coalitions), that contributed to more effective multi-stakeholder learning later in the policy process.

Our embedded position in the different stakeholder networks enabled us to conduct in-depth stakeholder analysis. This resulted in valuable knowledge and insights for drafting a sustainability framework that would be acceptable for different stakeholder groups. We could also signal problems more easily, for example that due to the limited space for multi-stakeholder debate and negotiation, civil society organisations and private sector were losing their trust in the policy process. Our position also provided the basis for effectively identifying and responding to (changing) knowledge demands, connect different stakeholders and stakeholder networks, and update them on the policy process. It illustrates how KM (joint learning with stakeholders) created a situation in which we could better understand stakeholder perceptions, and (more fundamental) institutional and relational dynamics. Consequently, it created awareness that addressing these dynamics as part of an IM strategy would highly affect the degree to which our research findings could provide an effectively basis for multi-stakeholder learning and negotiation in the policy process.

A last example of how KM and IM are closely connected relates to our efforts to support the multi-stakeholder consultation workshops. We constructively criticized the government's proposal to postpone stakeholder consultation till after the development of biofuel sustainability indicators. We expected serious problems with regard to the progress and quality of the policy process, as not consulting stakeholders would reduce the credibility – and eventually the acceptability and implementability – of the biofuel sustainability framework. Moreover, stakeholder participation had been formalized in both the ToR of the subgroup and the NBPS, which created a legal basis for stakeholder participation. In order to penetrate the political agenda we engaged in political lobbying and mobilised our informal network, which eventually led to the decision not to postpone stakeholder consultation. In so doing, our efforts contributed to creating an enabling environment for multi-stakeholder learning.

7.6.2 Roles of researchers in policy processes

In line with the previous section, we conclude that the combination of KM and IM roles may enhance the effective contribution of researchers to policy processes. The research approach provided a degree of flexibility to adapt our research to the changing context, and the uncertainty and unpredictability of the policy process. Based on regular reflection, we fulfilled a variety of KM and IM roles in the policy process, from the analysis of biofuel investment proposals to strategic lobbying to create an enabling environment for multi-stakeholder learning. According to Hoppe (2005 p. 202), such use of: "[M]ultiple research methods in a context of argumentation, public debate and political struggle [is needed] in order to create, evaluate and communicate policy-relevant knowledge."

As embedded researchers, we had better insight into the dynamics of the policy process, which enabled us to strategically fulfil certain knowledge and innovation management roles. Initially, we succeeded in creating and maintaining a degree of independence, but, when the government approached us to draft Version 0 of the sustainability framework, the dynamics in the policy process changed, and we were forced to think more carefully about our position and role in the process. This required the active management of the boundary between research and policy. Where we initially sought to 'blur' the boundary in order to embed ourselves in the policy process and different the stakeholder networks, we eventually also emphasised and used the boundary between research and policy to respond to accusations of defending specific stakeholder interests and to remain credible to the different stakeholders in the policy process (cf. Giller et al., 2005). The effective contribution of researchers to policy processes therefore very much depends on how the boundary between research and policy is managed during different phases of the policy process (cf. Jasanoff, 1990).

Although our initial research proposal stated that the research was supposed to take until February 2010, the evolution of the policy process made us realize that we needed more time to effectively mobilise the research findings in the policy process (eventually phase 1 of the policy process was finalized in November 2010). We think this pleads for more process-oriented research approaches in which researchers seek to strategically position themselves in policy processes (Pielke Jr., 2007 p. 9), rather than transferring their knowledge when the research project is finished.

7.7 Conclusions

KM as part of a research strategy that focuses on producing credible, relevant and legitimate knowledge through processes of multi-stakeholder learning is crucial, especially in policy processes characterized by high uncertainty and the involvement of many stakeholders. The basis for effective KM in policy processes is grounded in a holistic and interdisciplinary research approach (cf. Hoppe, 2005) that takes into account all relevant levels of policy influence (cf. Giller et al., 2008), and the needs and interests of different stakeholders. Consequently, KM can facilitate access to different stakeholder networks and provide insights into the more structural enabling and constraining institutional and relational dynamics in policy processes. However, to deal with such dynamics, KM alone is often not enough. We believe that addressing such dynamics may require researchers to engage in more strategic IM activities to improve the quality of policymaking. Consequently, this may also enhance the actionability of research in policy processes. In doing so, IM can create the conditions for more effective KM, for example by engaging in political lobbying or building stakeholder networks to create an enabling environment for multi-stakeholder learning.

We do not, and cannot, present a magic formula of what combinations of KM and IM strategies or roles are effective in policy processes. On the basis of our experience, we can conclude that the active embedding of researchers and an action-oriented research approach can enhance in-depth insight into the dynamics of the policy process. Furthermore, it provides a certain degree of flexibility to continuously determine what solution space that exists in policy processes, and – based on systematic reflection – decide on the most effective (combination of) KM or IM strategies or roles to enhance the actionability of research in, and the quality of the policy process. It pleads for process-oriented research approaches that provide researchers with the time and resources to become more flexible and actionable in policy processes, in which the active and strategic management of boundaries between research and policy is key.

Concluding, KM and IM are mutually reinforcing and inextricably bound. KM can provide the basis for engaging in IM activities or roles, which may consequently contribute to creating an enabling environment for more effective KM in policy processes. Our case demonstrates that notably the combination of KM and IM activities and roles can enhance the effective contribution of researchers to policy processes.

Acknowledgements

This research is part of the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions,' funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation (former Ministry of Agriculture, Nature Conservation and Food Quality). The research also formed part of the 'Competing Claims-Competing Models' programme jointly funded by Wageningen University and Research Centre and the Dutch Ministry of Foreign Affairs (DGIS).

The authors acknowledge the valuable contributions and support of CEPAGRI, members of the Mozambican Subgroup Sustainability Criteria, GTZ-ProBEC, and all the investors, farmers, extension workers, researchers, NGO representatives and policymakers that collaborated with us and provided data and insights necessary for this study.

CHAPTER 8

Beyond the research-policy interface

Boundary arrangements at research-stakeholder interfaces in the policy debate on biofuel sustainability in Mozambique

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Submitted for publication in Environmental Science & Policy.

KEYWORDS

Boundary arrangements

Research-stakeholder interface

Policy process

Competing claims contexts

Biofuels

Sustainability

Mozambique

ABSTRACT

This chapter explores the dynamics of boundary arrangements in policy processes in competing claims contexts. The chapter starts from the idea that understanding the role of research in multi-stakeholder policy processes requires going beyond the research-policy interface, by analysing boundary arrangements at multiple research-stakeholder interfaces. The chapter describes five episodes in the policy debate on biofuel sustainability in Mozambique. Within each episode, we analyse the boundary arrangements at the different research-stakeholder interfaces in relation to the policy context, research activities relating to policy content and policy process, and stakeholder dynamics inside and outside the policy arena.

The analysis demonstrates that research that actively engages in multi-stakeholder policy processes is likely to result in situations where multiple boundary arrangements at different research-stakeholder interfaces co-emerge and coexist. The direction in which boundary arrangements at a research-stakeholder interface develop over time is affected by the credibility, legitimacy and salience of the research as perceived by the specific stakeholder group, and the changing policy context that includes boundary arrangements at other research-stakeholder interfaces. Different boundary arrangements relating to policy content and policy process can coexist at a research-stakeholder interface. Furthermore, boundary arrangements show patterns of path dependency in terms of their credibility, legitimacy and salience for different stakeholders through time.

8.1 Introduction

Interest in the contribution of research to developing policy solutions for environmental problems has increased considerably (Cortner, 2000; Dilling, 2007; Boaz et al., 2009). Although research is often initiated to support policymaking, many research outcomes do not reach the policy arena (Opdam, 2006), arrive in fundamentally different ways than intended (Klosterman et al., 2009), are used and ignored selectively and strategically (Burton, 2006), or become available during phases when policy solutions have already been elaborated (Schut et al., 2010b). When analysing these phenomena, scholars often refer to the (apparent) gap between research and policymaking communities; often referred to as the research-policy interface (cf. McNie, 2007; Cutts et al., 2011; Edelenbos et al., 2011).

The concept of boundary work has been introduced to better understand dynamics at the research-policy interface and refers to the practices of safeguarding, withdrawing and redefining boundaries between research and policy (cf. Gieryn, 1983; Jasanoff, 1990). Boundary arrangements form an important part of boundary work. Boundary arrangements are the agreements and ideas about the division of tasks and responsibilities between research, policymakers and other stakeholders in policy processes (cf. Hoppe, 2005). Despite the fact that several authors acknowledge that boundary arrangements can have different meanings for different (groups of) stakeholders, and are negotiated and renegotiated over time (Sarewitz, 2004; McNie, 2007; Michaels, 2009; van Paassen et al., 2011), there seems to be a tendency to (1) group or classify projects or policy processes according to the dominant boundary arrangement at the research-policy interface (cf. Sterk et al., 2009), (2) promote specific boundary arrangements over others (cf. Cortner, 2000), or (3) suggest that boundary arrangements can be selected on the basis of a type of policy regime or problem (cf. Michaels, 2009). Such views may be too static to study boundary arrangements in policy processes in competing claims contexts that are characterised by high uncertainty and the involvement of a multiplicity of stakeholders (Waterton, 2005; Giller et al., 2008; Klerkx and Leeuwis, 2008). In such policy debates typically: "[F]acts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz and Ravetz, 1993 p. 744).

This chapter portrays a more dynamic image of the role of research in policy processes in competing claims contexts by describing and analysing boundary arrangements at the level of different research-stakeholder interfaces. We explore how boundary arrangements are influenced by multi-stakeholder dynamics, how boundary arrangements evolve over time, and whether they show patterns of 'path dependency' (Leeuwis, 2004). Understanding such processes is crucial for enhancing the contribution of research to more sustainable policy solutions in competing claims contexts.

8.2 Boundary arrangements in policy processes

In this chapter, policy processes are defined as formal and informal negotiation processes in which heterogeneous groups of stakeholders seek to influence the development and implementation of policy (Leeuwis, 2000; Aarts and Leeuwis, 2010). Research can be used selectively or strategically by stakeholders to influence policy negotiations (Hoppe, 2005), but can itself also be subject to negotiation (Schut et al., 2010b; Pleijte et al., 2011). Below, we distinguish between boundary arrangements at the more commonly used research-policy interface, and boundary arrangements at the research-stakeholder interface, focusing specifically on the interactions between research and different stakeholders or groups thereof. Subsequently, we discuss boundary arrangements in relation to multi-stakeholder and temporal dynamics in policy processes.

8.2.1 Boundary arrangements at the research-policy interface

There exists a growing body of literature that seeks to structure and explain dynamics at the research-policy interface (Pielke Jr., 2007; Turnhout et al., 2008). Hoppe (2005 p. 208) developed a framework that describes a number of idealised "models of boundary arrangements" for the "science-policy nexus." Hoppe's framework (Figure 8.1) differentiates between models presupposing primacy for research (enlightenment and technocracy), models presupposing primacy for policy (bureaucracy and engineering), and models presupposing not primacy, but dialogue, between research and policy (advocacy and learning). The horizontal axis represents the power relations and the degree of dependency between research and policy. The vertical axis represents the nature of the dialogue, subdividing between "divergent logics" and "convergent logics" of research and policy (Hoppe, 2005 p. 209). Boundary arrangements do not equal researchers' roles, as researchers may fulfil different roles within each boundary arrangement.

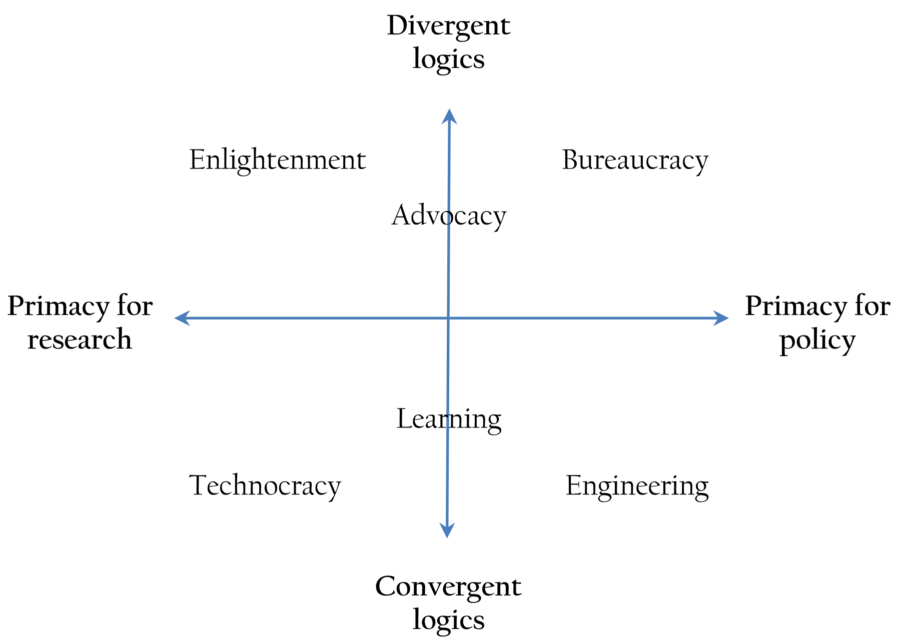


Fig. 8.1. Boundary arrangements at the research-policy interface (adapted from Hoppe, 2005 p. 208).

Table 8.1 provides a short description of the six models of boundary arrangements used in Figure 8.1.

Boundary arrangement	Description
Enlightenment	Research is objective and independent of policy. Research penetrates the policy arena with considerable time delay. It is up to policymakers and other stakeholders to use or ignore research.
Technocracy	Research is objective and independent of policy, but the research findings are actively mobilised in the policy arena (Hoppe, 2005). Scientification of policy is key (Weingart, 1999).
Advocacy	Research is considered one among multiple voices in the policy arena. Research can set the "[policy] agenda on topics in which they have a strong interest" (Cortner, 2000 p. 23) or use its position to lobby for policy solutions or a specific way of organising the policy process.
Learning	The focus is on joint learning and harmonious dialogue and collaboration between research and policy. Research and policy are mutually dependent, and research can facilitate learning and build bridges in the policy arena.
Bureaucracy	Research is at the service of policy. Research informs policy, irrespective of political judgement.
Engineering	Research is politicised (Weingart, 1999). Policy articulates research questions and research develops solutions. Policy determines demand and research supplies.

Table 8.1. Description of boundary arrangements at the research-policy interface (based on: Hoppe, 2005 unless indicated otherwise).

As explained in Section 8.1, Hoppe's framework is often applied statically to describe or analyse the role of research in policy processes. One of the reasons is that Hoppe focuses on 'policy' as the unit of analysis; this makes it difficult to apply to the analysis of empirical case study material in which research collaborates with multiple groups of stakeholders. This raises the question of whether studying the role of research in multi-stakeholder policy processes would benefit from an analysis of boundary arrangements at multiple research-stakeholder interfaces.

8.2.2. Boundary arrangements at the research-stakeholder interface

One of the suggested pathways for developing policy solutions in competing claims contexts is for research to actively engage with societal stakeholders in describing and explaining policy problems, and in exploring and designing policy solutions (Giller et al., 2008). According to McNie (2007 p. 19), stakeholders are: "[I]ndividuals or groups with a vested interest in the outcome of a decision and can include just about anyone, e.g., scientists,[54] citizens, farmers, resource managers, business, politicians, and the like." Stakeholders can

[54] Although we acknowledge that research and researchers could be considered as stakeholders in policy processes, we do not treat them as such in this chapter.

participate as policymakers[55] in the policy arena or influence policy from outside the policy arena.

In Figure 8.2, we propose a framework in which boundary arrangements have been formulated at the research-stakeholder level. As in Hoppe's framework, the horizontal axis represents the power relations and the degree of dependency between research and the specific stakeholder group. The vertical axis is partly inspired by the work by Michaels (2009 p. 997) and represents the nature of the collaboration and mutual commitment between research and stakeholders. The arrangements that are based on higher mutual commitment subsume those that are based on lower mutual commitment. Table 8.2 provides a short description of the nine boundary arrangements for the research-stakeholder interface.

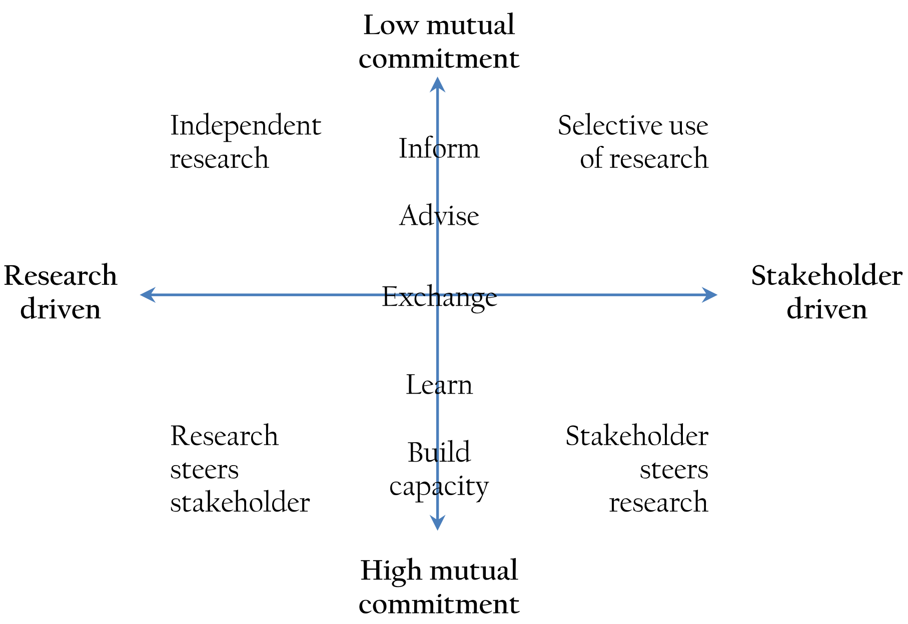


Fig. 8.2. Boundary arrangements at the research-stakeholder interface.

Note that we are aware that stakeholders or stakeholder groups such as 'farmers' or 'civil society' are not homogeneous entities and that within these groups a multiplicity of stakes and objectives may exist. Nevertheless, we want to explore whether describing and analysing boundary arrangements at the multiple research-stakeholder interfaces provides new insights into the role of research in policy processes in competing claims contexts. Furthermore, we inquire whether different boundary arrangements at the research-stakeholder interface may emerge with regard to (1) the nature of the policy issue (policy content) and (2) ideas about how 'best' to organise the policy debate (policy process).

[55] In our perception, the concept of 'policymaker' goes beyond that of the government representative or bureaucrat. It also involves politicians, entrepreneurs, farmers, civil society representatives and other actors with a stake in (public) policy development.

Boundary arrangement	Description
Independent research	Research is independent of stakeholder or political interests. Research is not concerned with how research findings are mobilised and used by stakeholders in policy processes.
Research steers stakeholder	Research actively seeks to persuade stakeholders to select a specific solution for the problem or a certain way of organising the policy process.
Inform	Dissemination of information on policy content and process. Research and stakeholders inform one another in a supply-oriented fashion (cf. Michaels, 2009). Inform can be unidirectional (one-way) or bidirectional (two-way).
Advise	Research and stakeholders operate in their own separate domains, but research can be used to provide advice to stakeholders, and stakeholder can advise research on the relevance of research questions. Advise can be unidirectional or bidirectional.
Exchange	Research acknowledges that stakeholders have specific needs and questions, and proactively seeks to reconcile demand and supply. Research and stakeholders interact on research demands and exchange information.
Learn	Co-production of research (cf. Edelenbos et al., 2011). Researchers and stakeholders engage in a joint learning process to generate stakeholder-relevant research. Research and policy complement each other.
Build capacity	Research builds capacity and seeks to strengthen the position of the stakeholder in the policy process. Stakeholders can also empower research by providing research with a platform to mobilise research findings. Capacity building can therefore be unidirectional or bidirectional.
Selective use of research	Research is used selectively and strategically by stakeholders to defend their interests and pursue their goals (Burton, 2006). Other than through learning and capacity building, research has little influence on how findings are interpreted, mobilised and used by the stakeholders in the policy debate (cf. Opdam, 2006; Klosterman et al., 2009).
Stakeholder steers research	Stakeholder influences and determines research agenda setting, how the research is conducted and/or used. The degree to which research can participate in, or contribute to, the policy process is controlled by the stakeholder.

Table 8.2. Description of boundary arrangements at the research-stakeholder interface.

8.2.3. Boundary arrangements and multi-stakeholder dynamics

Cash et al. (2003 p. 8086) argue that research is likely to be perceived as 'effective' by stakeholders when it is: "[N]ot only credible, but also salient and legitimate." Credibility refers to the trustworthiness and validity of research (cf. Haas, 2004). Legitimacy is the perception that research is fair, unbiased and integrative in how it addresses stakeholders' values, views and interests (Cash et al., 2003; Tuinstra, 2007; Cutts et al., 2011). Salience implies that research is provided in a timely manner and contains information that is relevant for stakeholders (Haas, 2004; Tuinstra et al., 2006).

Assuming that in competing claims contexts stakeholder groups have different (often competing) objectives, we hypothesise that there exist different expectations about the role and contribution of research to policy processes that may result in different boundary arrangements at multiple research-stakeholder interfaces. Consequently, this raises the questions of whether multiple boundary arrangements at different research-stakeholder interfaces can co-emerge and coexist, and whether research can support certain stakeholders or stakeholder interests, while at the same time remaining credible, legitimate and salient to other stakeholders in the policy process (Giller et al., 2005).

8.2.4. Boundary arrangements and temporal dynamics

Both research and policy processes consist of various phases. In this chapter, we distinguish between phases of describing and explaining problems, and phases of exploring and designing solutions that can apply both to research and policy[56] (Giller et al., 2008). A difference is that research can describe and explain problems without going into the phase of exploring and designing solutions. Phases in research processes and policy processes often do not align, are not clear-cut and are prone to stakeholder interpretation (Schut et al., 2010b).

Stakeholder perceptions about the nature of the policy problem and what are perceived as appropriate policy responses are likely to change as the policy process unfolds over time. This may be the result of the changing policy context, interactions in the policy arena, changing power relations, or changed perceptions based on insights from research or other sources of information. Such changes over time have challenged us to explore how temporal dynamics affect boundary arrangements at the various research-stakeholder interfaces, and whether boundary arrangements show patterns of path dependency or synergy in terms of their sequences and configurations through time (cf. Hoppe, 2005). Path dependency of boundary arrangements implies that boundary arrangements at any given point in time are influenced (either enabled or constrained) by previous boundary arrangements (cf. Leeuwis, 2004).

8.3 Research objective, approach and methodology

The objective of this chapter is to explore how boundary arrangements at research-stakeholder interfaces are influenced by multi-stakeholder and temporal dynamics in policy processes in competing claims contexts. Consequently, we discuss the implications of such dynamics for the role of research in policy processes in competing claims contexts and provide recommendations for further research.

[56] Describing and explaining policy problems and exploring and designing policy solutions should be seen as phases of policy development. Policy development is often followed by a phase of policy implementation.

We study this in the policy debate on biofuel sustainability in Mozambique, which led to the development of a national policy framework for biofuel sustainability. As part of a collaboration between the Dutch Ministry of Foreign Affairs (DGIS), the Mozambican Ministry of Agriculture (particularly its Centre for Agricultural Investment Promotion: CEPAGRI) and Wageningen University and Research Centre, the lead author of this chapter supported this policy process between December 2008 and November 2010.

To analyse the temporal dynamics, we describe five episodes in the policy debate on biofuel sustainability in Mozambique. The first two episodes describe the problem-oriented phase, and the third, fourth and fifth episode the solution-oriented phase[57] of the policy process. Within each episode, we describe the policy context, the research activities, the multi-stakeholder dynamics inside and outside the policy arena, and the boundary arrangements at the multiple research-stakeholder interfaces. In some cases – where it was difficult to select one specific arrangement – we indicate that the specific research-stakeholder interface was characterised by multiple or hybrid boundary arrangements.

The boundary arrangements are identified from the perspective of the researcher. As our empirical data will demonstrate, the sensitivity of the policy process and tensions at the research-stakeholder interface(s) did not allow for joint analysis with stakeholders. Data were gathered from participatory observations in the policy process, in which the lead author was an active participant. Such observations were analysed with a colleague – who also actively participated in the policy process – and documented in field notes and personal memos. During the two years of field work in Mozambique, we conducted, with different stakeholders, semi-structured and informal interviews that contributed to analysing the policy process and boundary arrangements that structured and facilitated our collaboration with different stakeholder groups. Lastly, we analysed secondary data such as policy documents, terms of references and research proposals that included information on the division of labour and responsibilities between research and stakeholders in the policy process.

8.4 Boundary arrangements in the policy debate on biofuel sustainability in Mozambique

Consequent to a workshop to provide feedback on the EU's proposed biofuel sustainability criteria in December 2007, the Mozambican government decided to develop its own national framework for biofuel sustainability. Two government departments (CEPAGRI and CONDES)[58] were responsible for developing terms of reference (ToR) to form a multi-stakeholder subgroup responsible for developing a biofuel sustainability framework for Mozambique (henceforth abbreviated as 'subgroup'). Before the start of the research in Mozambique, we developed a research proposal in collaboration with CEPAGRI. At that

[57] We focus on the policy development phase as we did not go into the policy implementation phase.
[58] National Council for Sustainable Development (CONDES), part of the Mozambican Ministry for the Coordination of Environmental Affairs (MICOA).

time, it was unclear what stakeholders would form part of the subgroup, as the ToR were still in the process of being developed. The objective of the research was to analyse stakeholder perceptions on biofuel sustainability, as this could provide the basis for developing the national framework for sustainable biofuels. Although it was our intention to support the policy process, the proposal included a clear division of tasks and responsibilities: "The scientific outcome provides the Mozambican government insight into how discourses, knowledge and knowledge gaps play a role in negotiations and public debate, which subsequently can result in research and policy recommendations."

Below, five empirical episodes are described. Each episode contains a schematic representation to illustrate the dynamics during that phase of the process and the nature of the boundary arrangements between research and stakeholders.

Episode 1

At the start of the research in December 2008, the subgroup's ToR were in the process of being developed. A draft of the ToR indicated that the subgroup would at least consist of representatives from different ministries, civil society organisations and the private sector. As formal subgroup activities would still take some time, we conducted a first round of interviews with representatives from these three stakeholder groups and participated in meetings and workshops on biofuels. This made us conclude that the lack of a comprehensive overview of biofuel developments in Mozambique was resulting in controversies between stakeholder groups, and that developing such an overview could form the starting point for a multi-stakeholder debate on biofuel sustainability. CEPAGRI approached the lead author of this chapter and a technical advisor of GTZ-ProBEC[59] to develop an action plan for the subgroup. As the subgroup would be multi-stakeholder, we (the lead author and GTZ's technical advisor) decided to base the action plan on the principles of social learning that focuses on: "[B]ringing together different stakeholders (actors) who have an interest in a problem situation and engaging them in processes of dialogue and collective learning that can improve innovation, decision making and action" (Woodhill, 2004 p. 47).

Furthermore, international biofuel sustainability criteria and their potential opportunities and challenges for Mozambique were analysed. In line with that, we studied the Mozambican government's National Biofuel Policy and Strategy[60] (NBPS) and other biofuel-related policies disclosing the Mozambican government's biofuel objectives. Under strict conditions, we could access and analyse biofuel investment proposals that had been submitted to the Mozambican government. Based on this analysis and field visits to biofuel

[59] The Programme for Basic Energy and Conservation (ProBEC) of the German Technical Cooperation (henceforth abbreviated as GTZ). GTZ provided technical support to the SADC Energy Sector and SADC Biofuel Taskforce. One of GTZ's regional technical advisors was based in Maputo and supported the policy debate on biofuel sustainability in Mozambique.

[60] The National Biofuel Policy and Strategy (NBPS – Resolution 22/2009) was approved in March 2009, and so was not available at the beginning of our research. In the NBPS, the right/responsibility of civil society and private sector stakeholders to participate in the development of biofuel sustainability criteria is formalised.

projects, an inventory of commercial and community-based biofuel developments in Mozambique was developed (see: Schut et al., 2010c; Schut et al., 2011b). During the field visits and from interviews, we developed a better understanding of the different stakeholder perceptions on biofuel sustainability.

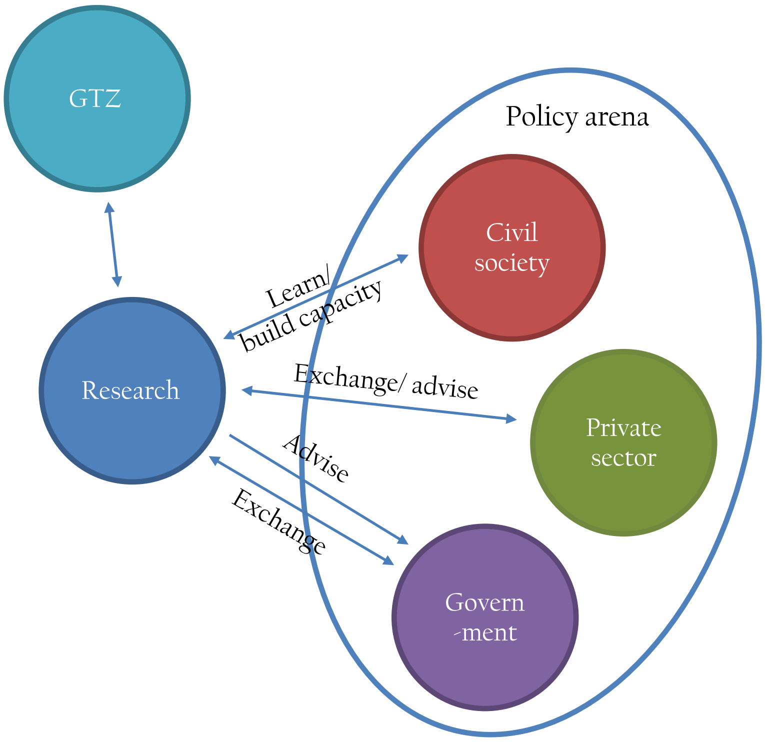


Fig. 8.3. Schematic representation of Episode 1.

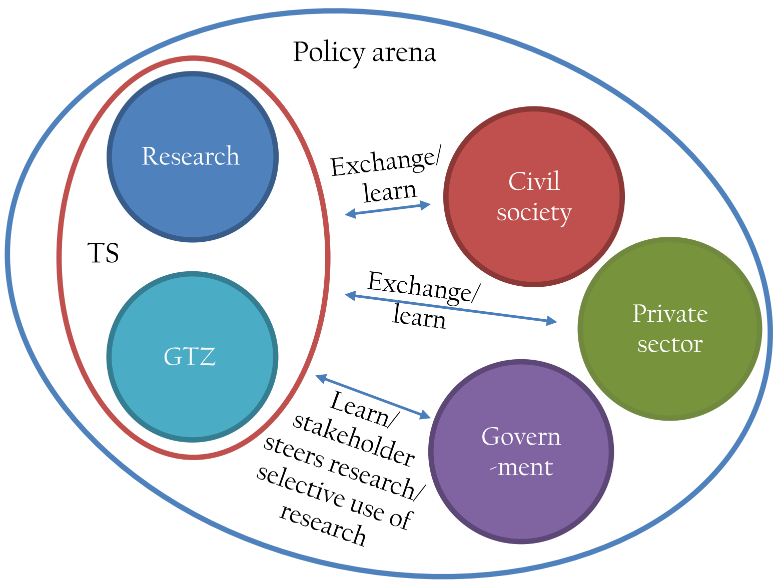
In March 2009, a workshop for civil society organisations was organised by GTZ and WWF to develop a joint vision and strategy to defend their interests in the policy debate on biofuel sustainability. The preliminary research findings served as input for the workshop, and the lead author contributed to the overall workshop facilitation.

The lack of subgroup activity resulted in establishing multiple boundary arrangements with individual groups of stakeholders (Figure 8.3). The boundary arrangement at the research-government interface focused on the exchange of information and data (policy content) and providing advice when CEPAGRI approached us to develop the action plan for the subgroup (policy process). The boundary arrangement at the interface of research and civil society stakeholders focused on learning and capacity building to strengthen the position of civil society in the debate. Although we advised private sector stakeholders to do the same, they did not manage to organise themselves as a collective. Consequently, the collaboration with individual private sector stakeholders focused on exchanging information. For practical reasons, we focus on describing the boundary arrangements between research and government, civil society and private sector stakeholders and do not actively describe the boundary arrangement between research and GTZ.

Episode 2

CEPAGRI approached GTZ's technical advisor and the lead author of this chapter to form a Technical Secretariat (TS), responsible supporting the multi-stakeholder subgroup by means of research. By formalising our role and mandate as TS in the subgroup's ToR, we became part of the policy arena. We framed this as a unique opportunity to enhance the contribution of research to the policy process, although it also created expectations among the different groups of stakeholders involved.

The collaboration with governmental stakeholders intensified. CEPAGRI approached us to support preparing feedback on EC policy, and the lead author of this chapter took part in a scientific jury to adjudicate on the granting of government scholarships for biofuel research. The report that summarised our research findings (see: Schut et al., 2010a) was edited by CEPAGRI. Firstly, this was done to get permission to publish the analysis of biofuel investment proposals,[61] and secondly to enhance the (internal) validity of the research findings. Due to a change in leadership in CEPAGRI, the joint editing process took several months (roughly from September 2009 until February 2010) and changes to the report were requested. Although this did not substantially change the overall conclusions, it was clear that a degree of dependency on the government had developed in relation to publishing our work. Moreover, only a slimmed-down version of the social learning action plan was included in the subgroup's ToR, implying selective use of research.



With civil society and private sector stakeholders, the collaboration focused mainly on exchanging information and data and on joint learning by analysing preliminary research findings during meetings and workshops. Due to the leadership changes in CEPAGRI (and also in an earlier phase within CONDES), the formation of the multi-stakeholder subgroup had completely stagnated.

Fig. 8.4. Schematic representation of Episode 2.

During this phase, we formally became part of the policy arena, in our role as members of the TS. We could say that this was the result of successful boundary work at the research-government interface. However, a degree of government steering had also developed in terms of how we could use and publish data, and how our research-based advice was used by the government. With regard to the collaboration with civil society stakeholders and private sector representatives, such steering and dependency did not exist. The relationship continued to be based on the exchange of research findings and information regarding developments in the policy arena (Figure 8.4). The joint analysis of the research findings facilitated mutual learning.

[61] As the individual biofuel investment proposals contained sensitive and confidential data, we had agreed to present the data in such a way that information about individual projects would not be revealed, but information about the sector as a whole could be analysed.

Episode 3

The policy context changed dramatically when the Mozambican government approached the TS to draft the biofuel sustainability framework for Mozambique. As a result of the leadership changes, the subgroup was still not operational as a multi-stakeholder platform,[62] and the chair of the National Biofuel Taskforce suggested that having a draft framework would enhance effective multi-stakeholder debate later in the process. Because of our mandate to support the multi-stakeholder subgroup, the TS accepted the assignment.

In drafting the framework, we worked together with the three government officials who were supposed to form part of the subgroup. Almost instantly, this collaboration was criticised, especially by civil society stakeholders. The credibility and legitimacy of the researcher (and of the research findings that had previously been perceived credible, legitimate and salient) were openly questioned and contested. As the TS, we understood this criticism; on the one hand, we had supported civil society organisations to strengthen their position in the policy debate, whereas, on the other hand, we were building the capacity of the government that had violated earlier promises of multi-stakeholder debate. Consequently, the relationship with private sector and civil society stakeholders became more one sided (unidirectional arrows in Figure 8.5), focusing on informing rather that exchanging information and joint learning. We advised civil society organisations to file an official complaint about the democratic process, as the participation of civil society in the development of the biofuel sustainability framework was formalised in the government's NBPS.

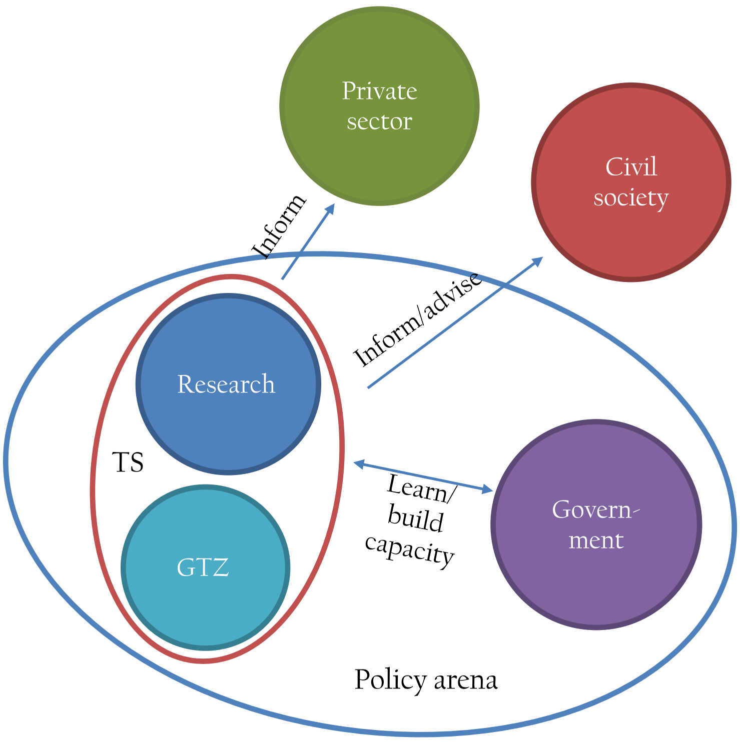


Fig. 8.5. Schematic representation of Episode 3.

Episode 4

To enhance the credibility and legitimacy of the policy framework for the different stakeholder groups, we tried to emphasise our independent position by demarcating the boundary between research and government. Furthermore, the draft biofuel sustainability principles and criteria were firmly rooted in the research findings, and we made sure that the key interests of the three key stakeholder groups (government, civil society and private sector) were addressed in the draft framework.

[62] At that time, the subgroup consisted of three government officials.

New developments in the policy arena made achieving this difficult. When the TS presented the draft sustainability principles and criteria to the government, CONDES proposed that sustainability indictors should be developed before consulting civil society and private sector stakeholders. Their motivation was that the principles and criteria did not contain sufficient detail for multi-stakeholder debate. Furthermore, the TS could not share the draft principles and criteria with other stakeholders until the government formally approved the official draft. Also, in the hands of government officials, the draft framework partly lost its research-based character as principles and criteria were included and taken out (Schut et al., 2011a). This was not necessarily negative, as it increased the relevance of the framework for government officials, and some principles and criteria that had not emerged from our research were included. However, we realised that we were in a phase of the process that was government driven and that our steering capacity in terms of the formulation of the sustainability principles and criteria was limited.

Nevertheless, because of our ideas about multi-stakeholder policy processes and the fact that the participation of civil society stakeholders had been formalised in the government's NBPS, the TS decided to constructively criticise the policy process, seeking to create space for stakeholder participation. Our strategy was to convince government that stakeholder participation was crucial for developing a credible and legitimate framework for sustainable biofuels that would be acceptable for different stakeholder groups. Referring to the fact that stakeholder participation had been formalised in the NBPS and the subgroup's ToR, the TS managed to convince the chair of the National Biofuel Taskforce that stakeholder consultation was crucial. The chair decided that three stakeholder consultation workshops were to be organised in different parts of the country.

During this phase, the interactions between the TS and civil society and private sector stakeholders were limited to informing them about our attempts to open up the policy process (Figure 8.6). At the research-government interface, the TS strategically sought to influence the government in our attempt to advocate for a multi-stakeholder debate (policy process). Although we tried to claim our independent position as research, the government dominated the drafting of the sustainability principles and criteria (policy content) and restricted us to discussing the draft sustainability framework with other stakeholders.

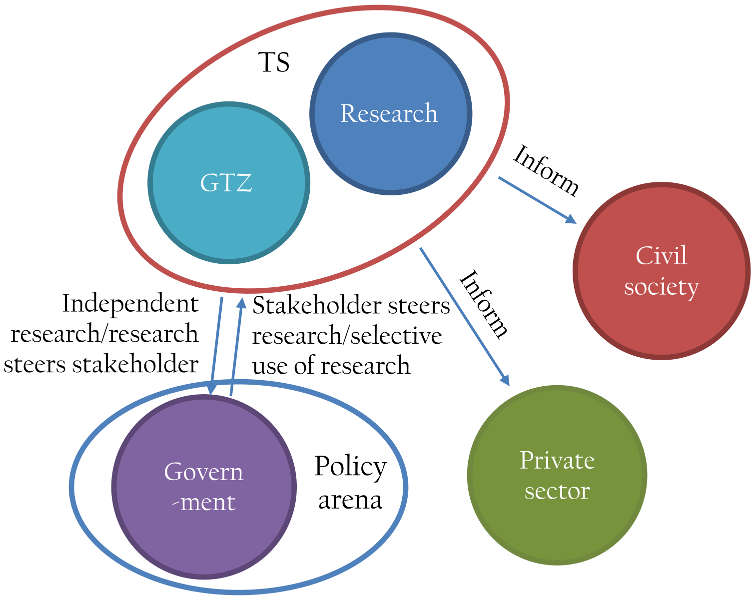


Fig. 8.6. Schematic representation of Episode 4.

Episode 5
Early 2010, the government decided that the subgroup would be an inter-ministerial platform – instead of a multi-stakeholder platform – representing different government ministries and departments. The collaboration between the TS and this 'new' subgroup continued. Together, we mobilised funds for the stakeholder consultation workshops, and the subgroup approached the TS to propose a workshop guide. The TS developed an interactive workshop methodology and a discussion-support tool to stimulate multi-stakeholder debate. The TS also proposed a list of potential participants to the government. Furthermore, we trained subgroup members in how to facilitate, observe and monitor multi-stakeholder debate. Although these activities had a strong focus on building capacity for the Mozambican government, we did not do this to strengthen the government in defending their biofuel objectives in the policy debate. The TS' reasons for supporting the government were process-oriented and based on creating an enabling environment for multi-stakeholder debate, facilitating learning and building bridges between stakeholders in the policy arena.

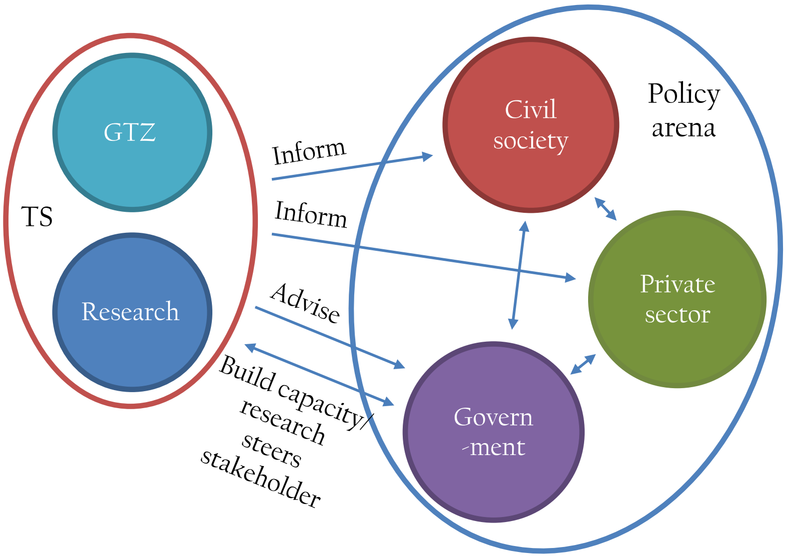


Fig. 8.7. Schematic representation of Episode 5.

This episode demonstrates that, although interaction with civil society and private sector stakeholders was limited to informing them on the progress of the process, the TS did attempt to strengthen its position in the policy process by proposing (or steering towards) an interactive workshop methodology (policy process) (Figure 8.7). In relation to the development of the sustainability principles and criteria (policy content), the TS supported the subgroup in analysing and processing the feedback received during the three stakeholder consultation workshops.

8.5 Analysis and discussion

Figure 8.8 and Table 8.3 summarise our findings and illustrate the sequence of boundary arrangements at the different research-stakeholder interfaces over time. In line with the objectives of this chapter, we analyse below how boundary arrangements at research-stakeholder interfaces were influenced by multi-stakeholder and temporal dynamics.

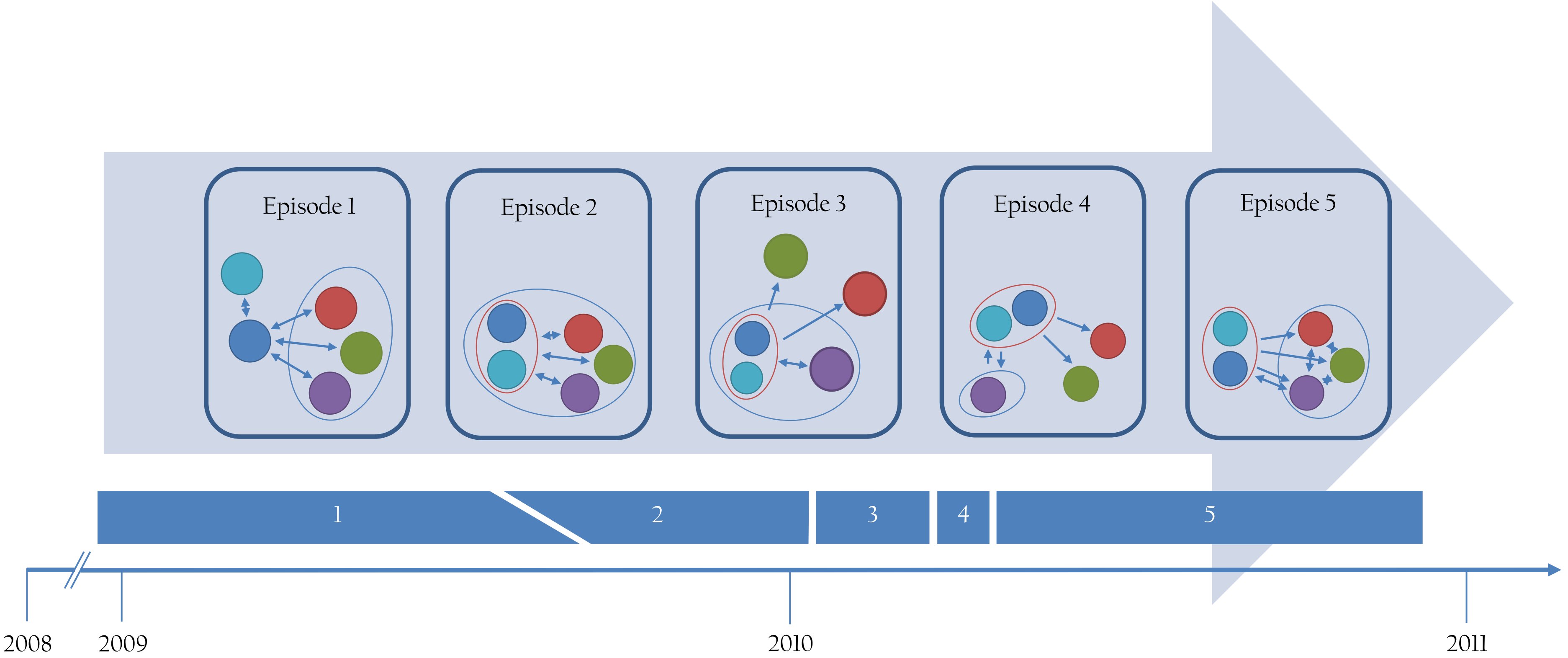


Fig. 8.8. Timeline that positions the five episodes.

Phase	Describe and explain problems				Explore and design solutions			
	Episode 1		Episode 2	Episode 3	Episode 4		Episode 5	
	Policy content	Policy process			Policy content	Policy process	Policy content	Policy process
Research-government interface	Exchange	Advise	Learn Stakeholder steers research Selective use of research	Learn Build capacity	Stakeholder steers research Selective use of research	Independent research Research steers stakeholder	Advise	Build capacity Research steers stakeholder
Research-civil society interface	Learn Build capacity		Exchange Learn	Inform Advise	Inform		Inform	
Research-private sector interface	Exchange Advise		Exchange Learn	Inform	Inform		Inform	

Table 8.3. Boundary arrangements at the research-stakeholder interfaces during the five episodes.

8.5.1 Boundary arrangements and multi-stakeholder dynamics

The collaboration between research and the three (separate) stakeholder groups resulted in the co-emergence and coexistence of multiple boundary arrangements at the different research-stakeholder interfaces. Especially during Episodes 1 and 2, these boundary arrangements were characterised by exchange of information and mutual learning. This somewhat blurred the boundaries between research and the individual stakeholder groups, and this provided insight into the characteristics of the different stakeholder groups, their objectives, position *vis-à-vis* each other, and the type of research that would be perceived as credible, legitimate and salient with regard to their specific needs and priorities.

However, Episode 2 demonstrated that the blurring of boundaries also created dependencies and expectations. For example, the access to biofuel investment data enriched and enhanced the relevance of the research, but the joint editing of the research report considerably delayed the publication of our data, and therefore the salience of the research for other stakeholders.[63] Similarly, the joint editing of the research report enhanced the credibility and legitimacy of the research within government circles, but also demonstrated a degree of power by government to steer and selectively use the outcome of the research, thus negatively affecting the credibility and legitimacy of the research for other stakeholders. Consequently, the idea that research can build capacity with a specific stakeholder or stakeholder group, and at the same time remain credible, legitimate and salient to other stakeholders in the policy process, may be problematic, as there are often trade-offs and compromises to be made (Giller et al., 2005).

Changing boundary arrangements at one research-stakeholder interface can affect boundary arrangements at other research-stakeholder interfaces. This was demonstrated during Episode 3 when the Mozambican government approached the TS to draft the biofuel sustainability principles and criteria. Furthermore, the government's decision to transform the subgroup into an inter-ministerial platform (Episode 5) altered the power play between stakeholders by changing the role of civil society and private sector stakeholders from policymakers to participants in the policy process. These stakeholder dynamics directly affected the boundary arrangements at the multiple research-stakeholder interfaces. As the TS was building the capacity of a stakeholder that was in control of deciding who was allowed to participate in the policy process, when, and in what form, this negatively affected our credibility and legitimacy towards other stakeholders in the process.

Episode 4 showed that it was difficult to demarcate the (blurred) boundary between research and the Mozambican government and claim an 'independent research' position in the policy debate. Nonetheless, this episode also demonstrated that different (opposing) boundary arrangements relating to policy content and policy process at the same research-stakeholder interface can coexist. Episodes 1 and 5 also showed this, but the fact that different boundary arrangements for policy content and policy process could be opposite (research driven and

[63] The investment data were for December 2008 and first published in Schut et al. (2010a) in February 2010.

stakeholder driven) was particularly evident in Episode 4. During Episode 4, the boundary arrangement that steered the re-formulation of the research-based sustainability principles and criteria (policy content) by the Mozambican government was stakeholder driven. However, the boundary arrangement that guided our lobby for multi-stakeholder debate (policy process) was research driven. It also shows that strengthening specific stakeholder groups in policy processes may include multiple strategies, including steering the stakeholder who controls access to the policy arena.

8.5.2 Boundary arrangements and temporal dynamics

As Figure 8.8 demonstrates, boundary arrangements can exist for longer or shorter periods and can gradually alter (e.g. transition from Episode 1 to 2), or abruptly change as the result of an event or decision (e.g. transitions from Episode 3 to 4 and 4 to 5). The extent to which boundary arrangements at different research-stakeholder interfaces can coexist is likely to change as the policy process unfolds. For example, during the problem-oriented phase (Episodes 1 and 2), the existence of multiple boundary arrangements focusing on 'learning' and 'exchange' was not problematic for any of the stakeholder groups involved. During this phase, conflicts of interest were less visible, coalitions were yet to be formed, and power relations and the impact of the policy were not yet tangible. Also, the fact that different stakeholder groups expected to participate in the subgroup, and our mandate to support this subgroup, enabled us to engage in joint learning activities with the different stakeholder groups, and "remain rather neutral in the process, by not engaging too much in the political debate" (Schut et al., 2011a p. 55). Although quite paradoxical, the lack of subgroup activity provided us with time to conduct credible and legitimate research for different stakeholder groups. Such time is often limited due to short-term demand for generating salient research for *ad hoc* decision making (cf. Haas, 2004 p. 574).

The policy context changed dramatically from Episode 3 onwards, when the government approached the TS to draft the sustainability framework. During this solution-oriented phase, it became more difficult to maintain constructive collaborations with the three stakeholder groups, as building the capacity of one particular stakeholder group had implications for other stakeholder groups. The case suggests that moving from problem-oriented phases to solution-oriented phases changes dynamics for stakeholders and – consequently – the extent to which different boundary arrangements at multiple research-stakeholder interfaces in policy processes in competing claims contexts can coexist.

Lastly, boundary arrangements at research-stakeholder interfaces show complex patterns of path dependency in policy processes. Boundary arrangements are stored in the 'memory' of the policy process, and previous boundary arrangements influence which future boundary arrangements at specific research-stakeholder interfaces are perceived as credible, legitimate and relevant. This was particularly evident in Episode 4 when we sought to claim our independent position as researchers by developing research-based biofuel sustainability principles and criteria but were confronted with the fact that the research-based principles and criteria were selectively used by the Mozambican government. It shows that the potential future range of boundary arrangements at research-stakeholder interfaces is influenced by previous boundary arrangements and stakeholder expectations. Such insights contribute to more strategic thinking about boundary work in policy processes, as the 'blurring' or 'demarcating' of boundaries between research and stakeholders is not something that can be done unlimitedly, because such actions influence the credibility, legitimacy and salience of research and researchers as perceived by multiple stakeholders in policy processes.

8.6 Conclusions and recommendations for research

To enhance the credibility, legitimacy and salience of research in policy processes, the active engagement of research with different societal stakeholders has often been proposed (cf. Gibbons, 1999; Cash et al., 2003; Giller et al., 2008). As this chapter shows, such active engagement can result in situations where multiple boundary arrangements between research and stakeholder groups co-emerge and coexist. It is noteworthy that different boundary arrangements can exist *vis-à-vis* policy content and policy process at one research-stakeholder interface.

Depending on the nature of the boundary arrangement, the active collaboration between research and different groups of stakeholders may enhance the effective contribution of research to policy processes. However, it may also create challenges in terms of strengthening a specific stakeholder group and of remaining credible, legitimate and salient to other stakeholder groups. The direction in which boundary arrangements at a specific research-stakeholder interface develop over time is influenced by the changing policy context, including boundary arrangements at other research-stakeholder interfaces. Furthermore, boundary arrangements show patterns of path dependency, meaning that previous boundary arrangements influence which future boundary arrangements at research-stakeholder interfaces are perceived as credible, legitimate and salient.

In line with Turnhout et al. (2008), we believe that our findings demonstrate a need for more nuanced and dynamic thinking on boundary work and boundary arrangements that influence the role of research in policy processes in competing claims contexts. The multi-stakeholder and temporal dynamics make it impossible, and also undesirable, to develop blueprint approaches or silver bullet solutions on how to enhance the contribution of research to policy processes. However, this chapter contributes to raising awareness about how multi-stakeholder and temporal dynamics affect the role of research in policy processes in competing claims contexts; not to discourage researchers from engaging with stakeholders, but rather to provide a more realistic impression of how such collaborations between research and stakeholders may evolve in practice.

We conclude with a suggestion for further research. In this chapter, we describe boundary arrangements from the perspective of research. We believe that further studies on boundary work and boundary arrangements at research-stakeholder interfaces could benefit from discursive analysis (cf. Huitema and Turnhout, 2009). Discursive analysis enables the analysis of perceptions on boundary arrangements from multiple perspectives and may go beyond the 'stakeholder group' as the unit of analysis.

Acknowledgements

This research is part of the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions,' funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation. The research also formed part of the 'Competing Claims-Competing Models' programme jointly funded by Wageningen University and Research Centre and the Dutch Ministry of Foreign Affairs (DGIS).

The authors acknowledge the valuable contributions and support of investors, farmers, extension workers, researchers, NGO representatives and policymakers who collaborated with us and provided data and insights necessary for this study. In particular, we thank Esther Turnhout for her constructive feedback on earlier versions of this chapter.

CHAPTER 9

Conclusions and discussion

9.1 Introduction

This thesis has explored the role of research in policy processes in competing claims contexts in different ways and from different perspectives. Policy debates in competing claims contexts are characterised by the involvement of a multiplicity of stakeholders. In (environmental) policy debates typically: "[F]acts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz and Ravetz, 1993 p. 744). Competing claims problems are often embedded in dynamics that include different scales (e.g. spatial, temporal or more administrative scales) and exceed different levels of policymaking. Furthermore competing claims problems are multidimensional, highly complex and surrounded by uncertainty.

The thesis is based on a sequential case study approach that contains two case studies; one from the Netherlands and one from Mozambique. As explained in the introduction to the thesis, the sequential case-study approach is particularly useful within an action-oriented research approach. It enables the researcher to use findings from the first case study to deepen or sharpen investigations in the second case study. Although the case studies address different competing claims problems (flood prevention and the sustainability of biofuels), were situated in different competing claims contexts (a so-called developed and developing country) and study the role of research in the different policy contexts, many interesting parallels and differences can be identified.

The first case study is based on the reconstruction of the policy process that led to the decision to depolder De Noordwaard in order to create Room for the River in the Netherlands (Chapter 3). The reconstruction of the policy process based on interviews and reflections with stakeholders provided the basis for identifying key drivers and features that influence the role of research in policy processes in competing claims contexts. Examples are: how perceptions about effective research depend on stakeholder objectives, and how policy phases and power dynamics influence the role of research in policy processes. This led to the conclusion that the contribution of research to policy processes in competing claims contexts could benefit from more action-oriented research approaches, where both the research and researchers are embedded in policy processes.

During the second case study, the key drivers that emerged from the first case study were studied in more detail, and more from within by actively participating in the policy debate on biofuel sustainability in Mozambique. The second case study can be subdivided in two stages (see Figure 1.3). During the first stage, the emphasis was on sharpening and aligning the research questions with the priorities and objectives of different groups of stakeholders in the policy process. The core of this exercise was exploring what research questions, methods and theories could generate research that would be perceived as credible, legitimate and salient for different stakeholder groups. This provided the basis for three chapters in this thesis. Chapters 4 and 5 analyse commercial and community-based biofuel developments in Mozambique from an interdisciplinary perspective, and provide an overview of different stakeholder perspectives and objectives in relation to biofuel sustainability. The chapters result in different types of policy recommendations relating to how stakeholder objectives can be harmonised, and how different enabling (policy) environments are needed to promote the sustainability of commercial and community-based biofuel developments in Mozambique. In Chapter 6, *ex-ante* scale dynamics analysis is used to better understand how interactions between different scales and levels influence the development of a national policy framework for biofuel sustainability in Mozambique. This research approach generated valuable insights on how solution space in policy processes is affected by complex interactions between different scales and levels. It also highlighted the opportunities and challenges of using scale dynamics analysis as part of an action-oriented research approach that seeks to support the development of policy that takes into account interactions between different scales and levels.

In retrospect, the first stage of the second case study provided the basis for my active participation in the policy debate during the second stage. This second stage provided insights into the dynamics of research that seeks to explore and design policy solutions in a multi-stakeholder policy context. In Chapter 7, the roles of researchers as knowledge and innovation managers in policy processes in competing claims contexts are analysed. The chapter demonstrates how combinations of researchers' roles can enhance the contribution of research to policy processes. Chapter 8 studies how different ideas emerge about the division of tasks and responsibilities reflected in boundary arrangements between researchers and different stakeholder groups, and how these ideas change as policy processes unfold.

In this final chapter of the thesis, I reflect on the original research questions of this study and address them using the findings from the two case studies (Section 9.2). The research questions were formulated as follows:

1. How is research mobilised and used in policy processes in competing claims contexts?
2. What factors influence the extent to which research can create space for stakeholders in policy processes in competing claims contexts?
3. What kinds of research approaches have the potential to enhance the contribution of research to policy processes in competing claims contexts?
4. What researcher's roles or combination of roles may enhance the contribution of research to policy processes in competing claims contexts?
5. How do dynamics at the interface of research and policy influence the role of research in policy processes in competing claims contexts?

Following Section 9.2, the overall conclusions of the study are synthesised in Section 9.3, introducing a tool to develop dynamic research configurations that can contribute to raising awareness and stimulate reflexive thinking for researchers in competing claims contexts. This is followed by a general discussion that positions the findings from the study in broader debates on research and policy (Section 9.4). This chapter, and the thesis, are concluded with some final remarks (Section 9.5).

9.2 Thesis findings

Below, the individual research questions are addressed by bringing together findings and insights from the different empirical chapters. Each section answers a research question, provides examples from the case studies and concludes with a summary of the main findings.

9.2.1 Research question 1: How is research mobilised and used in policy processes in competing claims contexts?

The cases discussed in this thesis demonstrate that research is mobilised and used in different ways and for multiple purposes during formal and informal negotiations in policy processes. Stakeholders strategically and selectively use combinations of content- and process-related research to influence the course and outcome of policy processes in competing claims contexts. Consequently, research can support certain stakeholder groups, but is also in itself subject to negotiation.

Research is often initiated to contribute to policy processes in competing claims contexts, but how research is used and whether it plays a decisive role in policy negotiations depends on several factors. The first case study showed how research is mobilised and used by different types of stakeholders during formal and informal negotiation phases in policy processes (Chapter 3). Informal negotiations often provided the basis for formal decision making, consequently forming the starting point for a new phase of negotiation in the policy process. During different phases in the policy process, stakeholders purposefully and tactically mobilised and used research with regard to policy content (nature of the policy problem at stake) and policy process (the way the policy process is organised) to strengthen their own position, or weaken the position of other stakeholders in the policy process. The Room for the River case study showed how policy processes in competing claims contexts can easily end up as "arenas of struggle" (Leeuwis, 2000 p. 946) in which each stakeholder group mobilises and uses its own research. Such situations often result in 'research battles'[64] in which research and researchers are likely to become contested.

Both case studies provide examples of how stakeholders strategically used research to criticise democratic processes as a way to penetrate the political agenda and create space to influence the policy debate. In the first case study the citizen platform Save De Noordwaard mobilised research to criticise and open up the government's democratic and legal procedures. This was necessary to put forward the platform's policy alternative that could save De Noordwaard (Chapter 3). In the second case study also, the democratic process was criticised by researchers to create space for stakeholder participation in the policy process. In this case however, researchers proactively sought to convince the Mozambican government that not consulting private sector and civil society stakeholders could have legal consequences later in the process, as stakeholder participation had been described in the

[64] Colleagues refer to: "knowledge battles" (van Buuren and Edelenbos, 2004 p. 297) or "report wars" (van Buuren, 2006 p. 2).

government's National Biofuel Policy and Strategy (Chapters 7 and 8). It shows that particularly the combination of research relating to policy content and policy process can be powerful, as it is often necessary to first open up the policy process in order to subsequently introduce alternative policy solutions.

Both the first and the second case study provide examples of how research that is in line with stakeholders' objectives and perceptions is likely to be framed as credible, legitimate and salient, and conducted by independent researchers, whereas research that is not in line with stakeholder objectives and perceptions is framed as less credible, legitimate and salient, and conducted by a subjective activist or advocate (Chapters 3, 7 and 8). Similar strategies were deployed in both cases by selectively and strategically referring to the reputation of individual researchers and research institutes to increase the credibility or legitimacy of a certain claim, or to undermine or weaken the claims made by others. As this thesis indicates, research can support or empower the negotiation position of stakeholders in policy processes, but is also in itself subject to negotiation.

Main findings on the mobilisation and use of research:

- Research relating to both policy content and policy process is used strategically and selectively by stakeholders to change the course and outcome of policy processes in competing claims contexts.
- The use of research on policy process (criticise democratic and legal procedures) combined with research on policy content (propose an alternative policy solution) is a powerful strategy to create space for change in policy processes.
- The credibility, legitimacy and salience of research and researchers in policy processes in competing claims contexts are highly dependent on stakeholder perceptions and objectives.
- Consequently, research is often subject to negotiation, and research and researchers are likely to become contested in policy processes in competing claims contexts.

9.2.2 Research question 2: What factors influence the extent to which research can create space for stakeholders in policy processes in competing claims contexts?

Analysis of the two case studies described in this thesis enabled the identification of three important factors that influence the extent to which research can create space for stakeholders in policy processes in competing claims contexts: firstly, the timing of research in policy processes; secondly, the strategic inclusion and exclusion of research and researchers in policy processes; and thirdly, the power of research to 'claim space' for stakeholders in policy processes, or to contribute to creating 'invited space' for stakeholders in policy processes. Below, these three factors are elaborated and supported by examples from the cases.

Both case studies showed that the timing of research in policy processes, or aligning research processes and policy processes, is a crucial factor that determines the role and contribution of research to policy processes. For example, in the Room for the River case, 'new' research findings on discharge norms that entered the policy debate during a later phase were framed as threatening the ongoing elaboration and implementation of the Room for the River policy. However, during earlier phases in the policy process, similar types of research had provided the foundation for the Room for the River policy. This shows that the role of research and the way it is perceived by stakeholders is determined by the phase of the policy process. What phases exist and the contribution of research during different phases is likely to be influenced by the way policy processes are organised and structured in different countries. This is further reflected upon in the discussion (Section 9.4).

This thesis indicates that research and researchers are strategically included and excluded from the policy arena by whoever is controlling the access to the policy process. An interview from the first case study showed that ecologists were strategically kept away from the policy debate, as they could 'slow down the process' (Chapter 3). The second case study showed how stakeholders (and thus the research that seeks to support them) are also strategically included and excluded from policy processes. For example, the contribution of research to strengthening the civil society network in Mozambique to defend their interest in the policy debate on biofuel sustainability acquired a different meaning when the Mozambican government decided to develop the biofuel sustainability framework in an inter-ministerial rather than in a multi-stakeholder policy setting (Chapters 7 and 8). The strategic exclusion of research and researchers made it more difficult to adequately 'time' or mobilise research in the policy process.

This thesis suggests that understanding how research can empower or create space for stakeholders in policy processes requires analysis of power at different levels. The work of Raik and colleagues (2008) is useful, as it differentiates between agent-centred and more structural or institutionalised forms of power, and the relation between them. From an agent-centred view, research can empower individual stakeholders or stakeholders groups by producing or mobilising research that can strengthen their position in the policy process (e.g. strengthening platform Save De Noordwaard or a civil society network in Mozambique), or by producing or mobilising research that weakens the position of other (competing) stakeholders (e.g. questioning the validity of discharge norms used by the Dutch government in Chapter 3). In doing so, research can empower stakeholders to "claim space" in policy processes (Gaventa, 2006 p. 30). The second case study showed that research can also address more structural power asymmetries by strategically influencing whoever controls the policy process and determines who is allowed to participate in the policy process. In so doing, research can contribute to creating 'invited space' for multi-stakeholder policy debate; in other words, space in which stakeholders are "invited to participate" (Gaventa, 2006 p. 26). In order to address more structural power asymmetries or create invited space, researchers need a degree of power. As demonstrated in Chapter 7, this power can be obtained from in-depth understanding of policy content and policy process, insights into stakeholder characteristics and multi-stakeholder dynamics, and the support of an informal network and individual actors who can facilitate or empower the research from behind the scenes.

Main findings on factors that influence whether research can create space:

- The role of research and how it is perceived by stakeholders is determined by the phase of the policy process. This makes the timing of research in policy processes a crucial factor that influences the extent to which research can create space in policy process.
- The strategic inclusion and exclusion of research and researchers in policy processes by those who control the access to the policy process influences the degree to which research can create space in policy processes.
- Research can strategically empower stakeholders to 'claim space,' or contribute to creating 'invited space,' by strategically influencing the stakeholder who controls the policy process.
- The power of research and researchers to create space in policy processes can be obtained from in-depth understanding of policy content (nature of the issue at stake) and policy process (legal procedures and stakeholder dynamics) and the support of individuals or networks that can empower the research from behind the scenes.

9.2.3 Research question 3: What kinds of research approaches have the potential to enhance the contribution of research to policy processes in competing claims contexts?

Both case studies provide examples of how research that seeks to enhance its contribution to policy processes in competing claims contexts can benefit from holistic analysis of competing claims problems that takes into account how interactions between different scales and levels influence policy. Furthermore, research and researchers who are embedded in policy processes and apply process-oriented research approaches are better able to anticipate the dynamics in the policy process. Lastly, the strategic packaging of research can enhance the accessibility and usability of research for stakeholders in the policy process.

The Room for the River case study in the Netherlands created awareness that competing claims problems often contain social–cultural, biophysical, economic, political and legal dimensions, and cannot be solved by addressing these dimensions separately. Furthermore, the first case study showed how mobilising a strategic combination of social-cultural, biophysical, economic, political and legal arguments seems to be an effective strategy to claim or create space in policy processes (Chapter 3). By emphasising the political and legal dimensions of competing claims problems, this way of thinking goes beyond generally accepted ideas about sustainable development, which often focus on social-cultural, environmental (biophysical) and economic issues. During the second case study, this holistic approach formed the basis for analysing interactions between social-cultural, biophysical, economic, political and legal dimensions of commercial and community-based biofuel dynamics in Mozambique (Chapters 4 and 5). Integrating different dimensions and analysing them from different disciplinary perspectives resulted in a holistic image of commercial and community-based biofuel production in Mozambique that was found credible, legitimate and salient by different stakeholder groups.

The case studies in this thesis provide examples of how interactions between social-cultural, biophysical, economic, political and legal dimensions play at different scales and levels, and how developments at higher levels can both constrain and enable developments at lower levels (cf. Giller et al., 2008). In Chapter 6, these interactions between different scales and levels are studied in more detail. The chapter concludes that *ex-ante* analysis of scale dynamics as part of an action-oriented research approach could considerably enhance the contribution of research to more scale-sensitive policy development; i.e. policy that takes into account interactions between different scales and levels. *Ex-ante* scale dynamics analysis has the potential to: (1) increasing awareness of interactions between scales and levels, and their implications for policy, (2) identifying immediate and potential matches and mismatches between scales and levels and developing (adaptive) capacity to address them, and (3) identifying stakeholders and their scale- and level-related interests that can provide the basis for collaborative multi-stakeholder learning. Chapter 6 also demonstrates how comparative analyses of scale dynamics in other countries and in other sectors generated valuable insights for the policy debate on biofuel sustainability in Mozambique. Processes of scale and level inclusion and exclusion are politicised and need careful attention, as they influence the type of scale- and level-sensitivity the research creates, but also what groups of stakeholders are perceived legitimate to defend their interest in the policy arena.

Both case studies show how the role of research in policy processes in competing claims contexts is influenced by changing policy contexts. To monitor such dynamics and respond to them, researchers should strategically embed themselves in policy processes, to better understand how problems are defined and how stakeholder dynamics and power relationships evolve over time (Chapters 3 and 7). This can enhance the adaptive capacity of research to anticipate the changing policy context and constantly determine how, in what form and when research can be strategically mobilised in the policy process (see also timing in Section 9.2.2). However, in the cases studied, the embedded position of research in policy processes also created expectations and challenges with regard to the roles and the division of tasks and responsibilities between the researcher and different groups of stakeholders; this aspect is addressed in Sections 9.2.4 and 9.2.5.

Lastly, the packaging of research can enhance the accessibility and usability of research for stakeholders in the policy process. Both case studies show that notably maps, scenarios and interactive planning tools can enhance the meaning and contribution of research to policy processes. In so doing, these products of research become ‘boundary objects’ (cf. Star and Griesemer, 1989; Carlile, 2002). For example, the maps used in Chapter 4 served as tangible boundary objects to which different groups of stakeholders could easily relate, and they provided a starting point for multi-stakeholder debate on biofuel sustainability. The effectiveness and value of a boundary object can vary for different stakeholders and change over time. Both the Dutch and the Mozambican case show that, in the hands of stakeholders, boundary objects can lose their research-based character. This was not necessarily negative in these two cases, as this process of re-interpreting research enhanced the salience and ownership of research finding for a stakeholder or stakeholder group.

Main findings on kinds of research approaches that can enhance the contribution of research to policy processes in competing claims contexts:

- Research that aims to enhance its contribution to policy processes in competing claims contexts should go beyond addressing the generally accepted dimensions of sustainability (social-cultural, biophysical and economic) and also include the political and legal dimensions of competing claims problems.
- Holistic analyses of competing claims problems can enhance the credibility, legitimacy and relevance of research findings for different groups of stakeholders.
- The *ex-ante* analysis of interactions between scales and levels as part of an action-oriented research approach has the potential to enhance the contribution of research to the development of policy that takes into account interactions between different scales and levels.
- The embeddedness of research in policy processes can lead to better understanding of the policy process and increases the adaptive capacity of research and researchers to adequately respond to contextual changes.
- Strategic packaging of research and the use of boundary objects can enhance the degree to which research can connect different stakeholders and – in so doing – enhance the accessibility and meaning of research in policy processes in competing claims contexts.

9.2.4 Research question 4: What researcher's roles or combination of roles may enhance the contribution of research to policy processes in competing claims contexts?

This thesis shows that embedded or action-oriented researchers in policy processes in competing claims contexts often fulfil a multiplicity of roles. Combinations of knowledge management and innovation management roles can enhance the contribution of research and researchers to policy processes in competing claims contexts. Lastly, process-oriented research approaches can provide a degree of flexibility for researchers to fulfil different roles and build trust with stakeholders.

The reconstruction of the Room for the River case study showed that embedded or action-oriented researchers can fulfil different roles in policy processes. Researchers can be involved in doing fundamental research, developing policy scenarios together with stakeholders, linking different networks of experts and stakeholders, criticising government procedures or fulfilling the role of independent expert in meetings or (political) debates (Chapter 3). The second case study describes how researcher's roles often emerge from the interactions with different groups of stakeholders, and that roles are not mutually exclusive, but rather mutually reinforcing, and sometimes even inextricably bound. As Chapter 7 demonstrates, effective knowledge management – including the production of credible, legitimate and salient research and joint interpretation of research findings with different groups of stakeholders – can build a degree of trust between research and stakeholders. This can provide the basis for engaging in more innovation management activities such as lobbying, penetrating political agendas, fundraising and addressing more structural power asymmetries in policy processes. Consequently, in the case studies, these innovation management roles facilitated effective knowledge management in policy processes, showing how the two can be mutually reinforcing.

Trust between researchers and stakeholders is important, but does not come easily in competing claims contexts (cf. Fleming and Waguespack, 2007). The second case study demonstrates that mutual trust between researchers and stakeholders can stimulate collaboration and the exchange of information, and it enables researchers to signal problems in the policy process (Chapters 7 and 8). Furthermore, in the Mozambican case, the joint analysis and interpretation of research findings facilitated reaching consensus about their meaning. Jasanoff (1996 p. 270, emphasis changed) reached a similar conclusion by arguing that: "[I]t seems that 'truth' is much easier to establish where the social setting engenders trust than in settings where distrust is rampant." Chapter 7 concludes that process-oriented research approaches can provide researchers with the time and flexibility to build trust and fulfil (combinations of) roles in policy processes in competing claims contexts.

Main findings on researcher's roles:

- Researchers in policy processes in competing claims contexts can play a multiplicity of roles relating to the production of knowledge and the facilitation of joint learning activities with stakeholders (knowledge management roles), but also in relation to addressing more fundamental institutional constraints (innovation management roles).
- Particularly the combination of knowledge management and innovation management roles and activities can enhance the contribution of research to policy processes in competing claims contexts.
- The legitimacy to fulfil innovation management roles in policy processes can result from producing knowledge that is perceived as credible, legitimate and salient by different stakeholder groups.
- Process-oriented research approaches can provide researchers with the time and flexibility to build the trust needed to fulfil different knowledge management and innovation management roles in policy processes in competing claims contexts.

9.2.5 Research question 5: How do dynamics at the interface of research and policy influence the role of research in policy processes in competing claims contexts?

This study argues that dynamics at the research-policy interface can best be studied as a gathering of research-stakeholder interfaces that are shaped by different ideas about the division of tasks and responsibilities (boundary arrangements) between research and different groups of stakeholders. Different boundary arrangements at multiple research-stakeholder interfaces can co-emerge and coexist, and boundary arrangements show patterns of path dependency over time.

Throughout the thesis, the role of research in policy processes in competing claims contexts has been linked to the credibility, legitimacy and salience of the research and the researcher as perceived by stakeholders in the policy process. Both the first and the second case study indicate that action-oriented research is likely to engage in active collaboration with different groups of stakeholders. In relation to the analysis of interactions between research and different groups of stakeholders, existing theories of boundary arrangements – which describe the division of tasks and responsibilities between research and policy (Hoppe, 2005) – proved to be static. Consequently, Chapter 8 introduces the idea of studying boundary arrangements at multiple research-stakeholder interfaces. This can provide the basis for developing a more dynamic image of how multi-stakeholder dynamics influence the role of research in policy processes through time. Chapter 8 concludes that different boundary arrangements at multiple research-stakeholder interfaces can co-emerge and coexist, and that boundary arrangements can create mutual expectations and dependency between researchers and stakeholders. Furthermore, different ideas about division of roles and responsibilities relating to policy content (the nature of the policy issue at stake) and policy process (the way the policy process is or should be organised) can coexist at one research-stakeholder interface.

As the second case study clearly shows, perceptions about the division of tasks and responsibilities between researchers and stakeholders changed as the policy process unfolded. The direction in which a boundary arrangement at a particular research-stakeholder interface develops is influenced by the types of collaborations and relations between research and other stakeholders. Empowering different (competing) groups of stakeholders simultaneously was possible in the second case study. During the problem-oriented phases of this policy process, research constructively collaborated with and empowered different stakeholder groups (see e.g. Figures 8.3 and 8.4). Nonetheless, during more solution-oriented phases, when stakes became more visible and the impact of policy outcomes became more tangible, it seemed more difficult to empower a specific stakeholder group, and at the same time remain credible, legitimate and salient to other stakeholder groups in the policy process. This suggests that the extent to which research and researchers can remain credible, legitimate and salient for different groups in policy processes relates to the phases in the policy process, and the power play between stakeholders during different policy phases; thus linking back to findings from Section 9.2.2.

As illustrated in Chapter 8, boundary arrangements show patterns of path dependency. This implies that the potential range of boundary arrangements and their impact at a particular moment in time is influenced by previous boundary arrangements at the multiple research-stakeholder interfaces. Chapter 8 shows that boundary arrangements cannot be unlimitedly or strategically chosen, as their use and consequences for multiple stakeholder groups is stored in the 'memory' of stakeholders in the policy process.

Main findings on boundary arrangements between research and stakeholders:

- Analysing boundary arrangements at research-stakeholder interfaces provides a more dynamic image of the multi-stakeholder dynamics that influence the contribution of research to policy processes in competing claims contexts over time.
- Different boundary arrangements between research and multiple (groups of) stakeholders can co-emerge and coexist.
- Different boundary arrangements with regard to policy content and policy process at a specific research-stakeholder interface can simultaneously exist.
- The extent to which research can create space for particular stakeholders, and remain credible, legitimate and salient to other stakeholders, depends on the phase of the policy process.
- Changing boundary arrangements between research and a particular stakeholder group are likely to influence boundary arrangements at other research-stakeholder interfaces.
- Boundary arrangements at research-stakeholder interfaces show patterns of path dependency, meaning that boundary arrangements and their impact are stored in the 'memory' of stakeholders in the policy process.

9.3 Towards dynamic research configurations

Section 9.2 demonstrates that the role of research in policy processes in competing claims contexts is influenced by different interrelated factors such as phases in the policy process, stakeholder dynamics, interactions between different scales and levels, the types of collaborations between research and stakeholders in the policy process, and the roles that researchers are able to fulfil in policy processes in competing claims contexts. It demonstrates that both research and policy processes consist of many different 'layers' and that acknowledging these layers is a first, but essential, step towards enhancing the contribution of research to policy processes in competing claims contexts.

On the basis of this thesis, I conclude that a more nuanced and dynamic idea is needed about what determines the effective contribution of research to policy processes in competing claims contexts. This section aims to increase awareness and stimulate reflection about the role of research in policy processes in competing claims contexts, to underline that such roles are likely to change as policy processes unfold and to elucidate the consequences of fulfilling certain roles. The concept of 'dynamic research configurations' (Figure 9.1) is based on the idea that it is more sustainable to provide researchers with a dynamic tool to determine or understand research configurations than to suggest blueprint research configurations.

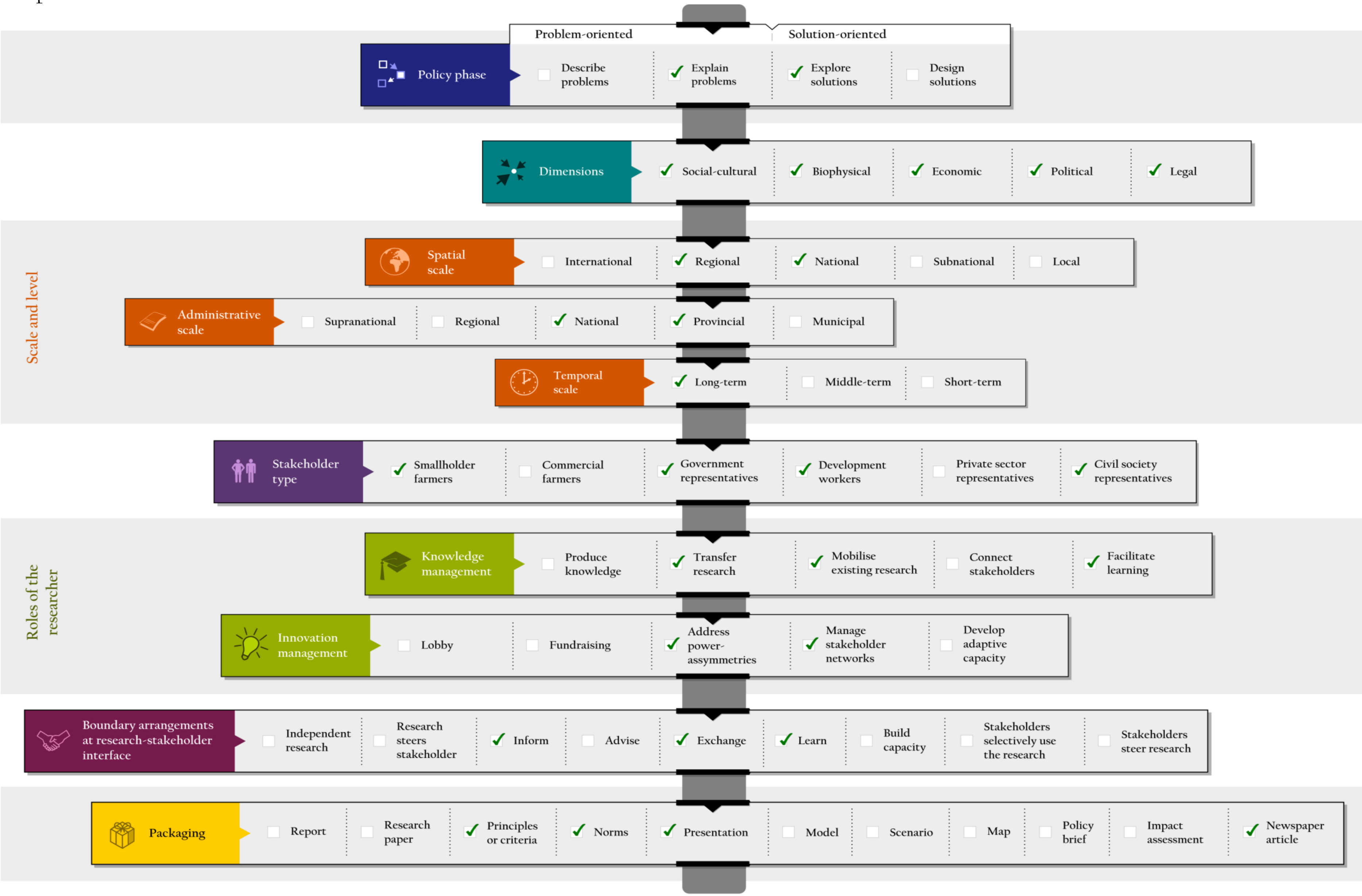


Fig. 9.1. Tool for dynamic research configurations in policy processes in competing claims contexts.

9.3.1 Explanation of the tool for dynamic research configurations

The objective of the tool for dynamic research configurations is principally to create awareness and trigger reflection when action-oriented research in competing claims contexts is being conducted. The tool consists of multiple layers (e.g. policy phase, dimensions, researcher role, etcetera) some of which are subdivided in sub-layers (e.g. spatial, administrative and temporal scales are sub-layers of scales and levels). Each layer consists of different categories or levels, for example groups of stakeholders, administrative levels or different types of boundary arrangements in policy processes. Some categories or levels are structured hierarchically (e.g. from international to local), whereas other categories or levels are non-hierarchical. Furthermore, the categories or levels contain 'tick boxes' that can be turned either 'on' or 'off'. The grey slide-rule running vertically down through the different layers indicates the focus or lens of the research at a particular moment in time. Each horizontal layer is movable to the right or to the left in relation to the position of the slide-rule; the tool is intended to support thinking about the research approach and can potentially provide the basis for selecting theories and methods for research.

How can researchers use the tool to guide dynamic research configurations? Although the examples provided are neither exhaustive nor exclusive, each layer poses a set of questions to the researcher, the group of researchers or the research project. Based on these questions, categories and levels within the different layers can be determined. The tool can be used preceding (*ex-ante*) and during (*ex-durante*) the research to reflect upon and potentially revise the action-oriented research approach. Below, each layer and its categories or levels are addressed and the questions are elaborated.

The first layer relates to the phase in the policy process. As indicated in this thesis, policy processes include phases of policy development and phases of policy implementation. Generally, policy development processes[65] consist of problem- and solution-oriented phases, each with their different dynamics. Problem-oriented phases are characterised by describing and explaining policy problems, whereas the solution-oriented phases focus on exploring and designing policy solutions. As concluded in Section 9.2.2, the role of research and how it is perceived by stakeholders is determined by the phase of the policy process. The tick boxes can be used to indicate to what phase or phases in the policy process the research seeks to contribute. Summarising, it is important to ask the following questions: In what phase is the policy process? What has happened in previous policy phases? To what phase in the policy process does research seek to contribute? How can the research process and the policy process be aligned to prevent temporal mismatches and optimise timing?

The second layer refers to the multiple dimensions of competing claims problems, which are often of a social-cultural, biophysical, economic, political and legal nature. Exploring and designing solutions for competing claims problems cannot be successful by addressing its dimensions separately, but requires an approach in which insights from different disciplines

[65] As this thesis focuses on policy development, policy implementation is not included in Figure 9.1.

are combined and integrated; therefore all tick boxes will usually be 'on.' This does not mean, however, that there cannot be phases in policy processes in which one dimension is more important than the others. Important questions include: What are the social-cultural, biophysical, economic, political and legal dimensions of the policy problem? What existing research is available on the different dimensions *vis-à-vis* the policy problem? How do the different dimensions relate? How can insights from different disciplines be combined? What dimensions require additional research? What dimensions can be covered/addressed by the researcher him/herself? What type of expertise is missing in the research team and how can this expertise be mobilised?

The third layer in the tool refers to interactions between different scales and levels. The idea is not so much that researchers have to choose or select scale and levels, but that the researcher is aware that interactions between multiple scales and levels influence the space within which policy solutions can be explored. The analysis of interactions between scales and levels can contribute to policy development that pays attention to multiscale and multilevel dynamics. For example, exploring solution space in policy processes at national level requires taking into account developments at the international level, as well as at subnational and local levels. Furthermore, the five categories of layer two (dimensions) have different meanings at different levels. For example, studying the economic impact of deforestation at provincial level would require a different type of research questions and research approach than studying the economic impact of deforestation at global level. Figure 9.1 includes examples of the spatial, administrative and temporal scales that should not – as already indicated – be interpreted as exhaustive or exclusive (see e.g. Chapter 6 and Cash et al., 2006 for other examples of scales and levels). The administrative scale and its levels require thinking about the administrative level at which the policy process is situated, and how research approaches can generate findings that are credible, legitimate and salient for policymakers at that level. The temporal scale requires thinking about how to avoid temporal mismatches that can emerge as a result of – for example – conducting a long-term research project to support *ad hoc* policymaking. Important questions include: What scales and levels are included and excluded in the research? How was the process of scale and level selection organised? What are the potential consequences of scale and level selection in terms of the inclusion and exclusion of stakeholders in the policy process? How do interactions across different scales and levels influence each other? What scale and level matches and mismatches can be identified and how can these be dealt with?

The fourth layer refers to the different types of stakeholders the research seeks to empower or collaborate with. This will partly be determined by the choices regarding scales and levels in the third layer (e.g. does the research target policymakers at provincial or at EU level?). However, targeting policymakers at EU level can imply working together with smallholder farmers to, for example, demonstrate the impact of newly develop EU legislation for the trade and export of biofuels. In action-oriented research approaches, the researcher often collaborates with different stakeholder groups, such as smallholder and commercial farmers, government officials, private sector or civil society representatives. Stakeholders can be either inside the policy arena as policymakers, or outside the policy arena. The roles of stakeholders can change over time, and stakeholder representatives at different policy levels can have different concerns with regard to the social-cultural, biophysical, economic, political and legal dimension of the policy problem. For example, the political interest of the provincial government official may be different from that of the government official working at the national level. Important questions include: What stakeholder groups have a stake in the policy process? What are the perceptions and needs of these different stakeholder groups? What are the power dynamics between different groups of stakeholders? How is research mobilised and used by different stakeholders? How can research collaborate with different stakeholders to create space for change?

The fifth layer relates to researchers' roles. Researchers may prefer to fulfil certain roles, or be expected to fulfil specific roles, as producers of knowledge, mobilisers of existing research or facilitators of multi-stakeholder learning processes. In this thesis, such researchers' roles are summarised as knowledge management roles. Knowledge management roles are essential in policy processes in competing claims contexts, but not always enough to address the enabling and constraining (institutional) factors that cause power asymmetries and conflicts (innovation management roles). Essentially, the combination of different knowledge and innovation management roles is a powerful tool to enhance the contribution of research to policy processes in competing claims contexts. Important questions include: What roles can the researcher(s) play? What roles are the researcher(s) willing to play? What roles are the researcher(s) expected to play by stakeholders in the policy? How do such expectations vary across different groups of stakeholders? What combinations of roles can enhance the contribution of research to the policy process? What roles can contribute to embedding the research in the policy process? What roles can build trust between research and stakeholders?

The sixth layer relates to boundary arrangements at research-stakeholder interfaces. As this thesis shows, ideas about the division of tasks and responsibilities and the mutual expectations and dependency of research and stakeholders are likely to change throughout policy processes. Examples of boundary arrangements are independent research, steering of stakeholders, inform, or empower and build capacity (more examples can be found in Chapter 8). Boundary arrangements that are based on higher mutual commitment (e.g. build capacity) subsume those that are based on lower mutual commitment (e.g. advise includes inform, exchange includes advise and inform, etcetera). Furthermore, research is likely to engage in multiple boundary arrangements with different groups of stakeholders, and different boundary arrangements relating to policy content and policy process can coexist. The extent to which different boundary arrangements can coexist is a complex interplay between the phase of the policy processes (problem- or solution-oriented) and the nature of boundary arrangements between research and the different stakeholders in the policy process. Important questions include: What are the ideas of researchers and stakeholders about the division of tasks and responsibilities in the policy processes? What boundary arrangement can coexist? How can research remain credible and legitimate towards different stakeholders in the policy process? How are stakeholders strategically using or steering the research? How do the boundary arrangements create path dependency in terms of future boundary arrangements? How do changing boundary arrangements at one research-stakeholder interface influence the boundary arrangements between research and other stakeholders in the process?

The seventh and final layer, packaging, is strongly influenced by the previous layers in the tool. There are different ways of packaging research, and different forms of packaging can be more or less useful for different stakeholder groups. More traditional forms are reports, articles and oral presentations. For scientific audiences, these ways of packaging research are often associated with doing credible and independent research. For other stakeholder audiences however, more applied and interactive forms of sharing the results of research can be more appropriate. This thesis has shown that the accessibility and usability of research in policy processes is highly influenced by the way research is packaged. Important questions include: Who are the stakeholders that the research seeks to reach? What type of packaging can enhance the accessibility and meaning of the research for this stakeholder group? Does this vary from other stakeholder groups? What types of packaging have the potential to mediate across or connect (different) stakeholder groups?

The user of the tool should keep in mind that, within each of the layers, different categories or levels can be 'on' (see tick boxes in Figure 9.1). This implies that the research collaborates with or focuses on different groups of stakeholders, or seeks to fulfil different types of roles. The vertical slide-rule indicates a focus, not that all other categories and levels are excluded. Moreover, changes in one of the layers often imply changes at other layers. For example, if the focus of research changes from addressing food security at regional level (e.g. EU or SADC level) to local (community) level, different research questions regarding social-cultural, biophysical, economic, political and legal dimensions of the problem need to posed, different stakeholders need to be included, and different types of roles may be expected from the researcher(s). In sum, the changing policy context requires a different research configuration.

9.3.2 Challenges relating to the tool for dynamic research configurations

As is often the case when a dynamic tool is presented on paper, there are a number challenges regarding the tool that need to be discussed. Firstly, the tool suggests that different configurations can be freely and unlimitedly chosen. In line with earlier findings in this thesis, research configurations are also stored in the 'memory' of stakeholders in the policy process and show patterns of path dependency (Chapter 8). This implies that the credibility, legitimacy and salience of research configurations as perceived by stakeholders at a particular point in time are influenced by earlier research configurations. Secondly, there is a challenge with regard to making choices, and who determines the focus of research. Making choices means having a degree of power. This can be power in relation to what research questions are formulated, what scales and levels are most appropriate to focus on, and consequently, what stakeholders are perceived as relevant, appropriate and legitimate in terms of defending their interests in the policy arena. Depending on the collaboration with different stakeholder groups, stakeholders can be included in making such choices together with researchers. This is not always feasible, for example when stakeholders are not organised. Thirdly, at what time interval can the tool be used? One may argue that even within one meeting researchers can play different roles, and that boundary arrangements between research and stakeholders are never fixed but constantly negotiated in discourse. There is no rule or norm on how often the tool should or can be used. As stated, the main objective is to contribute to raising awareness on key drivers that influence the role of research in competing claims contexts, and how they are related and can change throughout research and policy processes.

9.3.3 To what can the tool for dynamic research configurations contribute?

Although researchers can think about the impact of certain configurations, their real meaning for different groups of stakeholders cannot be predicted in advance (Duineveld et al., 2007). Researchers can only learn about their impact consequent to active monitoring and evaluation, which includes reflexive thinking about the research configuration. This thesis shows that embedded and process-oriented research approaches can provide the basis for better understanding the needs of different stakeholders in the policy processes, and how research can respond to these needs. In so doing, research questions can be fine-tuned to the changing policy context, thus allowing researchers to have insight into stakeholder relations, political interests and power dynamics, and how the policy process unfolds over time. These insights can enhance the possibility that specific research configurations contribute to creating space for change in policy processes in competing claims contexts, or explore and design policy solutions that are acceptable for different stakeholder groups.

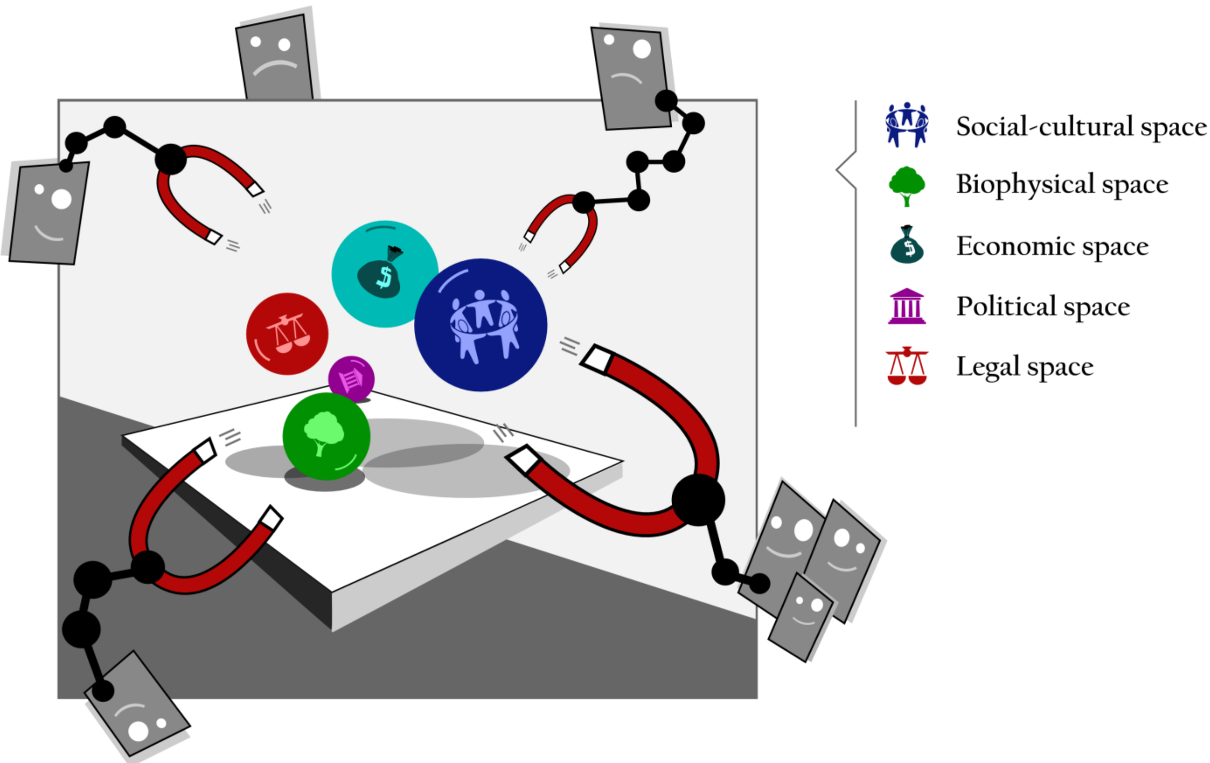


Fig. 9.2. Space for change in policy processes in competing claims contexts.

Figure 9.2 illustrates the idea that research can strategically contribute to creating space for change in policy processes. In the figure, the five circles represent social-cultural, biophysical, economic, political and legal space at a certain administrative level (e.g. the national policy level). In line with Chapters 3 and 5 of the thesis, space for change is conceptualised as the momentum or critical point at which the interaction and configuration between social-cultural, biophysical, economic, political and legal spaces provide space for innovation, breakthroughs or decision making in policy processes. It also shows how different stakeholders or stakeholder groups try to influence the configuration of the space. Some stakeholders try to claim or open up space, whereas other stakeholders may benefit from closing down space. Not all stakeholders have the power to influence the policy process, as they can be excluded from or denied access to the policy arena (visualised in Figure 9.2 as the 'unhappy' stakeholder with no magnet and outside the policy arena). Stakeholders can engage in coalitions to strengthen their position or to weaken the position of others. This is visualised in Figure 9.2 as the three stakeholders holding the largest magnet, implying that they have the ability to steer developments in the policy arena. Furthermore, even stakeholders that have access to the policy arena may be unable to create space to pursue their objectives or defend their interests and can eventually end up being disappointed (unhappy stakeholder with magnet at top of the figure and inside the policy arena in Figure 9.2). This illustrates how in competing claims contexts 'win-win' solutions for some groups of stakeholders "may at the same time still be [a] 'win-lose' scenario when looked at from other stakeholder positions" (Giller et al., 2008 p. 4 emphasis changed).

This thesis shows that research and researchers can also influence space in policy processes, sometimes directly as expert or policy advisor, or more indirectly by empowering one or multiple groups of stakeholders in the policy process. As concluded in this thesis, the ability of research to remain credible, legitimate and salient to different stakeholder groups in the policy process is likely to change over time. The tool for dynamic research configurations can create awareness and stimulate strategic and reflexive thinking about what research configuration could create space for change in policy processes and for whom.

9.4 Further reflections on research and policy

This section provides further reflections on the thesis by positioning some of the conclusions in broader debates on research and policy. One of the objectives of this section is to contribute to discussions about how the collaboration between researchers, policymakers and other societal stakeholders in policy processes in competing claims contexts can be enhanced.

9.4.1 'The best of both worlds'

A first debate to which I seek to contribute is whether research should be seen as an authorative and objective process conducted by a disinterested researcher and resulting in "unquestionable facts" (Funtowicz and Ravetz, 1993 p. 741), or whether research should be seen as the outcome of social processes and institutional guided actions that makes its outcomes more value driven and subjective (Drinkwater, 1994; Latour, 1999). On the basis of this thesis, it can be concluded that a more nuanced idea is needed. As described in this thesis, one of the objectives of action-oriented and embedded research is to understand the object of study from the inside; this often includes the "active involvement of the researcher" (Trondsen and Sandaunet, 2009 p. 18). In such situations, it is inevitable that the researcher affects the object of study (Kibwika, 2006). Advocates of action-oriented research do not consider this as a 'threat' to the quality of the research, but rather as an opportunity to enhance the relevance and contribution of research to societal problem solving (Trondsen and Sandaunet, 2009). From the findings and experiences in this thesis, I would even go a step further by claiming that, for research in competing claims contexts, the embedded position of the researcher is essential for identifying relevant research questions, selecting theories or research approaches, establishing relationships with stakeholders, accessing or connecting stakeholder networks, choosing scales and levels of analysis, discovering the type of boundary arrangements that emerge at the multiple research-stakeholder interfaces, and identifying what roles a researcher can, wants to, or is expected to fulfil in the policy process.

These kinds of discussions are rooted in debates on different "waves of science studies" (Collins and Evans, 2007 p. 143). Wave one positions research as "unbiased, disinterested, a free public good and subject to organised critical review," whereas wave two is rooted in the idea that research "cannot avoid human influence – [which] came to be called social constructivism [...]" (Collins, 2009 p. 30). Within both waves, there are extreme schools of thought. Advocates of wave one research argue that science and science alone can produce truth about nature. Wave two advocates are extremely sceptical about research, claiming that "science is just a form of faith or politics" (Collins, 2009 p. 30). This thesis shows that this debate has found its way into public (policy) debate. As Jasanoff (1996 p. 264) claims: "[P]oliticians, media personalities, and some social activists have taken the social constructivist account of science – or their interpretation of it – as license for discounting the authority of unpalatable scientific findings, for questioning wholesale the motives of researchers, and for selectively retreating from policies based on less than scientific certainty." This results in questions such as that posed by David (2005 p. 48): "Does increased reflexivity over the objectivity of scientific knowledge claims undermine science or improve it?"

Rather than taking sides or preferring one perspective over the other, I believe that both waves are relevant when conducting or studying research in policy processes in competing claims contexts. Chapter 8 discussed how boundaries arrangements between research and stakeholders are likely to change as policy processes unfold. During some phases in the policy process stakeholders may express the need for wave one types of research, whereas during other phases in policy processes wave two approaches may be found more desirable. This also implies that the boundary between researchers and stakeholders in the policy process may be firm during some phases, and more blurred during other phases.

Researchers that seek to enhance their contribution to policy processes in competing claims contexts could benefit from taking 'the best of both worlds.' On the one hand, wave one advocates should admit that: "All scientific decisions are intrinsically political, and that this is another reason why they cannot form an unproblematic basis for political decision making even when there is scientific consensus" (Collins and Evans, 2007 p. 145). If researchers continue to position themselves as 'untouchables' who "possess the absolute truth, this will inevitably lead to disappointments and irreparable distrust within politics and society" (Miedema, 2011 p. 21, translated from Dutch by the author). On the other hand, wave two advocates should: "[W]ork out what is right about science, not just what is wrong" (Collins, 2009 p. 30). The idea of "serviceable truth" introduced by Jasanoff (1990 p. 250) is still relevant, as it concerns conducting research that is scientifically acceptable and has the potential to support policy processes.

9.4.2 Interdisciplinary research

Working on questions of sustainability in policy processes in competing claims contexts demonstrated that societal stakeholders face real problems that cannot be reduced along disciplinary lines. Furthermore, when stakes and uncertainties are high, policymakers tend to avoid risks and can even be "legally bound not to experiment" (Hoppe, 2005 p. 203). Lastly, as has been discussed thoroughly in this thesis, different perceptions of time characterise the world of research and that of policy; research needs time to generate credible findings, whereas in policy there exists a need for short-term salient research (Haas, 2004). Holistic and interdisciplinary research can contribute to closing the gap between research and policy. Interdisciplinarity can be interpreted as practices that consciously transcend the disciplinary mode of knowledge production, in which researchers from different disciplines work together (Weingart, 2000). Traditionally, and in line with the generally embraced concept of sustainable development, these disciplines are often categorised as relating to the biophysical or environmental nature of the problem, the social and cultural practices in which the problem is embedded and the economic impact of the problem and different solutions scenarios. Still, many policymakers complain that research-based solutions are often too theoretical and are difficult to implement within the existing legislation and procedures. This thesis shows that enhancing the contribution of research to solving societal problems also requires thinking about the legal and political consequences of research findings, and ensuring that research is sensitive to interactions between different scales and levels. Furthermore, and in line with Smith and colleagues (2010 p. 446), I believe that "incorporating the analysis of policy processes" should be an intrinsic part of research that seeks to enhance its contribution to policy development, and that political and legal drivers should not merely be seen as "an external force or factor" that influences the role and impact of research in policy.

Personally, I highly valued working in an interdisciplinary research programme as it provided the opportunity to collaborate with colleagues from different disciplines. The interdisciplinary research programme provided access to a wide network of experts, within and outside the university. For Chapters 4, 5 and 6 in particular, I worked together with researchers from different disciplines and with policymakers from the Mozambican government. Although many of the disciplines and theories (e.g. investment theory, farming systems theories, policy science) could have been elaborated in much more detail, it was particularly the combination of insights from the different disciplines, and the timing, packaging and mobilisation of the findings by a researcher who was embedded in the policy process, that enhanced the overall credibility, legitimacy and salience of the findings.

9.4.3 How research is organised

But why is it so difficult to put interdisciplinary research into practice? According to Fuller (2000 p. 142): "The main source of the difficulty is that research proposals are ordinarily evaluated by peer review, which means that scientists are encouraged to write their proposals with an eye towards impressing experts in their own field, each encased in its own standards and jargon." This implies that the challenge is more institutional, and rooted in the way the academic system is organised. Furthermore, funding requirements often make research 'projects' rather than 'processes of inquiry.' Activities, outputs and deliverables (and even expected conclusions) need to be described in detail beforehand, leaving very little space for seeking the unexpected, or deviating from the prescribed research path, even if interesting discoveries or changing contexts may require it. As Nowotny and colleagues (2003 p. 184) put it: "It is said to be safer to deliver predictable [...] results on time than ground-breaking research, late." This thesis shows that in the context of competing claims, characterised by uncertainty and unpredictability, process-oriented and action-oriented research approaches can be more valuable (see Chapter 7). Such research approaches can enable the researcher to strategically embed him/herself in policy processes or other types of societal negotiations, identify relevant research questions with stakeholders and understand how research is used, abused or contested, rather than transferring research findings when the project is finished.

Closely related to the institutional challenges is the 'publish or perish' culture that is increasingly dominating the work of researchers. In a recent newspaper article, it was argued that: "Publishing in scientific journals has become a goal in itself, not a medium to spread [scientific] knowledge" anymore (De Volkskrant, 9 September 2011 p. 4-5, translated from Dutch by the author). Within many universities and research institutes, the performance of employees is to a large extent determined by how many scientific publications they publish in high quality journals. To illustrate, when university colleagues asked about the progress of my research, I would refer to the number of research papers submitted and published, rather than mention the work conducted in Mozambique to support the policy debate on biofuel sustainability. According to Holmes and Clark (2008 p. 708): "A researcher's peer group may look down on researchers who communicate their work to lay audiences [...], and time spent on interpretation work may well be at the expense of the publication record that a researcher requires to progress his or her career." Both directly and indirectly, the publish or perish culture puts pressure on researchers to generate results and to regurgitate research findings so that they can be published in different types of journals, rather than spending that time on addressing 'new' research questions that are societally relevant.

It is not my intention to disapprove the system of publishing in peer-reviewed scientific journals. However, measuring and valuing the societal impact of research is just as important and should receive more attention. Smith (2001 p. 258) proposes several indicators that could be useful for assessing the societal impact of research, such as the contribution of research to: "guidelines and protocols," "policy documents," "teaching materials," "organising workshops," being a "member of a committee" or "advisory committee." However, there are also important societal impacts that are perhaps less tangible or measurable, such as the ability of researchers to connect different stakeholder networks, to lobby for more democratic policy processes, or to empower marginalised or less-powerful stakeholders. However, as long as the societal impact is undervalued, such activities will have a low(er) priority for the majority of researchers working within publication-driven research institutes.

9.4.4 Roles of researchers

As Chapter 7 of this thesis demonstrates, researchers can fulfil a variety of knowledge and innovation management roles in policy processes. That researchers themselves perform innovation management roles differs somewhat from the innovation literature that describes how such roles are often fulfilled by "specialised organisations" (Klerkx et al., 2009 p. 430). This idea – specialised organisations fulfilling innovation management roles – is probably more applicable to the Dutch context than to the Mozambican context. However, this thesis argues that in competing claims contexts researchers can be in a better position to fulfil both knowledge and innovation management roles. Embedded researchers have insights into highly sensitive multi-stakeholder dynamics that are crucial for better understanding how, when and in what form research can contribute effectively to enhancing the quality of policy processes. On the other hand, specialised organisations probably have less trouble claiming an independent status when fulfilling innovation management roles (cf. Hocdé et al., 2009).

It is furthermore important to state that researchers do not have to fulfil or master the multiplicity of roles as knowledge and innovation managers discussed in this thesis. On the contrary, I would argue that researchers should not play roles with which they are not comfortable. In this thesis, the discussion about researcher's roles in policy processes is used mainly to create awareness about the importance of fulfilling certain roles and the strength of combining different roles in policy processes. It is not that researchers should always fulfil these roles, as other stakeholders or external facilitators can also do this.

The role of research and researchers is neither neutral nor apolitical. Researchers often have preconceived notions about why and how research should be conducted, have their own agendas, and may seek to promote certain ideas or preferences on how policy processes should be organised, or what solutions can be labelled as 'sustainable.' Furthermore, when discussing concepts such as 'credibility, legitimacy and salience,' 'space for change' or 'enhance the contribution of research,' one should immediately ask the questions 'for whom?' and 'for whom not?' As touched upon in this thesis, this sometimes creates dilemmas. For example, the process of scale and level inclusion and exclusion in scale dynamics analysis highly influences research questions and research outcomes, and consequently the type of awareness that research creates, and what types of stakeholders are perceived relevant, appropriate and legitimate to participate in the policy debate. I hope that the tool for dynamic research configurations can trigger awareness and reflection about these questions.

9.4.5 Ways of organising policy processes

As this thesis shows, the role of research in policy processes in competing claims contexts can be highly politicised. It may be initiated or funded to support policy, but it can also become politically laden as the research or policy process unfolds. The stakes in competing claims contexts are often high, and when research questions the basic assumptions behind a €2 billion spatial planning project (Room for the River), it is likely to become contested as shown in this thesis. Apparently, policymaking is all about trade-offs between (1) using the (best) available research, (2) capturing space or a 'policy window'[66] and (3) leaving (enough) space to integrate new research findings during a later stage in the policy process. The relation between the first two factors is mutually reinforcing in that the need for short-term salient research often results in mobilising existing research to shape policy, and developing criteria on which policy alternatives are to be evaluated. Furthermore, stakeholders strategically and selectively use ideas about the 'best available research' to capture a policy window that serves their interests, or claim that 'more research is needed' to postpone decision making or prevent stakeholders with competing interests from capturing a policy window. The idea of using the best available research to shape policy, and at the same time leaving space for the integration of new research findings during later phases in the policy process, seems paradoxical. If during a later phase in the policy process more accurate or legitimate research findings become available, these could be found unreliable if evaluated using the initial criteria based on best available research, whereas the 'new' research findings would actually suggest revising such criteria.

Especially in competing claims contexts, where policy and research are often evolving simultaneously, policy and policymakers (just as researchers) should be more susceptible, open and responsive to changing policy contexts and changing perceptions and stakes of societal stakeholders. According to Smith et al. (2010 p. 445): "Any policy measure, no matter how well it is understood, creates diverse responses that are difficult to know precisely beforehand." The solution is therefore not to narrowly focus on: "[I]ncreasing the supply of scientific information, funding more research that can lack any correlation to the [changing] information needs of [stakeholders] […]" (McNie, 2007 p. 17). Such approaches can unintentionally enhance uncertainty and conflict, rather than reducing it (Sarewitz, 2004).

The findings from this thesis also provide an incentive to further explore the relation between the role of research in policy processes and how policy processes are organised in different countries. In the Netherlands, policy processes are highly bureaucratised and often follow a step-wise, incremental approach in which the final decision is an accumulation of smaller formal decisions. In an attempt to enhance the transparency of, and accountability in policy processes, the rights and responsibilities of stakeholders are formalised in detailed procedures. In Mozambique, policy processes are less bureaucratised and remain more 'open.' This does not mean that smaller decisions are not taken throughout the process, but they are usually less formalised and do not have legal status. Both ways of organising policy processes

[66] Kingdon (1984) refers to policy windows as situations in which policy problems, solutions and stakeholders provide a 'match,' somewhat similar to how I define space for change in policy processes.

present advantages and disadvantages in relation to the role of research in policy processes. An advantage of the less bureaucratised policy process is that it leaves space to respond to changing policy contexts and creates a degree of flexibility to incorporate 'new' research or insights during later phases in the policy process. On the other hand, such policy processes are often vague and less transparent. However, highly bureaucratised policy processes are not automatically more transparent, nor do they always enhance the possibility for civilians to influence the course and outcome of policy processes. The 'jungle' of legal procedures and rules often increase rather than decrease the complexity of policy processes, and informal negotiations and politics still play an important role.

9.5 Final remarks

This thesis contributes to a better understanding of the dynamics that influence the role of research in policy processes in competing claims contexts. In these contexts, research and policymaking are two activities that are often carried out simultaneously. In such situations, action-oriented and process-oriented research approaches can provide researchers with the time and flexibility to become embedded in the policy process, build trust with different stakeholders, and engage with different stakeholder groups in describing and explaining problems, and exploring and designing policy solutions. In-depth understanding of policy processes is crucial for enhancing the contribution of research. It provides better insights into how, when and in what form or role research and researchers can contribute to creating space for stakeholders. However, this study also shows that research is likely to become contested in policy processes in competing claims contexts and that remaining credible, legitimate and relevant to different groups of stakeholders throughout policy processes can be problematic.

To create awareness and stimulate reflexive thinking among researchers, this thesis introduces a tool for dynamic research configurations. The tool shows the key drivers or layers that influence the role of research in policy processes in competing claims contexts, such as phases in the policy process, stakeholder dynamics, interactions between different scales and levels, packaging of research, the types of collaborations between research and stakeholders in the policy process, and the roles that researchers can fulfil in policy processes in competing claims contexts. The tool can contribute to more flexible and action-oriented research approaches that can enable researchers to adapt research approaches to align with the changing policy contexts and changing stakeholder configurations in the policy process. The thesis also concludes that similar flexible and adaptive approaches are needed in policy processes. Furthermore, it concludes that the academic system should attribute more value to the societal impact of research in order to further stimulate action-oriented research.

So... Who cares about research?!

The title of this thesis is of course a little provocative and can be interpreted in different ways. A more sceptical interpretation of 'who cares about research?' formed the starting point for this study, grounded in considerable doubt and probably a degree of disappointment from researchers about the extent to which research is used by stakeholders in policy processes. I believe this thesis shows that research is being used in policy processes. Different groups of stakeholders strategically and selectively mobilise and use research to defend their interests and influence the course and outcome of policy processes. This thesis also demonstrates that the fact that research is used selectively and strategically by stakeholders should no longer be a surprise for researchers, but should rather be seen as one of the factors that influence the role and impact of research in policy processes.

Subsequently, this thesis provides several points of departure for researchers to cope with dynamics in policy processes, such as thinking about phases in policy processes, the multiple dimensions and levels of competing claims problems, the various roles that researchers can play, and different modes of collaborating with different groups of stakeholders. These can provide the basis for more dynamic and action-oriented research configurations by continuously aligning the research questions and research approach with changing policy context and changing stakeholder demands and needs. This way of 'caring about research' can enhance the possibility that research effectively contributes to more integrative multi-stakeholder negotiations in policy processes and creates an enabling environment in which sustainable policy solutions can be developed and implemented.

REFERENCES

Aarts, N. and C. van Woerkum (1999). Communication and nature policies: the need for an integral approach to policy design. In: C. Leeuwis. *Integral desing: innovation in agriculture and resource management*. Mansholt Institute, Wageningen University and Research Centre, Wageningen. pp: 33-47.

Aarts, N. and C. Leeuwis (2010). Participation and power: reflections on the role of government in land use planning and rural development. The Journal of Agricultural Education and Extension 16(2): 131-145.

Adam, M., M. Carrier and T. Wilholt (2006). How to serve the customer and still be truthful: methodological characteristics of applied research. Science and Public Policy 33(6): 435-444.

Adger, W.N., K. Brown and E.L. Tompkins (2005). The political economy of cross-scale networks in resource co-management. Ecology and Society 10(2): 14. [online] URL: http://www.ecologyandsociety.org/vol10/iss12/art19/.

African Development Bank (2008). Mozambique private sector country profile. African Development Bank.

AGREF (2011, 17 January 2011). AGREF founding assembly accomplished. Retrieved 14 March 2011, from [online] URL: http://www.agref.info/index.php?id=5.

Agyare, W.A., J.M. Kombiok, N. Karbo and A. Larbi (2002). Management of pigeon pea in short fallows for crop-livestock production systems in the Guinea savanna zone of northern Ghana. Agroforestry Systems 54(2002): 197-202.

Albino, R. (2010). Strengthening economic evaluation and data for large scale investments in Mozambique. Annual Conference on Land Administration and Policy, World Bank, Washington D.C.

Allafrica.com (2007, 10 October 2007). Mozambique: contract signed for ethanol production. Retrieved 20 August 2009, from [online] URL: http://allafrica.com/stories/200710100997.html.

Allafrica.com (2009a, 19 August 2009). Mozambique: government approves new projects for biofuels. Retrieved 20 August 2009, from [online] URL: http://allafrica.com/stories/200908190980.html.

Allafrica.com (2009b, 10 April 2009). Mozambique: investments in ethanol production. Retrieved 18 April 2009, from [online] URL: http://allafrica.com/stories/200904090862.html.

Allen, C.R. and C.S. Holling (2010). Novelty, adaptive capacity, and resilience. Ecology and Society 15(3): 15. [online] URL: http://www.ecologyandsociety.org/vol15/iss13/art24/.

Alvesson, M. and D. Kärreman (2001). Odd couple: making sense of the curious concept of knowledge management. Journal of Management Studies 38(7): 995-1018.

Amalia, M. and Y. Nugroho (2011). An innovation perspective of knowledge management in a multinational subsidiary. Journal of Knowledge Management 15(1): 71-87.

Arndt, C., H.T. Jensen and F. Tarp (2000). Stabilization and structural adjustment in Mozambique: an appraisal. Journal of International Development 12(2000): 299-323.

Arndt, C., R. Benfica, N. Maximiano, A.M.D. Nucifora and J.T. Thurlow (2008a). Higher fuel and food prices: economic impacts and responses for Mozambique. IFPRI.

Arndt, C., R. Benfica, R. Tarp, J. Thurlow and R. Uaiene (2008b). Biofuels, poverty and growth: a computable general equilibrium analysis of Mozambique. IFPRI.

Arthur, M., de Fatima S. R., S. Zahran and G. Bucini (2010). On the adoption of electricity as a domestic source by Mozambican households. Energy Policy 38(11): 7235-7249.

Atwell, R.C., L.A. Schulte and L.M. Westphal (2011). Tweak, adapt, or transform: policy scenarios in response to emerging bioenergy markets in U.S. corn belt. Ecology and Society 16(1): 10. [online] URL: http://www.ecologyandsociety.org/vol16/iss11/art10/.

Awasthi, R. (2005). Food quality and safety development programme for Mozambique: improvement of food quality and safety standards with public institutions. Powerpoint Presentation UNIDO.

Batidzirai, B., A. Faaij and E. Smeets (2006). Biomass and bioenergy supply from Mozambique. Energy for Sustainable Development X(1): 54-81.

Bauen, A., J. Howes, A. Chase, R. Tipper, A. Inkinen, J. Lovell and J. Woods (2005). Feasibility study on certification or a Renewable Transport Fuel Obligation (RTFO). E4tech, ECCM and Imperial College London.

Beck, U. (1992). Risk society: towards a new modernity. SAGE, London.

BioEnergy Africa Ltd. (2009a). Proposed adoption of investing policy and change of name. BioEnergy Africa Limited.

BioEnergy Africa Ltd. (2009b). Final results. BioEnergy Africa Limited.

Boaz, A., S. Fitzpatrick and B. Shaw (2009). Assessing the impact of research on policy: a literature review. Science and Public Policy 36(4): 255-270.

Bos, S., W. Leonardo, A. Lerner and M. Schut (2010). Assessing the potential of bioenergy production in smallholder farming systems: the case of Nhambita community. GTZ-ProBEC, Maputo, Mozambique and Wageningen University and Research Centre, Wageningen, the Netherlands, Maputo.

Brabants Dagblad (7 December 2002). Noordwaard afstaan aan water: prijsgeven landbouwgebied in Biesbosch houdt groene rivier Altena mogelijk buiten deur [Give Noordwaard to the water: sacrificing agricultural land in Biesbosch can prevent green river Altena] Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (7 November 2003). Gaten in Bandijk geven water de ruimte [Holes in Bandijk provide room for water]. Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (17 December 2002). 'We bedenken de waterplannen niet voor onze lol' - Bureau Benedenrivieren zoekt in Land van Heusden en Altena naar maatregelen voor ruimte voor de rivier [We are not proposing the measures for fun - Bureau Lower Rivier Region is exploring Room for the River measures in Land of Heusden and Altena]. Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (17 June 2005). 'Koploperschap gaat de kant op van chantage' [Forerunner status starts to look like blackmailing]. Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (20 April 2006). 'Geen nieuwe inzichten over prijsgeven van Noordwaard' [No new insights on sacrificing Noordwaard] Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (20 July 2005). 'Beloften Noordwaard nu waarmaken' [Now fulfil promises Noordwaard]. Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (26 March 2003). Waterschap wijst opofferen Noordwaard af - Alm en Biesbosch neemt standpunt in over maatregelen 'Ruimte voor de Rivier' [Waterboard rejects depoldering Noordwaard - Alm and Biesbosch take a stand on measures Room for the River]. Brabants Dagblad [Brabant Newspaper].

Brabants Dagblad (27 January 2005). 'TU-plan Noordwaard maakt geen kans' [Plan Technical University Delft does not stand a chance]. Brabants Dagblad [Brabant Newspaper].

BSI (2009). Version 2 of the BSI standard. Retrieved 2 December 2009, from [online] URL: http://www.bettersugarcane.com.

Buizer, M., B. Arts and K. Kok (2011). Governance, scale, and the environment: the importance of recognizing knowledge claims in transdisciplinary arenas. Ecology and Society 16(1): 21. [online] URL: http://www.ecologyandsociety.org/vol16/iss21/art21/.

Bunce, M., K. Brown and S. Rosendo (2010). Policy misfits, climate change and cross-scale vulnerability in coastal Africa: how development projects undermine resilience. Environmental Science & Policy 13(6): 485-497.

Bureau Benedenrivieren (BLRR) (2004). Benedenrivieren in samenhang: stand van zaken regionale voorkeuren Ruimte voor de Rivier [Lower river region in harmony: overview of regional preferences Room for the River]. Bureau Lower River Region, Ministry of Transport, Public Works and Water Management, Rotterdam.

Burton, P. (2006). Modernising the policy process: making policy research more significant? Policy Studies 27(3): 173-195.

BusinessReport (2009, 6 August 2009). Tongaat Hulett to turn sugar cane into renewable energy. Retrieved 7 August 2009, from [online] URL: http://www.iol.co.za/business.

Campbell, B., P. Frost and N. Byron (1996). Miombo woodlands and their use: overview and key issues. In: B. Campbell. *The Miombo in transition: woodlands and welfare in Africa.* Center for International Forestry Research (CIFOR), Bogor, Indonesia. pp: 1-10.

Carlile, P.R. (2002). A pragmatic view of knowledge and boundaries: boundary objects in new product development. Organization Science 13(4): 442-455.

Carlsson, B., S. Jacobsson, M. Holmén and A. Rickne (2002). Innovation systems: analytical and methodological issues. Research Policy 31(2): 233-245.

Cash, D.W. and S.C. Moser (2000). Linking global and local scales: designing dynamic assessment and management processes. Global Environmental Change 10(2): 109-120.

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Guston, J. Jäger and R.B. Mitchell (2003). Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences of the United States of America 100(14): 8086-8091.

Cash, D.W., W.N. Adger, F. Berkes, P. Garden, L. Lebel, P. Olsson, L. Pritchard and O. Young (2006). Scale and cross-scale dynamics: governance and information in a multilevel world. Ecology and Society 11(2): 8. [online] URL: http://www.ecologyandsociety.org/vol11/iss12/art18/.

Castanheira Bilale, F.J. (2007). Educational performance in Mozambique: an economic perspective. Department of economics. University of Stellenbosch.

CEPAGRI (2009). Balanço do plano económico e social de 2008 [Economic and social balance 2008]. CEPAGRI, Ministry of Agriculture, Maputo.

Chiseri-Strater, E. and B. Stone-Sunstein (1997). Fieldworking: reading and writing research. Blair Press: Upper Saddle River, New York.

Cloke, P.J. and C.C. Park (1985). Rural resource management: a geographical perspective. Croom Helm Ltd., Beckenham and Sydney.

Collier, J. (1945). United States indian administration as a laboratory of ethnic relations. Social Research 12(3): 265-303.

Collins, H. and R. Evans (2007). Rethinking expertise. The University of Chicago Press, Chicago.

Collins, H. (2009). We cannot live by scepticism alone. Nature 458(7234): 30-30.

Commission of the European Communities (2006, 8 February 2006). An EU strategy for biofuels. Retrieved 29 January 2009, from [online] URL: http://ec.europa.eu/agriculture/bioenergy/index_en.htm.

Cortner, H.J. (2000). Making science relevant to environmental policy. Environmental Science & Policy 3(1): 21-30.

Coughlin, P.E. (2006). Agricultural intensification in Mozambique: infrastructure, policy and institutional framework. EconPolicy Research Group, Lda.

Council of the European Union (2008). Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (17086/08).

CPI (2009). Invest in Mozambique: US trade and investment conference. Retrieved 4 February 2010, from [online] URL: http://www.tipmoz.com/library/resources/documents/USInvestorConference/ByCPI.pdf. Additional information can be found on [online] URL: http://www.icex.es/icex/cma/contentTypes/common/records/viewDocument/0,,,00.bin?doc=4088732.

Cumming, G.S., D.H.M. Cumming and C.L. Redman (2006). Scale mismatches in social-ecological systems: causes, consequences, and solutions. Ecology and Society 11(1): 14. [online] URL: http://www.ecologyandsociety.org/vol11/iss11/art14/.

Cutts, B.B., D.D. White and A.P. Kinzig (2011). Participatory geographic information systems for the co-production of science and policy in an emerging boundary organization. Environmental Science & Policy 14(2011): 977-985.

d'Angremond, K. (2001). Pompen of verzuipen [Pump or drown]. De Academische Boekengids 29. Retrieved 26 June 2010, from [online] URL: http://www.academischeboekengids.nl/abg/do.php?a=show_visitor_artikel&id=105.

David, M. (2005). Science in society. Palgrave Macmillan, Houndmills, Basingstoke, Hampshire.

Davidson, W.H. (1980). The location of foreign direct investment activity: country characteristics and experience effects. Journal of International Business Studies 11(2): 9-22.

De Boer, E. (2003). Het noodoverloopgebied: airbag of luchtzak? Een kritiek op het rapport van de Commissie Luteijn [The emergency flooding area: airbag or bag of air? A critic to the report of the Commission Luteijn]. Commissioned by the municipalities

Angerlo, Beuningen, Druten, Duiven, Kleve (D), Kranenburg (D), Millingen, Ubbergen, West Maas and Waal & Wijchen, Delft.

de Jongh, J., Ed. (2010). The jatropha handbook, from cultivation to application. FACT Foundation, Eindhoven.

De Matteis, A., L. De Oliveira, P. Martell and J.S. Correia (2006). Baseline survey of food security and nutrition in Mozambique. Technical Secretariat for Food Security and Nutrition: Vulnerability Analysis Group, Maputo.

de Vaus, D.A. (2001). Research design in social research. SAGE, Los Angeles, London, New Delhi, Singapore and Washington DC.

De Volkskrant (9 September 2011). De druk is enorm: publiceer of crepeer [The pressure is enourmous: publish or perish]. De Volkskrant.

Dehue, B., C. Hamelinck, S. de Lint, R. Archer, E. Garcia and E. van den Heuvel (2008). Sustainability reporting within the RTFO: framework report. Ecofys BV, Utrecht, the Netherlands.

Dewulf, A., M. Mancero, D. Sucozhañay and G. Cárdenas (2006). Hoe actoren complexe situaties kaderen en herkaderen: een gevalstudie over het beheer van het Paute-rivierbekken [How actors frame and reframe complex situations: a case study of the management of the Paute river catchment]. In: J. Hovelynck, S. De Weerdt and A. Dewulf. *Relationeel organiseren. Samen leren en werken in en tussen organisaties [Rational organizing. Learning and working together in and between organizations]*. Liber amicorum voor Prof. dr. René Bouwen. Lannoo Campus., Leuven, Belgium.

Di Lucia, L. (2010). External governance and the EU policy for sustainable biofuels, the case of Mozambique. Energy Policy 38(11): 7395-7403.

Diao, X., P. Hazall, D. Resnick and J. Thurlow (2007). The role of agriculture in pro-poor growth in sub-Saharan Africa. IFPRI Washington D.C.

Diaz-Chavez, R. and C. Jamieson (2008). South African case study for RFA review of indirect effects of biofuels. Renewable Fuels Agency.

Dilling, L. (2007). Towards science in support of decision making: characterizing the supply of carbon cycle science. Environmental Science & Policy 10(1): 48-61.

Dovers, S.R. (1995). A framework for scaling and framing policy problems in sustainability. Ecological Economics 12(1995): 93-106.

Drinkwater, M. (1994). Knowledge, consciousness and prejudice: adaptive agricultural research in Zambia. In: I. Scoones and J. Thompson. *Beyond farmer first: rural people's knowledge, agricultural research and extension practice*. Intermediate Technology Publication Ltd, London. pp: 32-41.

Duineveld, M., R. Beunen, R. van Ark, K. van Assche and R. During (2007). The difference between knowing the path and walking the path. Wageningen University and Research Centre, Wageningen.

EarthTimes (2009, 12 November 2009). Brazil to invest 300 million dollars in Mozambique infrastructure. Retrieved 13 November 2009, from [online] URL: http://www.earthtimes.org/.

Econergy (2008). Mozambique biofuels assessment. Ministry of Agriculture and Ministry of Energy, Mozambique.

Edelenbos, J., R. Monnikhof and O. van de Riet (2003). A double helix approach: a proposal to forge a better integration of analysis and process in policy development. International Journal of Technology, Policy and Management 3(1): 1-21.

Edelenbos, J., A. van Buuren and N. van Schie (2011). Co-producing knowledge: joint knowledge production between experts, bureaucrats and stakeholders in Dutch water management projects. Environmental Science & Policy 14(6): 675-684.

Ellemers, J.E. (1956). De februari-ramp: een sociologie van een samenleving in nood [The February-disaster: a sociology of a society in distress]. Van Gorcum, Assen.

Embassy of the United States (2006). Country commercial guide 2006. Chapter 5: trade regulations and standards. Retrieved 18 August 2009, from http://maputo.usembassy.gov/.

Engineering News/ Reuters (2009, 14 February 2009). Investment worth $710m flows into Mozambique ethanol projects. Retrieved 18 April 2009, from [online] URL: http://www.engineeringnews.co.za/article/investment-worth-710m-flows-into-mozambique-ethanol-projects-2009-04-14.

Envirotrade (2006). Annual report 2006: plan vivo. Envirotrade Ltd.

EU (2009). Directive 2009/28/EC of the European Parliament and of the Council on the promotion of biofuels and other renewable fules for transport. Official Journal of the European Union, L 140/16.

Euler, H. and D. Gorriz (2004). Case study "Jatropha curcas". Global Facilitation Unit for Underutilized Species (GFU) and GTZ, Frankfurt, Germany.

Ewenstein, B. and J. Whyte (2009). Knowledge practices in design: the role of visual representations as 'epistemic objects'. Organization Studies 30(1): 7-30.

FAO (2006). Regulations, standards and certification for agricultural exports; a practical manual for pruducers and exporters in East Africa. A.L. Coulibaly and P. Liu. FAO.

FAO (2007). Mozambique fact sheet. FAO Emergency and Rehabilitation Programme in Mozambique.

FAO (2008a). The state of food and agriculture: biofuels: prospects, risks and opportunities. FAO, Rome, Italy.

FAO (2008b). Soaring food prices: facts, perspectives, impacts and actions required. High-Level Conference on World Food Security: The Challenges of Climate Change and Bioenergy, Rome, Italy.

FAO (2010). Jatropha: a smallholder bioenergy crop. The potential for pro-poor development. IFAD and FAO, Rome.

FAO/WFP (2010). Special report: FAO/WFP crop and food security assessment mission to Mozambique. Food and Agriculture Organization (FAO) and World Food Programme (WFP), Rome.

FAOSTAT (2009). Yields per hectare Brazilian sugarcane industry. Retrieved 28 October 2009, from [online] URL: http://faostat.fao.org/.

Ferguson, J., K. Mchombu and S. Cummings (2008). Management of knowledge for development: meta-review and scoping study. IKM Working Paper No. 1, March 2008.

Ferguson, J., M. Huysman and M. Soekijad (2010). Knowledge management in practice: pitfalls and potentials for development. World Development 38(12): 1797-1810.

Fleming, L. and D.M. Waguespack (2007). Brokerage, boundary spanning, and leadership in open innovation communities. Organization Science 18(2): 165-180.

Frontier Markets (2008, 10 October 2008). Africa's biofuel boom: Mozambique. Retrieved 22 April 2009, from [online] URL: http://frontiermarkets.wordpress.com/2008/10/08/africas-biofuel-boom-mozambique/.

Frost, P. (1996). The ecology of Miombo woodlands. In: B. Campbell. *The Miombo in transition: woodlands and welfare in Africa.* Center for International Forestry Research (CIFOR), Bogor, Indonesia. pp: 11-55.

FSC (2009). About FSC. Retrieved 9 August 2009, from [online] URL: http://www.fsc.org/about-fsc.html.

FSC (2010, 17 June 2010). Conference on FSC certification in Mozambique to take place in July. Retrieved 14 March 2011, from [online] URL: http://www.fsc.org/news.html?&no_cache=1&tx_ttnews%5Btt_news%5D=600&cHash=5cda5f71bb.

Fuller, S. (2000). The governance of science: ideology and the future of the open society. Open University Press, Buckingham.

Funtowicz, S.O. and J.R. Ravetz (1993). Science for the post-normal age. Futures 25(7): 739-755.

Funtowicz, S.O., J. Martinez-Alier, G. Munda and J.R. Ravetz (1999). Information tools for environmental policy under conditions of complexity. European Environment Agency, Environmental Issues Series, Copenhagen.

Gaventa, J. (2006). Finding the spaces for change: a power analysis. Institute of Development Studies (IDS) Bulletin 37 (6): 23-33.

GBEP (2010). Global BioEnergy Partnership. Retrieved 14 January 2010, from [online] URL: http://www.globalbioenergy.org/aboutgbep/0/.

Gelderland Province, Rijkswaterstaat Oost-Nederland and Ministerium für Umwelt und Naturschutz Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen (2004). Grensoverschrijdende effecten van extreem hoogwater op de Niederrhein [Cross-boundary effects of extreme high-water on the Niederrhein]. Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen, Staatskanzlei Nordrhein-Westfalen, Bezirksregierung Düsseldorf, Staatliches Umweltamt Krefeld, Arbeitskreis der Deichpflichtigen im Regierungsbezirk Düsseldorf, Provincie Gelderland, Ministerie van Verkeer en Waterstaat, Waterschap Rivierenland & Vereniging Nederlandse Riviergemeenten.

GeoVisie (2006). Leven met water [Living with water]. Geovisie.

Gibbons, M. (1994). Transfer sciences: management of distributed knowledge production. Empirica 21(3): 259-270.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow (1994). The new production of knowledge: the dynamics of science and research in contemporary societies. SAGE, London, UK.

Gibbons, M. (1999). Science's new social contract with society. Nature 402(6761): C81-C84.

Gibson, C.C., E. Ostrom and T.K. Ahn (2000). The concept of scale and the human dimensions of global change: a survey. Ecological Economics 32(2): 217-239.

Gieryn, T.F. (1983). Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists. American Sociological Review 48(6): 781-795.

Giller, K.E. (2001). Nitrogen fixation in tropical cropping systems. CAB International, Wallingford.

Giller, K.E., C. Leeuwis, J.A. Andersson, W. Andriesse, A. Brouwer, P. Frost, P. Hebinck, I. Heitkönig, M.K. van Ittersum, N. Koning, R. Ruben, M. Slingerland, H. Udo, T. Veldkamp, C. van de Vijver, M.T. van Wijk and P. Windmeijer (2005). Competing claims on natural resources: overcoming mismatches in resource use through a multi-scale perspective. Wageningen University and Research Centre, Wageningen.

Giller, K.E., C. Leeuwis, J.A. Andersson, W. Andriesse, A. Brouwer, P. Frost, P. Hebinck, I. Heitkönig, M.K. van Ittersum, N. Koning, R. Ruben, M. Slingerland, H. Udo, T. Veldkamp, C. van de Vijver, M.T. van Wijk and P. Windmeijer (2008). Competing claims on natural resources: what role for science? Ecology and Society 13(2): 34. [online] URL: http://www.ecologyandsociety.org/vol13/iss32/art34/.

Giller, K.E., P. Tittonell, M.C. Rufino, M.T. van Wijk, S. Zingore, P. Mapfumo, S. Adjei-Nsiah, M. Herrero, R. Chikowo, M. Corbeels, E.C. Rowe, F. Baijukya, A. Mwijage, J. Smith, E. Yeboah, W.J. van der Burg, O.M. Sanogo, M. Misiko, N. de Ridder, S. Karanja, C. Kaizzi, J. K'Ungu, M. Mwale, D. Nwaga, C. Pacini and B. Vanlauwe (2011). Communicating complexity: integrated assessment of trade-offs concerning soil fertility management within African farming systems to support innovation and development. Agricultural Systems 104(2): 191-203.

Glaser, B.G. and A.L. Strauss (1967). The discovery of grounded theory: strategies for qualitative research. Aldine, New York.

Government of Mozambique (2009). Política e estratégia de biocombustíveis - Resolução 22/2009 [Biofuel policy and strategy - Resolution 22/2009], Maputo, May 2009.

Gunderson, L.H. and C.S. Holling, Eds. (2002). Panarchy: understanding transformations in human and natural systems. Island Press, Washington D.C., USA.

Haas, P.M. (2004). When does power listen to truth? A constructivist approach to the policy process. Journal of European Public Policy 11(4): 569-592.

Habermas, J. (1981). The theory of communicative action, volume 1: reason and the rationalization of society, volume 2: lifeworld and system: a critique of functionalist reason. Suhrkamp Verslag, Frankfurt am Main.

Hajer, M.A. (1995). The politics of environmental discourse: ecological modernization and the policy process. Clarendon, Oxford.

Hall, A., V. Rasheed Sulaiman, N. Clark and B. Yoganand (2003). From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. Agricultural Systems 78(2): 213-241.

Hall, A. and N. Clark (2010). What do complex adaptive systems look like and what are the implications for innovation policy? Journal of International Development 22: 308-324.

Hartwich, F., M.M. Pérez, L.A. Ramos and J.L. Soto (2007). Knowledge management for agricultural innovation: lessons from networking efforts in the Bolivian agricultural technology system. Knowledge Management for Development Journal 3(2): 21-37.

Hekkert, M.P., R.A.A. Suurs, S.O. Negro, S. Kuhlmann and R.E.H.M. Smits (2007). Functions of innovation systems: a new approach for analysing technological change. Technological Forecasting and Social Change 74(4): 413-432.

Hessels, L.K. and H.v. Lente (2008). Re-thinking new knowledge production: a literature review and a research agenda. Research Policy 37(4): 740-760.

Hocdé, H., B. Triomphe, M. Faure and M. Dulcire (2009). From participation to partnership: a different way for researchers to accompany innovation processes – challenges and difficulties. In: P. Sanginga, A. Waters-Bayer, S. Kaaria, J. Njuki and C. Wettasinha. *Innovation Africa: enriching farmers livelihoods*. Earthscan, London. pp: 135–150.

Holmes, J. and R. Clark (2008). Enhancing the use of science in environmental policy-making and regulation. Environmental Science & Policy 11(8): 702-711.

Hoppe, R. (2005). Rethinking the science-policy nexus: from knowledge utilization and science technology studies to types of boundary arrangements. Poiesis und Praxis 3(3): 199-215.

Howard, J., E. Crawford, V. Kelly, M. Demeke and J.J. Jeje (2003). Promoting high-input maize technologies in Africa: the Sasakawa-Global 2000 experience in Ethiopia and Mozambique. Food Policy 28(4): 335-348.

Huitema, D., E. Mostert, W. Egas, S. Moellenkamp, C. Pahl-Wostl and R. Yalcin (2009). Adaptive water governance: assessing the institutional prescriptions of adaptive (co-) management from a governance perspective and defining a research agenda. Ecology and Society 14(1): 26. [online] URL: http://www.ecologyandsociety.org/vol14/iss21/art26/.

Huitema, D. and E. Turnhout (2009). Working at the science-policy interface: a discursive analysis of boundary work at the Netherlands environmental assessment agency. Environmental Politics 18(4): 576-594.

IIAM and DNTF (2008). Zoneamento agrário: resultados do exercício de validação de resultados de terra disponível a nível local (fase 2) [Agricultural zoning - results of the validation exercise of land available at the local level (phase 2)]. IIAM and DNTF, Maputo.

In 't Veld, R.J. (2000). Willingly and knowingly: the roles of knowledge about nature and the environment in policy processes. Advisory Council for Research on Spatial Planning, Nature and the Environment, Rijswijk.

Jasanoff, S. (1990). The fifth branch: science advisors as policymakers. Harvard University Press, Cambridge.

Jasanoff, S. (1996). Is science socially constructed - and can it still inform public policy? Science and Engineering Ethics 2(3): 263-276.

Jongschaap, R.E.E., W.J. Corré, P.S. Bindraban and W.A. Brandenburg (2007). Claims and facts on Jatropha curcas L.: global Jatropha curcas evaluation. Breeding and propagation programme. Report / Plant Research International; 158. Plant Research International, Wageningen University and Research Centre, Wageningen.

Jongschaap, R.E.E., R.A.R. Blesgraaf, T.A. Bogaard, E.N. van Loo and H.G. Savenije (2009). The water footprint of bioenergy from Jatropha curcas L. PNAS: Proceedings of the National Academy of Sciences 106, E92.

Jumbe, C.B.L., F.B.M. Msiska and M. Madjera (2009). Biofuels development in sub-Saharan Africa: are the policies conducive? Energy Policy 37(11): 4980-4986.

Keeney, D. and C. Nanninga (2008). Biofuel and global biodiversity. Institute for Agriculture and Trade Policy (IATP), Minneapolis, Minnesota.

Kibwika, P. (2006). Learning to make change. Developing innovation competence for recreating the African university of the 21st century. Wageningen University and Research Centre, Wageningen.

Kingdon, J.W. (1984). Agendas, alternatives, and public policies. Little Brown and Company, Boston.

Klerkx, L. (2008). Matching demand and supply in the Dutch agricultural knowledge infrastructure. The emergence and embedding of new intermediaries in an agricultural innovation system in transition. Communication and Innovation Studies. Wageningen University and Research Centre, Wageningen.

Klerkx, L. and C. Leeuwis (2008). Delegation of authority in research funding to networks: experiences with a multiple goal boundary organization. Science and Public Policy 35(3): 183-196.

Klerkx, L., A. Hall and C. Leeuwis (2009). Strengthening agricultural innovation capacity: are innovation brokers the answer? International Journal of Agricultural Resources, Governance and Ecology 8(5-6): 409-438.

Klerkx, L., N. Aarts and C. Leeuwis (2010). Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agricultural Systems. 103(2010): 390-400.

Klosterman, J., F. Geerling-Eiff, M. Schut, E. van Slobbe, C. Terwisscha van Scheltinga and E. Wielinga (2009). Samen breien aan gebiedsontwikkeling. Verkenning van de theorie over het gebruik van wetenschappelijke kennis in gebiedsprocessen [Working together on sustainable spatial development. An exploration of theory of the use of scientific knowledge in spatial development processes]. LEI, Wageningen University and Research Centre, The Hague.

Kok, K. and T. Veldkamp (2011). Scale and governance: conceptual considerations and practical implications. Ecology and Society 16(2): 23. [online] URL: http://www.ecologyandsociety.org/vol16/iss22/art23/.

Koppenjan, J. and E.H. Klijn (2004). Managing uncertainties in networks: a network approach to problem solving and decision making. Routledge, London.

Kristjanson, P., R.S. Reid, N. Dickson, W.C. Clark, D. Romney, R. Puskur, S. MacMillan and D. Grace (2009). Linking international agricultural research knowledge with action for sustainable development. Proceedings of the National Academy of Sciences 106(13): 5047-5052.

Kumar, R. (2005). Research methodology: a step-by-step guide for beginners. SAGE, London.

Latour, B. (1999). Pandora's hope: essays on the reality of science studies. Harvard University Press, Cambridge.

Lebel, L., P. Garden and M. Imamura (2005). The politics of scale, position, and place in the governance of water resources in the Mekong region. Ecology and Society 10(2): 18. [online] URL: http://www.ecologyandsociety.org/vol10/iss12/art18/.

Lebel, L. (2006). The politics of scale in environmental assessments. In: W.V. Reid, F. Berkes, T. Wilbanks and D. Capistrano. *Bridging scales and knowledge systems. Concepts and applications in ecosystem assessment. A contribution to the Millennium Ecosystem Assessment*. Island Press, Washington. pp: 37-57.

Leeuwis, C. (2000). Reconceptualizing participation for sustainable rural development: towards a negotiation approach. Development and Change 31(5): 931-959.

Leeuwis, C. (2004). Communication for rural innovation. Rethinking agricultural extension (with contributions of Anne van den Ban). Blackwell Science, Oxford.

Leeuwis, C. and N. Aarts (2011). Rethinking communication in innovation processes: creating space for change in complex systems. The Journal of Agricultural Education and Extension. 17(1): 21-36.

Lewin, K. (1946). Action research and minority problems. Journal of Social Issues 2(4): 34-46.

Maas, G.J., B. Makaske, P.W.F.M. Hommel, B.S.J. Nijhof and H.P. Wolfert (2003). Verstoring en successie: rivierdynamiek en stroomdalvegetaties in de uiterwaarden van de Rijntakken [Disturbance and succession: river dynamics and river vegetation in the floodplains of the Rhine]. Alterra, Wageningen University and Research Centre, Wageningen.

Macauhub (2009a, 18 September 2009). Mozambique to create special duty free areas in Nacala. Retrieved 19 September 2009, from [online] URL: http://www.macauhub.com.mo/en/.

Macauhub (2009b, 14 September 2009). Britain's Sun Biofuels designs biofuel factory to be installed in Manica province, Mozambique. Retrieved 16 September 2009, from [online] URL: http://www.macauhub.com.mo/en/.

Macauhub (2009c, 7 July 2009). Biofuel refinery project in Sofala. Retrieved 14 July 2009, from [online] URL: http://www.macauhub.com.mo/en/.

Mandemaker, M., M. Bakker and J. Stoorvogel (2011). The role of governance in agricultural expansion and intensification: a global study of arable agriculture. Ecology and Society 16(2): 8. [online] URL: http://www.ecologyandsociety.org/vol16/iss12/art18/.

Mangoyana, R.B. and T.F. Smith (2011). Decentralised bioenergy systems: a review of opportunities and threats. Energy Policy 39(3): 1286-1295.

Manson, S.M. (2008). Does scale exist? An epistemological scale continuum for complex human–environment systems. Geoforum 39(2): 776-788.

Marshall, G. and L. Jonker (2010). An introduction to descriptive statistics: a review and practical guide. Radiography 16(4): e1-e7.

Mather, D., B. Cunguara and D. Boughton (2008). Household income and assets in rural Mozambique, 2002-2005: can pro-poor growth be sustained? Ministry of Agriculture, Directorate of Economics, Government of Mozambique.

McNie, E.C. (2007). Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature. Environmental Science & Policy 10(1): 17-38.

Meeuws, R. (2004). Mozambique: trade and transport facilitation audit. NEA Transport Research and Training, Rijswijk, the Netherlands.

Michaels, S. (2009). Matching knowledge brokering strategies to environmental policy problems and settings. Environmental Science & Policy 12(7): 994-1011.

Miedema, F. (2011). Iedereen kan expert worden! Hoe lever je wetenschappelijk advies in tijden van Facebook en Twitter? [Everybody kan be an expert! How to deliver scientific advice in times of Facebook and Twitter?]. De Academische Boekengids [The Academic Book Guide].

Ministry of Transport Public Works and Water Management (1997). Vierde nota waterhuishouding: regeringsvoornemen [Fourth nota water management: government's position], The Hague.

Ministry of Transport Public Works and Water Management (2000). Anders omgaan met water. Waterbeleid voor de 21e eeuw: kabinetsstandpunt [A different approach to water. Water policy for the 21st century: government's position]. Ministry of Transport Public Works and Water Management, The Hague.

Moret, A., D. Rodrigues and L. Ortiz (2006). Indicadores e criterios de sustentabilidade para bioenergia [Indicators and criteria for bioenergy sustainability]. Gabinete de Trabalho de Energia: forum Brazileira de ONGs e movimentos sociais para o meio ambiente e desenvolvimento (GTE-FBOMS) [Brazilian forum of NGOs and social movements for environment and development].

Newitt, M. (1995). A history of Mozambique. Indiana University Press, Bloomington and Indianapolis.

Noticias (21 August 2009). Grown Energy investe na produção de bioetanol [Grown Energy invests in the production of bioethanol]. Noticias, Maputo.

Nowotny, H., P. Scott and M. Gibbons (2003). Introduction: 'Mode 2' revisited: the new production of knowledge. Minerva 41(3): 179-194.

OCIN (2006). Mozambique electricity IV. Project appraisal report. African Development Fund.

Olsson, P., C. Folke, V. Galaz, T. Hahn and L. Schultz (2007). Enhancing the fit through adaptive co-management: creating and maintaining bridging functions for matching scales in the Kristianstads Vattenrike Biosphere Reserve, Sweden. Ecology and Society 12(1): 28. [online] URL: http://www.ecologyandsociety.org/vol12/iss21/art28/.

Opdam, P. (2006). Groenblauwe netwerken: brug tussen wetenschap en praktijk bij gebiedsontwikkeling [Green-blue networks: a bridge between science and practice in sustainable spatial development]. Landschap 23(3): 147-154.

Opdam, P., J. van den Berg, F. Geerling-Eiff, C. Leeuwis, G.-J. Noij, E. Steingröver and J. Klostermann (2007). Werkdocument gebiedskunde en gebiedsontwikkeling [Working document sustainable spatial development of ecosystems, landscapes and seas and regions]. Wageningen University and Research Centre.

Ottosson, S. (2003). Participation action research: a key to improved knowledge of management. Technovation 23(2): 87-94.

Ozawa, C.P. (1996). Science in environmental conflicts. Sociological Perspectives 39: 219-230.

PARPA II (2006). Action plan for the reduction of absolute poverty 2006-2009. UN Mozambique.

Patton, M.Q. (1990). Qualitative evaluation and research methods (2nd ed.). SAGE, Thousand Oaks, CA.

Patton, M.Q. (2002). Qualitative research and evaluation methods. SAGE, Thousand Oaks, CA.

PetroMoc (2009). Biocombustíveis [Biofuels]. PABO – Powering Africa: The Biofuels Options, Maputo, Mozambique.

Pielke Jr., R.A. (2007). The honest broker: making sense of science in policy and politics. Cambridge University Press, Cambridge.

Pijnenburg, B. (2004). Keeping it vague: discourses and practices of participation in rural Mozambique. Wageningen University and Research Centre, Wageningen.

Pleijte, M., R. During, A. Gerritsen and L. Stuyt (2005). Noordwaard: over stromingen in denken over hoogwater en natuur: ruimte voor meer stromen om de Noordwaard [Noordwaard: about schools of thought in thinking about high water and nature: space for more streams around the Noordwaard]. Wetenschapswinkel Wageningen University and Research Centre [Science shop], Wageningen.

Pleijte, M., M. Schut and R. During (2011). Reflexivity in action research: two spatial planning cases. In: A. van Paassen, J. van den Berg, E. Steingröver, R. Werkman and B. Pedroli. *Knowledge in action. The search for collaborative research for sustainable landscape development*. Mansholt Publication Series, Wageningen Publishers, Wageningen. 11. pp: 221-243.

Pohl, C., S. Rist, A. Zimmermann, P. Fry, G.S. Gurung, F. Schneider, C.I. Speranza, B. Kiteme, S. Boillat, E. Serrano, G.H. Hadorn and U. Wiesmann (2010). Researchers' roles in knowledge co-production: experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal. Science and Public Policy 37(4): 267-281.

Practical Action Consulting (2009). Small-scale bioenergy initiatives: brief description and preliminary lessons on livelihood impacts from case studies in Asia, Latin America and Africa. Prepared for Pisces and FAO by Practical Action Consulting, Rome.

Project Group Resilience Study (2002). Spankrachtstudie: de spankracht van ons rivierenland [Resilience study: the resilience of our rivers]. Ministry of Transport Public Works and Water Management, VROM, LNV, Provincie Utrecht, Gelderland, Overijssel, Noord Brabant, Zuid-Holland, Waterschappen & Vereniging Nederlandse Riviergemeenten, The Hague.

Project Group Sustainable Production of Biomass (2007). Testing framework for sustainable biomass. Advice of the project group "sustainable production of biomass." Energy Transition's Interdepartmental Programme Management (IPM).

Project Organisation Room for the River (2005). PKB 1: design spatial planning procedure. Ministry of VWS, Ministry of VROM and Ministry of Agriculture, Nature and Food Quality, Hardenberg.

Project Organisation Room for the River (2006). PKB 4: spatial planning key decision Room for the River, approved decision. Ministry of V&W, Ministry of VROM and Ministry of Agriculture, Nature and Food Quality, The Hague.

Project Organisation Room for the River (2009). Safety for four million Dutch citizens. Retrieved 11 August 2011, from [online] URL: http://www.ruimtevoorderivier.nl/media/18566/brochureeng.pdf.

Pruitt, D.G. and P.J. Carnevale (1993). Negotiation in social conflict. Open University Press, Buckingham.

Quintas, P., P. Lefrere and G. Jones (1997). Knowledge management: a strategic agenda. Long Range Planning 30(3): 385-391.

Raik, D.B., A.L. Wilson and D.J. Decker (2008). Power in natural resources management: an application of theory. Society & Natural Resources 21(8): 729-739.

Ramutsindela, M. (2004). Glocalisation and nature conservation strategies in 21st-century Southern Africa. Tijdschrift voor economische en sociale geografie [Journal for economic and social geography] 95(1): 61-72.

Rebello Da Silva, G. and L. Da Silva Garrilho (2003). Bridging the standards divide: a case study and action plan for Mozambique. In: J. S. Wilson and V. O. Abiola. *Standards & Global Trade; a voice for Africa*. The World Bank, Washington, D.C. pp: 65-164.

Regeer, B.J., A.C. Hoes, M. van Amstel-van Saane, F.F. Caron-Flinterman and J.F.G. Bunders (2009). Six guiding principles for evaluating Mode 2 strategies for sustainable development. American Journal of Evaluation 30(4): 515-537.

Research and Verification Bureau (2006). Verificatie PKB Ruimte voor de Rivier [Verification spatial planning procedure Room for the River]. Parliament (Tweede Kamer), The Hague.

RIZA and Bosch Slabbers (1999). Rivierverruiming en landschapsontwikkeling in de Biesbosch: integrale verkenning benedenrivieren. Deelstudie landschap [Widening rivers and landscape development in the Biesbosch: an integral exploration of the lower river region. Sub-study landscape], The Hague.

RIZA and Bosch Slabbers (2000). Rivierverruimende maatregelen. Integrale verkenning benedenrivieren. Deelstudie landschap [River widening measures. Integral exploration of the lower river region. Sub-study landscape], The Hague.

Röling, N. (1994). Facilitating sustainable agriculture: turning policy models upside down. In: I. Scoones and J. Thompson. *Beyond farmers first*. Intermediate Technology Publications Ltd., London. pp: 301.

Roth, D., J. Warner and M. Winnubst (2006). Een noodverband tegen hoog water: waterkennis, beleid en politiek rond noodoverloopgebieden [First-aid bandage against high water: water-knowledge, policy and politics around emergency flooding areas]. Wageningen University and Research Centre, Wageningen.

Roth, D. and J. Warner (2007). Flood risk, uncertainty and changing river protection policy in the Netherlands: the case of 'calamity polders'. Tijdschrift voor economische en sociale geografie [Journal for economic and social geography] 98(4): 519-525.

Roundtable on Sustainable Biofuels (2008). Global principles and criteria for sustainable biofuels production (version 0). Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland.

Runhaar, H. and K. van Nieuwaal (2010). Understanding the use of science in decision-making on cockle fisheries and gas mining in the Dutch Wadden Sea: putting the science-policy interface in a wider perspective. Environmental Science & Policy 13(3): 239-248.

Russell Bernard, H. (2006). Research methods in anthropology. Qualitative and quantitative approaches (4th ed.). AltaMira Press, Oxford, UK.

Ryan, C.M. (2009). Carbon cycling, fire and phenology in a tropical savanna woodland in Nhambita, Mozambique. University of Edinburgh, Edinburgh.

SADC (2010). SADC framework for sustainable biofuel use and production. Retrieved 30 November 2010, from [online] URL: http://www.probec.org/fileuploads/fl06022010194145_SADC_framework_for_sustainable_biofuels_2010.pdf.

Sanderson, I. (2002a). Making sense of 'what works': evidence based policy making as instrumental rationality? Public Policy and Administration 17(3): 61-75.

Sanderson, I. (2002b). Evaluation, policy learning and evidence-based policy making. Public Administration 80(1): 1-22.

Sarewitz, D. (2004). How science makes environmental controversies worse. Environmental Science & Policy 7(5): 385-403.

Schut, M., S. Bos, L. Machuama and M. Slingerland (2010a). Working towards sustainability. Learning experiences for sustainable biofuel strategies in Mozambique. Wageningen University and Research Centre, Wageningen, the Netherlands in collaboration with CEPAGRI, Maputo, Mozambique.

Schut, M., C. Leeuwis and A. van Paassen (2010b). Room for the River – Room for Research? The case of depoldering De Noordwaard, the Netherlands. Science and Public Policy 37(8): 611-627.

Schut, M., M. Slingerland and A. Locke (2010c). Biofuel developments in Mozambique. Update and analysis of policy, potential and reality. Energy Policy 38(9): 5151-5165.

Schut, M., C. Leeuwis, A. van Paassen and A. Lerner (2011a). Knowledge and innovation management in the policy debate on biofuel sustainability in Mozambique: what roles for researchers? Knowledge Management for Development Journal 7(1): 45-64.

Schut, M., A. van Paassen, C. Leeuwis, S. Bos, W. Leonardo and A. Lerner (2011b). Space for innovation for sustainable community-based biofuel production and use: lessons learned for policy from Nhambita community, Mozambique. Energy Policy 39(9): 5116-5128.

Senate (2006). Planologische kernbeslissing Ruimte voor de Rivier (30080) [Spatial planning procedure Room for the River (30080)]. Eerste Kamer [Senate], The Hague.

Silva, W. (2001). Hoogwaterbescherming langs de Rijntakken. Onzekerheden en omgaan met onzekerheden [High water protection in the Rhine delta. Uncertainty and dealing with undertainty]. RWS/RIZA Werkdocument nr. 2000.179X. Ministry of Transport, Public Works and Water Management, The Hague.

Silverman, D. (2006). Interpreting qualitative data: methods for analyzing talk, text and interaction. SAGE, London.

Smeets, E., A. Faaij, I. Lewandowski and W. Turkenburg (2007). A bottom-up assessment and review of global bio-energy potentials to 2050. Progress in Energy and Combustion Science 33(2007): 56-106.

Smeets, E., M. Junginger, A. Faaij, A. Walter, P. Dolzan and W. Turkenburg (2008). The sustainability of Brazilian ethanol. An assessment of the possibilities of certified production. Biomass and Bioenergy 32(8): 781-813.

Smith, A., J.-P. Voß and J. Grin (2010). Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. Research Policy 39(4): 435-448.

Smith, R. (2001). Measuring the social impact of research: difficult but necessary. British Medical Journal 323(7312): 528.

Smits, R. and S. Kuhlmann (2004). The rise of systemic instruments in innovation policy. International Journal of Foresight and Innovation Policy 2004(1): 4-32.

Snowden, D. (2002). Complex acts of knowing: paradox and descriptive self-awareness. Journal of Knowledge Management 6(2): 100 - 111.

Spielman, D.J., J. Ekboir and K. Davis (2009). The art and science of innovation systems inquiry: applications to sub-Saharan African agriculture. Technology in Society 31(4): 399-405.

Star, S.L. and J.R. Griesemer (1989). Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907-39. Social Studies of Science 19(3): 387-420.

Steel, B., P. List, D. Lach and B. Shindler (2004). The role of scientists in the environmental policy process: a case study from the American west. Environmental Science & Policy 7(1): 1-13.

Sterk, B., P. Carberry, C. Leeuwis, M.K. van Ittersum, M. Howden, H. Meinke, H. van Keulen and W.A.H. Rossing (2009). The interface between land use systems research and policy: multiple arrangements and leverages. Land Use Policy 26: 434-442.

Steyaert, P., M. Barzman, J.-P. Billaud, H. Brives, B. Hubert, G. Ollivier and B. Roche (2007). The role of knowledge and research in facilitating social learning among stakeholders in natural resources management in the French Atlantic coastal wetlands. Environmental Science & Policy 10(6): 537-550.

Swan, J., S. Newell, H. Scarbrough and D. Hislop (1999). Knowledge management and innovation: networks and networking. Journal of Knowledge Management 3(4): 262-275.

TechnoServe and ICRAF/IIAM (2006). Jatropha plan. Jatropha Research and Development Team, Maputo.

Termeer, C.J.A.M., A. Dewulf and M. van Lieshout (2010). Disentangling scale approaches in governance research: comparing monocentric, multilevel, and adapative governance. Ecology and Society 15(4): 29. [online] URL: http://www.ecologyandsociety.org/vol15/iss24/art29/.

Tittonell, P., B. Vanlauwe, P.A. Leffelaar, E.C. Rowe and K.E. Giller (2005). Exploring diversity in soil fertility management of smallholder farms in western Kenya I. Heterogeneity at region and farm scale. Agric. Ecosyst. Environ. 110: 149-165.

Tittonell, P., M.T. van Wijk, M. Herrero, M.C. Rufino, N. de Ridder and K.E. Giller (2009). Beyond resource constraints: exploring the biophysical feasibility of options for the intensification of smallholder crop-livestock systems in Vihiga district, Kenya. Agricultural Systems 101(1-2): 1-19.

Trondsen, M. and A.G. Sandaunet (2009). The dual role of the action researcher. Evaluation and Program Planning 32(1): 13-20.

Tschirley, D.L. and M.T. Weber (1994). Food security strategies under extremely adverse conditions: the determinants of household income and consumption in rural Mozambique. World Development 22(2): 159-173.

TU-Delft (2004). Project Noordwaard. TU-Delft, Delft.

Tuinstra, W., L. Hordijk and C. Kroeze (2006). Moving boundaries in transboundary air pollution co-production of science and policy under the convention on long range transboundary air pollution. Global Environmental Change 16(2006): 349–363.

Tuinstra, W. (2007). Preparing for the European thematic strategy on air pollution: at the interface between science and policy. Environmental Science & Policy 10(5): 434-444.

Turnhout, E., M. Hisschemöller and H. Eijsackers (2007). Ecological indicators: between the two fires of science and policy. Ecological Indicators 7(2007): 215-228.

Turnhout, E., M. Hisschemöller and H. Eijsackers (2008). Science in Wadden Sea policy: from accommodation to advocacy. Environmental Science & Policy 11(3): 227-239.

Turnhout, E. (2009). The effectiveness of boundary objects: the case of ecological indicators. Science and Public Policy 36(5): 403-412.

Turnhout, E. and S. Boonman-Berson (2011). Databases, scaling practices, and the globalization of biodiversity. Ecology and Society 16(1): 35. [online] URL: http://www.ecologyandsociety.org/vol16/iss31/art35/.

UNDP (2009). Human development report 2009 Mozambique. Retrieved 13 November 2009, from [online] URL: http://hdrstats.undp.org/en/countries/profiles/MOZ.html.

United Press International (2009, 24 December 2009). Mozambique voids biofuel contract. Retrieved 6 January 2010, from [online] URL: http://www.upi.com/Science_News/Resource-Wars/2009/12/24/Mozambique-voids-biofuel-contract/UPI-47471261700272/.

University of Edinburgh (2008). Miombo community land use & carbon management Nhambita pilot project. The University of Edinburgh, School of GeoSciences.

USAID (2009a). Food security framework: underlying factors. Retrieved 12 April 2009, from [online] URL: http://www.fews.net/ml/en/info/Pages/fmwkfactors.aspx?gb=mz&l=en&fmwk=factor.

USAID (2009b, 28 July 2009). Mozambique. Retrieved 5 August 2009, from [online] URL: http://www.usaid.gov/locations/sub-saharan_africa/countries/mozambique/.

van Bueren, E.M., E.H. Klijn and J.F.M. Koppenjan (2003). Dealing with wicked problems in networks: analyzing an environmental debate from a network perspective. Journal of Public Administration Research and Theory 13(2): 193-212.

van Buuren, A. and J. Edelenbos (2004). Conflicting knowledge. Why is joint knowledge production such a problem? Science and Public Policy 31(4): 289-299.

van Buuren, A., J. Edelenbos and E.-H. Klijn (2004). Managing knowledge in policy networks. Organising joint fact-finding in the Scheldt estuary. Paper presented at the International Conference on Democratic Network Governance, 21-22 October 2004, Copenhagen, Denmark.

van Buuren, A. (2006). Competent decision-making: the management of multi-faceted knowledge in spatial development processes. Erasmus University, Rotterdam.

van Dam, J., M. Junginger, A. Faaij, I. Jürgens, G. Best and U. Fritsche (2008). Overview of recent developments in sustainable biomass certification. Biomass and Bioenergy 32(8): 749-780.

van den Hooff, B. and M. Huysman (2009). Managing knowledge sharing: emergent and engineering approaches. Information & Management 46(1): 1-8.

van der Meulen, Y.A.M. (2007). Ontpoldering Noordwaard is omvangrijkste maatregel [Depolderling Noordwaard is most significant measure]. Land + water: magazine voor civile- en milieutechniek [Land + water: journal for civil and environmental engineering] 47(12): 82-84.

van der Veen, A. and G. Tagel (2011). Effect of policy interventions on food security in Tigray, Northern Ethiopia. Ecology and Society 16(1): 18. [online] URL: http://www.ecologyandsociety.org/vol16/iss1l/art18/.

van Eeten, M.J.G. (1999). 'Dialogues of the deaf' on science in policy controversies. Science and Public Policy 26(3): 185-192.

van Eijck, J. and H. Romijn (2008). Prospects for Jatropha biofuels in Tanzania: an analysis with Strategic Niche Management. Energy Policy 36(1): 311-325.

van Lieshout, M., A. Dewulf, N. Aarts and C.J.A.M. Termeer (2011). Do scale frames matter? Scale frame mismatches in the decision making process about a "mega farm" in a small Dutch village. Ecology and Society 16(1): 38. [online] URL: http://www.ecologyandsociety.org/vol16/iss31/art38/.

van Mierlo, B., M. Arkesteijn and C. Leeuwis (2010). Enhancing the reflexivity of system innovation projects with system analyses. American Journal of Evaluation 31(2): 143 - 161.

van Paassen, A., R. Werkman, B. Pedroli, J. van den Berg, E. Steingröver and C. Leeuwis (2011). Conclusion: from knowledge for action to knowledge in action. In: A. van Paassen, J. van den Berg, E. Steingröver, R. Werkman, and B. Pedroli. *Knowledge for action. The search for effective collaborative research for sustainable landscape development*. Mansholt series, Wageningen Publishers, Wageningen.

van Stokkom, H.T.C., A.J.M. Smits and R.S.E.W. Leuven (2005). Flood defense in the Netherlands: a new era, a new approach. Water International 30(1): 76-87.

van Wijk, M.T., P. Tittonell, M.C. Rufino, M. Herrero, C. Pacini, N.d. Ridder and K.E. Giller (2009). Identifying key entry-points for strategic management of smallholder farming systems in sub-Saharan Africa using the dynamic farm-scale simulation model NUANCES-FARMSIM. Agricultural Systems 102(1-3): 89-101.

Veldkamp, T., N. Polman, S. Reinhard and M. Slingerland (2011). From scaling to governance of the land system: bridging ecological and economic perspectives Ecology and Society 16(1): 18. [online] URL: http://www.ecologyandsociety.org/vol16/iss1l/art1l/.

Verdonk, M., C. Dieperink and A. Faaij (2007). Governance of the emerging bio-energy markets. Energy Policy 35(7): 3909-3924.

Villarreal, M. (1992). The poverty of practice. Power, gender and intervention from an actor-oriented perspective. In: N. Long and A. Long. *Battlefields of knowledge: the interlocking of theory and practice in social research and development*. Routledge, London. pp: 247–267.

Warner, J.F. (2008). The politics of flood insecurity: framing contested river management projects. Wageningen University and Research Centre, Wageningen.

Waterton, C. (2005). Scientists conceptions of the boundaries between their own research and policy. Science and Public Policy 32(6): 435-444.

Watson, H. (2008). Biofuels in Africa – the land use issue. Bioenergy Policies for Sustainable Development in Africa, Hotel Olympe International, Bamako, Mali.

Weingart, P. (1999). Scientific expertise and political accountability: paradoxes of science in politics. Science and Public Policy 26(3): 151-161.

Weingart, P. (2000). Interdisciplinarity: the paradoxal discourse. In: P. Weingart and N. Stehr. *Practicing Interdisciplinarity*. University of Toronto Press, Toronto. pp: 25-41.

WFP (2009). World Food Programme country brief on Mozambique. Retrieved 31 October 2009, from [online] URL: http://www.wfp.org/countries/mozambique.

Wheeler, D. and A. Mody (1992). International investment location decisions: the case of U.S. firms. Journal of International Economics 33(1-2): 57-76.

Wiering, M.A. and P.P.J. Driessen (2001). Beyond the art of diking: interactive policy on river management in the Netherlands. Water Policy 3(4): 283-296.

Woodhill, J. (2004). Dialogue and transboundary water resources management: towards a framework for facilitating social learning. In: J.G. Timmerman and S. Langaas. *Environmental Information in European Transboundary Water Management*. IWA Publishing, London, UK. pp: 44-59.

Woods, J. and R. Diaz-Chavez (2007). The environmental certification of biofuels. OECD, International Transport Forum and Faculty of Natural Sciences (Imperial College), London, UK.

World Bank (2005). Mozambique: country economic memorandum sustaining growth and reducing poverty. World Bank, Poverty Reduction and Economic Management I, Africa Region.

World Bank (2006a). Enhancing agricultural innovation: how to go beyond the strengthening of research systems. World Bank, Washington DC, USA.

World Bank (2006b). Mozambique agricultural development strategy: stimulating smallholder agricultural growth. Worldbank: Agriculture, Environment, and Social Development Unit, Country Department 2, Africa Region.

World Bank (2008, 24 September 2008). Mozambique at a glance. Retrieved 7 April 2009, from [online] URL: http://devdata.worldbank.org/AAG/moz_aag.pdf.

World Bank (2009, March 2009). Mozambique - country brief. Retrieved 5 August 2009, from [online] URL: http://go.worldbank.org/70UK6S1X30.

Wynne, B. (1996). Misunderstood misunderstandings: social identities and public uptake of science. In: A. Irwin and B. Wynne. *Misunderstanding science? The public reconstruction of science and technology*. Cambridge University Press, Cambridge & New York. pp: 19-46.

Yin, R.K. (2003). Case study research: design and methods (3rd ed.). SAGE, Thousand Oaks, CA.

Yin, R.K. (2009). Case study research: design and methods (4th ed.). SAGE, Los Angeles, London, New Dehli, Singapore and Washington DC.

Zingore, S., H.K. Murwira, R.J. Delve and K.E. Giller (2007). Influence of nutrient management strategies on variability of soil fertility, crop yields and nutrient balances on smallholder farms in Zimbabwe. Agriculture, Ecosystems & Environment 119(1-2): 112-126.

Zingore, S., E. González-Estrada, R.J. Delve, M. Herrero, J.P. Dimes and K.E. Giller (2009). An integrated evaluation of strategies for enhancing productivity and profitability of resource-constrained smallholder farms in Zimbabwe. Agricultural Systems 101(2009): 57-68.

Zingore, S., P. Tittonell, M. Corbeels, M.T. van Wijk and K.E. Giller (2011). Managing soil fertility diversity to enhance resource use efficiencies in smallholder farming systems: a case from Murewa District, Zimbabwe. Nutrient Cycling in Agroecosystems 90(1): 87-103.

APPENDICES

Appendix A. List of field visits between December 2008 and November 2010 in Mozambique

Company/ project	Type	Date	Location
Procana Ltd.	Sugarcane for bioethanol project	12 December 2008	Massingir, Mozambique
ENERGEM Ltd.	Jatropha for biodiesel project	12 February 2009	Bilene, Mozambique
Agropecuaria de Manica	Jatropha for biodiesel project	10 March 2009	
Small-scale biofuel producer	Experimental, small-scale biofuel project	12 March 2009	Sussendenga, Mozambique
Galp Jatropha	Jatropha for biodiesel project	13 March 2009	Chimoio, Mozambique
ADPP-FACT Foundation jatropha Project	Community-based biofuel project	10- 17 April 2009	Bilibiza, Mozambique
Sun Biofuels	Jatropha for biodiesel project	22 April 2009	Chimoio, Mozambique
Principle Energy Ltd.	Sugarcane for bioethanol project	20-21 July 2009	Dombe, Mozambique
NiQeL	Jatropha for biodiesel project	21-22 July 2009	Grudja, Mozambique
Envirotrade/ Nhambita community-based jatropha project	Carbon offset project to support forest conservation and management	28 July 2009	Nhambita community, Gorongosa, Mozambique
NiQeL	Jatropha for biodiesel project	28-29 July 2009	Grudja, Mozambique
Envirotrade/ Nhambita community-based jatropha project	Carbon offset project to support forest conservation and management	31 August 2009 – 4 September 2009	Nhambita community, Gorongosa, Mozambique
Sun Biofuels	Jatropha for biodiesel project	21 May 2010	Chimoio, Mozambique
Envirotrade/ Nhambita community-based jatropha project	Carbon offset project to support forest conservation and management	July 2010	Nhambita community, Gorongosa, Mozambique

Note: During the field visits both formal and informal interviews with project managers and staff were conducted.

Appendix B. List of interviewees for case study De Noordwaard

Affiliation	Date	Location	Type	Recorded	Trans-cribed
Consultant Arcadis	29 December 2008	Arnhem, the Netherlands	Exploratory	No	No
Journalist Brabants Dagblad	6 May 2008	De Waterman, Werkendam, the Netherlands	Exploratory	No	No
Director Biesbosch museum	8 May 2008	Biesbosch Museum, Werkendam, the Netherlands	Exploratory	No	No
Researcher 1 Alterra (WUR)	4 June 2008	Alterra, Wageningen, the Netherlands	In-depth	Yes	Yes
	12 June 2008	Alterra, Wageningen, the Netherlands	In-depth	Yes	No
Inhabitant Noordwaard	13 June 2008	Werkendam, the Netherlands	In-depth	Yes	No
Researcher 2 Alterra (WUR)	30 June 2008	Alterra, Wageningen, the Netherlands	In-depth	Yes	No
Former Manager Project Bureau Noordwaard – Ministry of Infrastructure and the Environment	1 July 2008	Ministry, Lelystad, the Netherlands	In-depth	Yes	Yes
	18 November 2008	De Tijd, Utrecht, the Netherlands	In-depth	No	No
Manager Project Bureau Noordwaard – Ministry of Infrastructure and the Environment	22 July 2008	Ministry, Utrecht, the Netherlands	Exploratory	No	No
Researcher Alterra (WUR)	23 July 2008	Alterra, Wageningen, the Netherlands	In-depth	Yes	No
Representative Platform Save De Noordwaard	13 June 2008	Werkendam, the Netherlands	Exploratory	No	No
	25 June 2008	By telephone	In-depth	No	No
	28 July 2008	Werkendam, the Netherlands	In-depth	Yes	No
Researcher 3 Alterra (WUR)	26 May 2008	Alterra, Wageningen, the Netherlands	In-depth	Yes	Yes
	29 July 2008	Alterra, Wageningen, the Netherlands	In-depth	No	No
Professor TU-Delft/ inhabitant Noordwaard	10 September 2008	Het Fort, Werkendam, the Netherlands	In-depth	Yes	No
Former Manager Project Bureau Noordwaard Dutch Ministry of Infrastructure and the Environment	3 October 2008	Ministry, Lelystad, the Netherlands	In-depth	Yes	No
Former manager Bureau Lower River Region – Dutch Ministry of Infrastructure and the Environment	20 November 2008	Ministry, Rotterdam, the Netherlands	In-depth	Yes	No

Appendix C. List of interviewees for case study Mozambique (Stage 1)

Affiliation	Date	Location
Researcher IITA Mozambique	25 June 2008	Wageningen, the Netherlands
Senior policymaker at CEPAGRI, Ministry of Agriculture	December 2008	Maputo, Mozambique
GTZ-ProBEC – Regional advisor to the SADC Secretariat on sustainability for biofuels and bioenergy	December 2008	Maputo, Mozambique
Three MSc-students Wageningen University	24 January 2009	Bilene, Mozambique
Senior policymaker at CEPAGRI, Ministry of Agriculture	4 February 2009	Maputo, Mozambique
Junior policymaker at CEPAGRI, Ministry of Agriculture	4 February 2009	Maputo, Mozambique
Three researchers Wageningen University	9 February 2009	Maputo, Mozambique
Senior staff-member faculty agronomy, Eduardo Mondlane University (UEM)	11 February 2009 18 February 2009	Maputo, Mozambique
Several smallholder farmers from Bilene area	13 February 2009	Bilene, Mozambique
Director and Manager ENERGEM Ltd.	14 February 2009	Bilene, Mozambique
Professor Forestry, Eduardo Mondlane University (UEM)	16 February 2009 19 February 2009	Maputo, Mozambique
Junior policymaker at CEPAGRI, Ministry of Agriculture	16 February 2009	Maputo, Mozambique
Representative of Martifer, PRIO (food production company)	16 February 2009	Maputo, Mozambique
Staff member of FOS Belgium (development organisation)	17 February 2009	Maputo, Mozambique
Programme officer sustainable development, Dutch Embassy Mozambique	19 February 2009 9 April 2009	Maputo, Mozambique
ADF Maputo (French development organisation)	25 February 2009	Maputo, Mozambique
Deputy director of National Directorate for Renewable Energy (DNER), Ministry of Energy	27 February 2009	Maputo, Mozambique
Director of Procana, sugarcane for bioethanol project	2 March 2009	Maputo, Mozambique
ARRAKIS consultant, FACT Foundation, the Netherlands	5 March 2009	Skype-interview
GTZ Manica (German development organisation)	9 March 2009	Chimoio, Mozambique
Agropecuaria de Manica, small-scale biofuel project	10 March 2009	Chimoio, Mozambique
Staff-member land registry Manica province	11 March 2009	Chimoio, Mozambique
Staff-member provincial government forestry and fauna	11 March 2009	Chimoio, Mozambique

Staff-member provincial government mineral resources and energy	11 March 2009	Chimoio, Mozambique
ADPP Chimoio	11 March 2009	Chimoio, Mozambique
Director ADIPSA Manica	11 March 2009	Chimoio, Mozambique
ADPP Manica	12 March 2009	Chimoio, Mozambique
Smallholder farmer experimenting with biofuel production	12 March 2009	Sussendenga, Mozambique
Government official Sussendenga District	12 March 2009	Sussendenga, Mozambique
Staff-member land registry Manica province	13 March 2009	Chimoio, Mozambique
Director Galp Mozambique, jatropha for biodiesel project	13 March 2009	Chimoio, Mozambique
ADPP Manica	13 March 2009	Chimoio, Mozambique
Senior staff member Roundtable of Sustainable Biofuels (RSB)	31 March 2009	Johannesburg, South Africa
Biofuel expert, University of Stellenbosch	31 March 2009	Johannesburg, South Africa
Agricultural officer, Dutch Embassy in South Africa	1 April 2009	Johannesburg, South Africa
Consultant FACT Foundation, the Netherlands	9 April 2009	Maputo, Mozambique
Deputy director CEPAGRI, Ministry of Agriculture	9 April 2009	Maputo, Mozambique
Sun Biofuels, jatropha for biodiesel project	22 April 2009	Chimoio, Mozambique
Chief operating officer Principle Energy Ltd, sugarcane for bioethanol project	20 July 2009	Dombe, Mozambique
Operations officer at NiQeL Ltd., jatropha for biodiesel project	21 July 2009	Grudja, Mozambique
Senior extensionists Envirotrade project	28 July 2009	Nhambita, Mozambique
Managing director NiQeL Ltd., jatropha for biodiesel project	28 July 2009	Grudja, Mozambique
Managing director Sun Biofuels, jatropha for biodiesel project	21 May 2010	Chimoio, Mozambique
Operating officer Envirotrade	July 2010	Nhambita, Mozambique

Appendix D. Farming systems questionnaire

1. General data		
1.1. Name:		
1.2. Age:		
1.3. Location (GPS)		
1.4. Education	None Primary Secondary Technician University	
1.5. Position in the community	Chief	
	Big farmer	
	Son of …	
1.6. Household size	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 – ……..	
1.7. Number of household members providing labour (on- and off-farm activities)	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 – ……..	
1.8. Number of houses homestead		
1.9. Other remarks		

2. Income generating activities				
2.1. Main activities	Agriculture		Handicraft	
	Labourer			
	Off farm activities			
2.2. Number of fields		Fields		
2.3. Total size		Ha/ acres		
2.4. Main crops	Maize		Banana	
	Sweet Sorghum		Papaya	
	Cassava			
2.5. Vegetable garden				
2.6. Main vegetables				
2.7. # of livestock				
2.8. Type of livestock	Cows		Chicken	
	Goats		Pigs	
2.9. Off-farm activities (paid activities inside the community)				
2.9.1. From which activities?	Charcoal		Brewing	
	Wood production			
	Honey			

2.9.2. How much?		
2.10. Remittances (household members with paid job outside the community)		
2.10.1. From where?	Mozambique	
	Outside Mozambique	
2.10.2. How much?	… MZN/ Rand	
2.11. You describe that these are your main income-generating activities… could you divide these 10 paper balls over the activities?	1 … 2 … 3 … 4 …	% % % %

We would like to visit your fields and garden later…

3. **Expenditure pattern**				
	MZN per month	MZN per year		% of total
3.1. School				%
3.2. Food				%
3.3. Groceries, such as: ………………………………				%
3.4. Clothes				%
3.5. Communication (telephone, etcetera.)				%
3.6. Transport				%
3.7. Energy				%
3.7.1. Fuel				
3.7.2. Electricity				
3.8. Health				%
3.9. Agricultural inputs				%
3.9.1. Seeds				%
3.9.2. Fertilizer				%
3.9.3. Pesticides				%
3.9.4. VET				%
3.10. Remittances				%
3.10.1.To whom, to where				
3.10.2. How much?	MZN		Per month/ year	
3.11. Savings				%
3.12. House (maintenance, renovation)				%
3.13. You describe that these are your main expenditure activities… could you divide these 10 paper balls over the activities?				

4. Social organisation and extension services		
4.1. Social organisation (farmers organisation, cooperation)		
4.2. Size of the farmers' group	Farmers	
4.3. What activities do they do together?	Planting	
	Weeding	
	Ploughing	
4.3.1. Do you buy inputs together?		
4.3.1.1. What?		
4.3.1.2. From where?		
4.3.2. Do they sell together?		
4.3.2.1. What?		
4.3.2.2. To where?		
4.3.3. Is their support of an extensionist in the community?	YES/ NO	
4.3.3.1. How often?	…….. times per week/ month/ year	
4.3.3.2. What do they do offer (technology transfer)?		
4.4. Access to loans/ credit?		
4.4.1. How much per year?		
4.4.2. Where do they use this for?		
4.4.3. What is the amount of interest they are paying?		

5. Livestock					
5.1. Type					
5.2. # per type		#		#	
	Cattle		Chicken		
	Pigs				
	Goats				
5.3. Grazing area/ feed/ residues?					
5.4. Amount of grazing area (ha) 5.5. Where					
5.6. Herding					
5.6.1. By whom?					
5.7. Inputs:					
5.7.1. Medicine			… times per year	MZN	
5.7.2. VET-services				MZN	
5.7.3. Other				MZN	
5.8. Outputs:					
5.8.1. Manure (collect/ corral/ leave it)					
5.8.2. Renting out animal draught power					

5.8.2.1. To whom		
5.8.2.2. How many days per year		
5.8.2.3. Per diem (.........MZN) or labour in exchange (......... hours/ days)		MZN
5.8.3. Animal products		
5.8.3.1. Household consumption		
5.8.3.1.1. Type of product(s)		
5.8.3.2. Selling for cash		
5.8.3.2.1. Type of product(s)		
5.8.3.2.2. Income		MZN

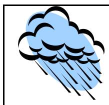
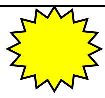
6. **Farming system**

   6.1. You mentioned that you have ... (#) fields. What is the most/ least productive field?
   6.2. On which field do you spend most of your time?

Field:	Field 1:		Field 2:		Field 3:		Field 4:	
Type of field (gardening/ cropping/ fallow):								
Location (homestead/ outfield)								
Distance from homestead:								
Geographic location (lowland, upland, close to river?)								
Size (ha)								
Hedge? Fence	Yes/ no		Yes/ no		Yes/ no		Yes/ no	
Type of hedge/ fence?								
No. of cropping seasons								
Crop(s):	Maize Cassava – – –		Maize Cassava – – –		Maize Cassava – – –		Maize Cassava – – –	
Harvesting/ yield		Kg		Kg		Kg		Kg
	Maize		Maize		Maize		Maize	
	Cassava		Cassava		Cassava		Cassava	
	–		–		–		–	
	–		–		–		–	
	–		–		–		–	
Consumption/ cash crops (different crops/ amount sold/ prices per crop?)			Consump tion		Cash crop			
	Maize							
	Cassava							
	–							
	–							

Market?				
Intercropping/ Monocultures What? Why?				
Ploughing (source of plough, animal draft)				
From where				
How much time				
Land history (previous crops, intercropping, crop rotation, fallow):				
Activities and labour input (ranking):				
Burning	Yes/ No	Yes/ No	Yes/ No	Yes/ No
Land preparation				
Sewing				
Weeding and pest-management				
Pesticides	Yes/ No	Yes/ No	Yes/ No	Yes/ No
Where do you buy them				
Residues? What do you do with them? Composting Animal fodder				
Inputs:				
Manure	Yes/ No	Yes/ No	Yes/ No	Yes/ No
Fertilizer	Yes/ No	Yes/ No	Yes/ No	Yes/ No
Type 1: Type 2:				
Pesticides	Yes/ No	Yes/ No	Yes/ No	Yes/ No
Type 1: Type 2:				
Main risks? How often?				
What do you do is yields are low? How do you manage				
Of total	Consumption		Cash crop	
	Kg	%	Kg	%
Maize Cassava				

7. **Cropping calendar**

												
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
												+/–
												% of 100
												W / H

+/– is lot of work/ little work
% of 100 = 100 paper dots divided over 12 months
W = Weeding, H = Harvesting

8. Final conclusions	
8.1. In what area do you consider yourself to be an expert?	
8.2. In what area would you like to develop yourself/ learn more?	
We learned a lot about your farm and the region. You told a lot about things that could be improved. You told this and that...	
8.3. How could we improve these things?	
8.4. From where we can start?	

9. We have asked you so many questions? Is there anything you want to ask us?

Appendix E. GTZ Low cost energy technologies field survey

No of questionnaire:	
Date:	
Name of Interviewer:	

Country:	
District:	
Village:	
Address/ street:	
GPS:	
Name of interviewee:	

a) Housing

	Sex	1. Under 16	2. Over 16	3. TOTAL
How many people live in your household in total on a permanent basis?	Male			
	Female			
Which is the highest level of education one of the household members received? 1. None, 2. Primary, 3. Secondary, 4. Technician, 5. University	Male			
	Female			

b) Personal information

What is the regular occupation of each household member? (multiple answers possible) CODE MAIN OCCUPATION=1 FURTHER OCCUPATION =2								
	1. School	2. Agriculture	3. Commerce	4. Artisan	5. Construction worker	6. Technician	7. Domestic work	8. Other? What?
1. Head of household								
2. Spouse								
3. Children < 16								

c) Electric grid

4. What is your nearest town/village connected to the electric grid?	(NAME OF TOWN/VILLAGE)
5. How close is this town/village or your nearest mains power line?	(In km)

6. Do you know of any extension plans to include your village to the grid? Or do you know of other electrification projects (generator, photovoltaic…) of your government or international donors?				
Yes 1		No 0		IF YES
1. What kind of project? Project name?				2. When should the project start?

d) Energy sources used in the household

7. Are you connected to the electric grid?							
Yes 1 (mini-grid)			No 0		IF YES		
Yes 2 (national grid)							
1. Do you have your own meter?			2. Are you connected to a shared meter?				3. How much did you pay last month for your electricity?
Yes 1		No 0		Yes 1		No 0	

8. Do you use a generator?				
Yes 1		No 0		IF YES
1. How many days a week?	2. How many hours per day?			3. How much do you pay per month in total for using the generator?

9. Which of the following energy sources do you use in your household? READ OUT CIRCLE ALL THAT APPLY	10. Code the most important ones 1= most important	11. Quantity per typical week	12. Unity price	13. Expenditures per typical week	14. Place of purchase	15. Distance to the place of purchase	16. How many hours do you spend per week to get the energy sources
1. Candles		_pieces	one candle			____km	_____hr
2a. Kerosene for illumination		_litres	one litre			____km	_____hr
2b. Kerosene for other		_litres				____km	_____hr
3a. Dry cell batteries for lighting		__pairs	one pair			____km	_____hr
3b. Dry cell batteries for radio		__pairs				____km	_____hr
4. Car battery		_piece	unity			____km	_____hr

5. Gas		__litres	one bottle			____km	_____hr
6. Wood		package	one package			____km	_____hr
7. Coal		__kg	one sac/kg			____km	_____hr
8. Diesel/ fuel (generator)		__litres	one litre			____km	_____hr
8. Electricity (grid)		__kWh	one kWh			____km	_____hr
9. Other		__( )	unity			____km	_____hr

e) Household lighting

17. Which of the following lighting devices do you use? USE PHOTOS TO IDENTIFY LAMPS AND CIRCLE ALL THAT APPLY	18. How many of each device do you use on a typical evening? WRITE IN EXACT NUMBER	19. Where is the lighting device located while using it? 1. Floor 2. Table 3. Wall 4. Ceiling 5. Outside 6. Carried	20. How many days a week do you use each type of lighting?	21. How many hours do you light each source the days you use them?	22. How much does the lighting devise costs itself?	23. How much do you spend per week to light each lighting device (running costs per week for paraffin)?	24. What do you mainly use the light-ing for?
1. Firelight							
2. Candles							
3. Paraffin glass cover							
4. Paraffin simple wick							
5. Pressure lamp (gas)							
6. Lamp to gas bottle							
7. Light bulb in socket							
8. Lantern (battery)							
9. Torch (battery)							
10. Electric Incandescent Watt?____							

11. Electric Fluorescent. Watt?____							
12. Solar lamp WHICH ONE______							

25. What, if anything, do you use to light the main room (what is your main lighting source indoors)?_________________________

26. What, if anything, do you use to light outside the house (what is your main lighting source outdoors)?___________________

What would you say are the strengths and weaknesses of your main lighting sources Indoors/outdoors? RECORD EXACT VERBATIM RESPONSE		
Use of lighting devices	1. Strength	2. Weakness
27. Indoors		
28. Outdoors		

29. On average, at what time in the evening do you begin to use lighting devices?	30. On average, at what time in the evening do you turn of the last lighting device?
31. On average, at what time in the morning do you begin to use lighting devices?	32. On average, at what time in the morning do you turn off the last lighting device?

Which activities do household members pursue mainly at night and in the morning when it is dark outside? DO NOT READ OUT ONE CODE ONLY						
Activity	33. Men		34. Women		35. Children<16	
	Morning	Night	Morning	Night	Mor-ning	Night
1. Listening to the radio						
2. Watching TV						
3. Reading						
4. Studying/Homework for school						
5. Some activity that will be compensated in some way What kind of?_________						
6. Domestic work						
7. Socializing/reunions						
8. Other? What?						

36. How many rooms in this dwelling were used after dark yesterday evening? WRITE IN EXACT NUMBER INCLUDING SEPARATE HOUSES, COOK-HOUSES, LAVATORIES__________________

37. How many rooms in this dwelling were lit at all yesterday evening? WRITE IN EXACT NUMBER INCLUDING SEPARATE HOUSES, COOK-HOUSES, LAVATORIES, ETCETERA___________________________

38. Did the use of one of the lighting devices have caused any accidents in your household?

Yes 1		No 0	
IF YES			

1. What kind of lighting device?	2. What kind of accident?

39. Could the light in this household be improved	Yes 1		No 0		IF YES 1. How might it be improved? ONE CODE ONLY READ OUT
1. Introduce lights					
2. Add more lights					
3. Increase the amount of light from each devise					
4. Use a light which is less glaring (so I do not have to shield my eyes)					
5. Operate the light for more hours					
6. Use a light that can be placed in a different position					
7. Other					

40. Do you think there is a current lack of lighting in your household?

Yes 1		No 0	
IF YES			

1. What kind of problems/inconveniences does the current lack of lighting cause? RECORD EXACT VERBATIM RESPONSE

41. Which activities could not be done well or comfortably due to lack of lighting? (multiple mentions possible) DO NOT READ OUT.		What would you or other members of your household do at night if you had better light? (multiple mentions possible) DO NOT READ OUT.		
		Head of household	42. Spouse	43. Children under 16
1. Listening to the radio				
2. Watching TV				
3. Reading				
4. Studying/Homework for school				
5. Some activity that will be compensated in some way, What kind of?_________				
6. Domestic work (cooking, cleaning etcetera				
7. Socializing				
8. Resting				

9. Other, what?				
10. Other, what?				

For each of the following lighting devises you use how would you rate them?
READ OUT DEVISES ONE BY ONE AND APPLY ONLY THOSE THAT ARE USED BY HOUSEHOLD INSERT RELEVANT CODE INTO BELOW GRID

Excellent	4	4	Very easy	4
Good	3	3	Easy	3
Poor	2	2	Difficult	2
Very poor	1	1	Very Difficult	1
	44. Light Quality	45. Adopted to the main use	46. Ease of operation	
1. Paraffin lamp with glass cover				
2. Paraffin lamp with simple wick – no cover				
3. Light bulb in socket or connected to car battery				
4. Candles				
5. Pressure lamp				
6. Lamp connected to a LPG or gas bottle				
7. Battery powered stand up lantern				
8. Flashlight or torch				
9. Incandescent electric light				
10. Fluorescent electric light				
11. Solar lamp FILL IN WHICH ONE______				

47. What is your preferred type of light, excluding mains powered light bulbs? ONE CODE ONLY READ OUT ALL BEFORE THE ANSWER

Type of lighting		1. Why?
1. Nothing / moonlight / starlight / natural light		
2. Firelight		
3. Paraffin lamp with glass cover		
4. Simple paraffin lamp with wick and no cover		
5. Pressure lamp		
6. Lamp connected to a LPG bottle of gas		
7. Light bulb in socket or a lamp connected to a car battery or inverter		
8. Candles		
9. Battery powered stand up lantern		
10. Flash-light / torch (usually hand held)		
11. Other		
12. SOLAR LAMP FILL IN WHICH ONE__________		

f) Health effects

48. Do you ever worry about the health effects using paraffin/kerosene in your home may have on you and your family?

Yes 1		No 0	
IF YES			
1. What kind of?			

g) Radio

49. Do you or some of the household members use a radio?

Yes 1		No 0		
IF YES				

50. How many radios do you use in your household?	51. What is the energy source of the radios? 1. Dry cell batteries, 1. how many? 2. Grid 3. Generator 4. Solar panel 5. Other_______	52. On average, for how long do you use each radio per day?

	53. Head of household	54. Spouse	55. Children <16
1. How long do household members listen to the radio on average per day? (NOT LISTENING CODE=0)			
2. What do they mainly listen to? ONE CODE ONLY 1. Music 2. Information 3. Entertainment 4. Church 5. Community radio 6. Price information 7. Other, what?			

h) Cell phone

56. Do you or some of the household members use a cell phone?

Yes 1		No 0		
IF YES				

57. How many cell phones do you use in your household?	58. Where do you charge the cell phones? 1. Grid at home 2. Grid at neighbour 3. Generator 4. Solar panel 5. Other_______		59. On average, how much do you pay to charge your phone?
	Cell 1		

	60. Head of household	61. Spouse
1. On average, how much do you spend for cell phone credits per week? (NO USE CODE=0)		
2. What do you use the cell phone mainly for? ONE CODE ONLY 1. Call friends/family 2. Work 3. Entertainment 4. Other, what?		

Appendix F. Overview of four frameworks for sustainable biofuels

	European Commission (EC)	European Commission (EC) – general	Roundtable Sustainable Biofuels	Roundtable Sustainable Biofuels – general	Roundtable Sustainable Biofuels – all criteria	Cramer Criteria (NL)	RTFO (UK)
Legalities					Biofuels shall be produced in the most cost-efficient way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain (#11)		
Legal framework			Respect country's existing legal framework (#1)			No violation of national laws and regulation applicable to biomass production and the production area (land and land-use rights), soil management, water management (water-use) and emissions and air quality (air emissions and waste management) (specified under #4, 5, 6 and 7)	Compliance with national laws and regulations relevant to biomass production and the area where biomass production takes place, soil degradation and soil contamination and depletion of water sources. air emissions and burning practices (#2, 3, 4 and 5)
Water rights			Not violate existing formal and customary water rights (#9)				
Land rights	Respect of land use rights (#5a)		Not violate formal and customary land rights (#12)				Not adversely affect existing land rights (#7)
Social		Biannual reporting on social sustainability		Contribute to economic and social development of local rural peoples and communities (#5)			
Stakeholder participation			Participatory process with all relevant stakeholders (#2)				No new plantings are established on local peoples' land without their free, prior and informed consent (#7.1)
Human and labour rights and social well-being	International Labour Organisation Conventions No 29, 87, 98, 100, 105, 111, 138 and 182 (#5a)		Not violate human and labour rights, ensure decent work and well-being of workers (#4)			No negative effects on human rights and working conditions of employees (specified under #9)	Not adversely affect workers' rights and working relationships (#6) and community relations (#7)
Food security and other biomass-applications	Availability of foodstuffs at affordable prices, in particular for people living in developing countries, and wider development issues (#5a)		Biofuel production shall not impair food security (#6)			Production of biomass must not endanger food supply and local biomass applications (#3)	
Economic							
Micro economy						Contribute towards local prosperity (#8)	
Environmental		Requirements and standards under heading "Environment" in Council Regulation (EC) No 1782/2003 (Part A and point 9 of Annex III) and in accordance with the minimum requirements for good agricultural and environmental condition de- fined pursuant to Article 5(1) of that Regulation (#5)					
GHG emission	GHG emission saving of at least 35% (#2)		Contribute significant to GHG emission reduction (#3)			Positive GHG balance of the production chain and application of the biomass (#1)	
Biodiversity	Biofuels and other bioliquids shall not be made from raw material obtained from land with high biodiversity value (#3). Carthagena protocol on biosafety and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (#5a)		Avoid negative impacts on biodiversity, ecosystems and High Conservation Value Areas (#7)			Not affect protected or vulnerable biodiversity and will – where possible – have to strengthen biodiversity (#4)	Biomass production will not lead to the destruction or damage of high biodiversity areas (#2)
Soil – Soil carbon stocks	Biofuels and other bioliquids shall not be made from raw material obtained from land with high carbon stock (#4)					Not be at the expense of carbon sinks in vegetation or soil (#2)	Preservation of above and below ground carbon stocks (#1)
Soil – Soil quality	Soil, water and air protection (#5a)		Improve soil health and minimize degradation (#8)			Soil and soil quality are retained or improved (#5)	Biomass production does not lead to soil degradation (#3)
Water			Optimize surface and groundwater use, minimize contamination or depletion (#9)			Ground and surface water must not be depleted and quality must be maintained or improved (#6)	Biomass production does not lead to the contamination or depletion of water sources (#4)
Air			Minimizing air pollution along the supply chain (#10)			Air quality must be maintained or improved (#7)	Biomass production does not lead to air pollution (#5)

Notes with Appendix F

#5a refers to the proposed principle or criteria in the framework (e.g. #5 means principle or criteria 5).

The appendix includes four frameworks for sustainable biofuels:

1. The EU policy framework for sustainable biomass production (Directive 2009/28/EC) (Council of the European Union, 2008). Under Article 15, the draft Directive proposes seven sustainability criteria for biofuels and other bioliquids. Criteria 1, 6 and 7 refer to the administrative terms, conditions and consequences of demonstrating compliance with Article 15 of the Directive and have therefore not been included in the scheme. Criteria 5 and 5a were so widely formulated, that the authors decided to subdivide the several issues addressed. The final version of Directive 2009/28/EC refers to Council Regulation (EC) 73/2009 of 19 January 2009 that repealed Council Regulation (EC) No. 1782/2003.
2. The Roundtable on Sustainable Biofuels (RSB), a multi-stakeholder platform that developed a voluntary, third-party certification system for biofuel sustainability (Roundtable on Sustainable Biofuels, 2008). Version 0 contains 12 principles of which some are subdivided. The 12 principles have been used in Appendix F.
3. The Dutch Cramer Criteria; a biofuel sustainability framework designed for biomass that is produced, processed and used in the Netherlands (NL) or subsidized by the Netherlands (Project Group Sustainable Production of Biomass, 2007). This framework contains six themes operationalized in nine principles. The nine principles have been used in Appendix F.
4. The UK Renewable Transport Fuels Obligation (RTFO) including sustainability criteria and indicators (Dehue et al., 2008). Seven principles, subdivided in several criterion and indicators. The seven principles have been used in Appendix F.

As – during the study – the EU and RSB frameworks were in the process of being developed, we studied the policy proposal by the Counsel of the European Union (17086/08 of 11 December 2008), and Version 0 of the RSB.

Appendix G. Overview of the SADC sustainability principles (SADC, 2010)

1. Biofuel production shall follow national relevant law and, where applicable, international law.
2. Biofuel production shall be guided by free prior and informed consent by relevant stakeholders.
3. Biofuel production shall contribute positively to rural development through:
   - Non-violation of human and labour rights, promotion of decent work conditions and the wellbeing of workers;
   - Social and economic development of local, rural and indigenous people and communities;
   - Decentralized value-added processing and local participation in the entire value chain.
4. Biofuel production shall contribute positively to local and national food security.
5. Biofuel production shall respect formal and customary land rights and land use rights.
6. Biofuel production shall contribute positively to local and national energy security.
7. Biofuel production shall contribute positively to protect natural resources, ecosystems that provide essential services and biodiversity.
8. Biofuel production shall contribute positively to availability and quality of water and air.
9. Biofuel production shall not lead to deforestation or forest degradation and where possible contribute to rehabilitation of degraded land.
10. Biofuel production shall contribute positively to climate change adaptation and mitigation.
11. Biofuel production shall contribute positively to reduction of greenhouse gas emissions.
12. Agro-ecological zoning should provide guidance on what feedstock to use and where to plant them.

Appendix H. Introduction to FSC, GlobalGAP and Fairtrade

Forest Stewardship Council (FSC) is an independent, non-governmental, non-profit organisation that promotes responsible forest management. FSC is an association of members consisting of a diverse group of representatives from environmental and social groups, the timber trade, indigenous peoples' organisations, responsible corporations, community forestry groups and forest product certification organisations from around the world (FSC, 2009). In Mozambique, two companies are FSC certified.

Global Partnership for Good Agricultural Practice or GlobalGAP certification is a voluntary system driven by the private sector that sets standards for the certification of agricultural products. In Mozambique, there is currently one company with GlobalGAP certification. We know of two companies that are in the process of becoming GlobalGAP certified.

Fairtrade organisations work to improve market access and trading conditions for small-scale producers and plantation workers. Fairtrade organisations pay a minimum guaranteed price to the producer, plus a Fairtrade premium, which must be used for organisational strengthening and community development (FAO, 2006 p. 25). Fairtrade Labelling Organizations International (FLO) is the worldwide umbrella organisation for Fairtrade standard setting and certification. In Mozambique, a few peanut and cashew producers are Fairtrade certified.

SUMMARY

This thesis explores the role of research in policy processes in competing claims contexts. The notion of competing claims is increasingly relevant, in both so-called developing and developed countries. Competing claims often arise in the field of natural resource management. Natural resources have characteristics (limited quantity, increasingly scarce, extractability, culturally defined meaning and unevenly distributed) that give rise to situations in which people have competing claims on those natural resources. Competing claims contexts are characterised by the involvement of a multiplicity of stakeholders. Furthermore, competing claims problems are often embedded in dynamics that exceed different scales and policy levels, are multidimensional, highly complex and surrounded by uncertainty.

Although research is often initiated to support policy processes, practice shows that many research outcomes do not reach the policy arena, arrive in fundamentally different ways than intended, or are used strategically or selectively by stakeholders as ammunition to legitimise political positions. The objective of this thesis is to better understand the dynamics that influence the role of research in policy processes in competing claims contexts. Consequently, this provides the basis for recommendations to enhance the contribution of research to policy processes in competing claims contexts. The study applies an action-oriented research approach, and combines theories and methods from different scientific disciplines. The study is based on a sequential case-study approach that consists of two case studies. The first case study on 'Room for the River' in the Netherlands is exploratory and based on the reconstruction of the policy process that led to the depoldering[67] of De Noordwaard; an agricultural area in the west of the Netherlands (Chapter 3). The study reveals key drivers and sensitising issues that influence the 'space' that research can create in policy processes. These key drivers were studied in more detail during the second case study on the policy debate on biofuel sustainability in Mozambique. The second case study consists of two stages. The first stage describes and explains biofuel developments in Mozambique, and explores what research questions, methods and/or theories can generate research that is perceived credible, legitimate and salient for different stakeholder groups in policy processes (Chapters 4, 5 and 6). The second stage of the case study explores the dynamics of researchers' roles and interactions between research and stakeholders in policy processes when they are contributing to exploring and designing solutions in a multi-stakeholder policy context (Chapters 7 and 8).

Chapter 3 is the first empirical chapter and explores the role of research in the context of the Dutch spatial planning procedure Room for the River. The objective of this chapter is to analyse dynamics that influence the mobilisation and use of research to policy processes in competing claims contexts. In doing so, the study identifies drivers that

[67] Depoldering can best be described as returning a piece of reclaimed land (a polder) to the sea or river.

influence how and to what extent different types of research contribute to opening up or closing down space for stakeholders to influence the course and outcome of policy processes. On the basis of the analysis of secondary data, and interviews and reflections with stakeholders, the policy process was reconstructed, and 11 critical events that led to the decision to depolder De Noordwaard have been identified. Within each of the events, the role of research is analysed. This provides the basis for identifying key drivers that influence the role of research in policy processes in competing claims context. Chapter 3 concludes that what constitutes effective research strongly depends on stakeholder perceptions and objectives, and that research and researchers are strategically included and excluded from the policy arena. Furthermore, the contribution and role of research is highly related to the phase in the policy process, and researchers can fulfil different roles in policy processes. Notably, holistic research approaches that combine research on the policy process (e.g. analysis of legal procedures) with research on policy content (e.g. introduce an alternative policy to depoldering) can create space for change in policy processes. Moreover, strategic timing of research that includes a combination of social-cultural, biophysical, economic, political and legal arguments can create space for change in policy processes in competing claims contexts. The chapter concludes that the contribution of research to policy processes can benefit from more action-oriented research approaches, where both research and researchers are embedded in policy processes.

Chapter 4 introduces the second case study on biofuel sustainability in Mozambique. The chapter provides an up-to-date overview of biofuel developments in Mozambique and explores the extent to which the reality of biofuel developments in Mozambique matches the suggested biofuel production potential in the country. The research approach is based on the idea that understanding biofuel developments in Mozambique requires integral analysis of social-economic, biophysical, political and legal factors. The chapter analyses biofuel legislation and political developments, analyses existing data on Mozambique's biophysical potential for producing biofuels, discusses social and economic drivers, and provides a detailed inventory and analysis of the emerging biofuel sector in Mozambique, including the analysis of 17 biofuel investment proposals that were formally submitted to the Mozambican government. The main conclusion is that biofuel developments mainly take place in areas near good infrastructure, processing and storage facilities, where there is (skilled) labour available, and access to services and goods. The maps used to visualise the geographic spread of biofuel activity in the country served as a starting point for discussions on biofuel sustainability with different stakeholder groups. Moreover, the research findings demonstrate the need for timely harmonisation of investor and government objectives as the majority of projects do not focus on remote rural areas, and – in the absence of domestic markets – principally focus on producing biofuels for international markets.

Chapter 5 provides insights and recommendations for policy on the opportunities and constraints that influence the space for innovation for sustainable community-based biofuel production and use. Promoted by the Mozambican government, jatropha trials were established in Nhambita community in 2005. Initial results were promising, but crop failure and the absence of organised markets led to scepticism amongst farmers. The chapter introduces the idea that understanding the potential and performance of community-based biofuel production and use requires account to be taken of interactions between social-cultural, biophysical, economic, political and legal subsystems across different scales and levels of analysis through time. The chapter builds on theories and methods from different disciplines, and data were collected by a multi-disciplinary team. The analysis demonstrates that heterogeneous farming strategies and their synergies at community level need to be assessed carefully when promoting smallholder biofuel production. Furthermore, national and international political and legal developments, such as the development of biofuel sustainability criteria, influence the local space in which community-based biofuel developments take place. The chapter concludes that *ex-ante* integrated assessment may provide insights into the opportunities and constraints for different types of smallholders. Such insights may provide the basis for creating an enabling environment for sustainable community-based biofuel production and use, and promote the development of adequate policy mechanisms to prevent biofuels from becoming a threat rather than an opportunity for smallholders.

Chapter 6 explores how *ex-ante* scale dynamics analysis can contribute to developing more scale- and level-sensitive policies by analysing how interactions between scales (e.g. spatial, temporal, administrative or institutional) and levels (e.g. local or supranational administrative level) influence solution space in policy processes. In the chapter, the policy debate on biofuel sustainability in Mozambique is positioned in regional (SADC) and international (EU) debates on biofuel sustainability. Firstly, biofuel sustainability frameworks at the international level are analysed, and the potential matches and mismatches between these frameworks and the objectives of the Mozambican government are explored. Secondly, the chapter explores how experiences from commercial and community-based biofuel projects in Mozambique (Chapters 4 and 5) shape the development of a national biofuel sustainability framework. The chapter also makes comparative analyses of biofuel policy development in other countries (Brazil) and other Mozambican sectors (e.g. sustainable forestry) that provide valuable lessons on how challenges related to interactions between scales and levels in the policy debate on biofuel sustainability in Mozambique can be addressed. The chapter concludes that *ex-ante* scale dynamics analysis contributes to: (1) increasing awareness of interactions between scales and levels, and their implications for policy; (2) identifying scale matches and mismatches and developing (adaptive) capacity to address them; and (3) identifying stakeholders and their scale- and level-related interests, and developing an enabling environment for collaborative multi-stakeholder learning. From a more methodological point of view, the chapter concludes that *ex-ante* scale dynamics analysis as part of an action-oriented social science research approach can contribute to policy and policy development that takes into account interactions between different scales and levels. However, it is important that attention is paid to processes of scale and level inclusion and exclusion in scale dynamics analysis. These choices are often political and may affect what stakeholder groups are perceived legitimate and appropriate to defend their interests in the policy arena.

Chapter 7 studies the roles of researchers in policy processes in competing claims contexts, and particularly the relationship between knowledge management roles and innovation management roles in policy processes. By describing and analysing the roles of researchers as knowledge and innovation managers in the policy debate on the sustainability of biofuels in Mozambique, this chapter explores what researchers' roles or combination of researchers' roles can enhance the effective contribution of research to policy processes in competing claims contexts. Based on the analysis of events over time, the chapter describes how action-oriented researchers in the policy debate on biofuel sustainability in Mozambique can fulfil a multiplicity of roles, ranging from knowledge production, to facilitating joint learning in stakeholder networks, to lobbying and fundraising. The chapter concludes that knowledge management roles and innovation management roles are mutually reinforcing and inextricably bound; knowledge management can provide the basis for engaging in innovation management activities or roles, which may – consequently – create an enabling environment for more effective knowledge management in policy processes. The active embedding of researchers in policy processes, an action-oriented research approach and systematic reflection can enable researchers to continuously determine what (combination of) knowledge management and innovation management strategies or roles can enhance the contribution of research to, and the quality of, the policy process. To do so successfully, flexible and process-oriented research approaches are essential.

Chapter 8 studies the dynamics of ideas about the division of tasks and responsibilities (boundary arrangements) between research and stakeholders in policy processes in competing claims contexts. The chapter starts from the perspective that understanding the role of research in multi-stakeholder policy processes requires going beyond the research-policy interface, by analysing boundary arrangements at multiple research-stakeholder interfaces. The chapter describes five episodes in the policy debate on biofuel sustainability in Mozambique. Within each episode, boundary arrangements at the different research-stakeholder interfaces are analysed in relation to the policy context, research activities relating to policy content and policy process, and stakeholder dynamics inside and outside the policy arena. The analysis demonstrates that multiple boundary arrangements at different research-stakeholder interfaces can co-emerge and coexist. Boundary arrangements at a specific research-stakeholder interface are affected by boundary arrangements at other research-stakeholder interfaces. The direction in which boundary arrangements at a research-stakeholder interface develop over time is a complex interplay between the credibility, legitimacy and salience of the research as perceived by stakeholders and the changing policy context over time. Different boundary arrangements relating to policy content (nature of the policy problem) and policy process (the organisation of the policy debate) can coexist at a research-stakeholder interface. Furthermore, boundary arrangements show patterns of path dependency in terms of their credibility, legitimacy and salience for different stakeholders through time.

Chapter 9 concludes the thesis. In competing claims contexts, research and policymaking are two activities that are often carried out simultaneously. In such situations, action-oriented and process-oriented research approaches can provide researchers with the time and

flexibility to become embedded in the policy process. This can build trust with different stakeholders, and enable researchers to engage with different stakeholder groups in describing and explaining problems, and exploring and designing solutions. In-depth insights into policy processes are crucial for enhancing the contribution of research. This provides better understanding of the dynamics in policy processes and how, when and in what form or role research and researchers can contribute to creating space for stakeholders in policy processes in competing claims contexts. Based on insights from the two case studies, a tool for dynamic research configurations is introduced. The tool is developed based on findings from this thesis and visualises the relation between key drivers (e.g. policy phase, scale dynamics, stakeholder groups, researcher's roles or boundary arrangements at research-stakeholder interfaces) that influence the role of research in policy processes in competing claims contexts, how they are related, and how they can change throughout research and policy processes. The tool aims to create awareness and stimulate reflexive thinking among researchers on the role of research in policy processes in competing claims contexts. In so doing, the tool can contribute to more flexible research configurations that can enable researchers to adapt research approaches in light of the changing policy contexts and changing stakeholder configurations in policy processes. The thesis also concludes that similar flexible and adaptive approaches are needed in policy processes and that the academic system should attribute more value to the societal impact of research in order to further stimulate action-oriented research.

RESUMO

Esta tese explora o papel da pesquisa nos processos políticos nos contextos de demandas conflitantes (em Inglês: *competing claims contexts*). O conceito de demandas conflitantes é cada vez mais relevante em chamados países desenvolvidos e países em desenvolvimento. Demandas conflitantes muitas vezes surgem na área da gestão dos recursos naturais. Os recursos naturais têm características (quantidade limitada, cada vez mais escassos, extractabilidade, significado culturalmente definido e distribuição desigual) que dão origem a situações em que as pessoas têm demandas conflitantes sobre estes. Contextos de demandas conflitantes são caracterizados pelo envolvimento duma multiplicidade de intervenientes. Além disso, os problemas que resultam de demandas conflitantes são muitas vezes incorporados em dinâmicas que excedem diferentes escalas e níveis políticos, são multidimensionais, altamente complexos e rodeados de incerteza.

A pesquisa é frequentemente iniciada para apoiar processos políticos. No entanto, a prática mostra que os resultados de muitas pesquisas não chegam à arena política, chegam de forma fundamentalmente diferente do que era pretendido, ou são utilizados estrategicamente ou selectivamente pelos intervenientes como munição para legitimar posições políticas. O objectivo desta tese é compreender melhor as dinâmicas que influenciam o papel da pesquisa nos processos políticos nos contextos de demandas conflitantes. Consequentemente, a tese fornece a base de recomendações para aumentar a contribuição da investigação nos processos políticos nos contextos de demandas conflitantes. O estudo aplica uma abordagem de pesquisa orientada para a acção, e combina teorias e métodos de diferentes disciplinas científicas. O estudo é baseado numa abordagem de estudo de caso sequencial, que consiste de dois estudos de casos. O primeiro estudo de caso, sobre 'Espaço para o Rio' nos Países Baixos, é exploratório e baseado na reconstrução do processo político que resultou em '*depoldering*'[68] De Noordwaard; uma área agrícola no oeste dos Países Baixos (Capítulo 3). O estudo revela os principais factores que afectam o 'espaço' que a pesquisa pode criar para os intervenientes em processos políticos. Esses factores foram estudados em mais detalhes durante o segundo estudo de caso que concerne o debate político sobre a sustentabilidade de biocombustíveis em Moçambique. O segundo caso consiste em duas fases. A primeira fase descreve e explica a evolução de biocombustíveis em Moçambique, e explora que questões de pesquisa, métodos e/ou teorias podem gerar pesquisa que seja considerada credível, legítima e relevante para os diferentes grupos de intervenientes em processos políticos (Capítulos 4, 5 e 6). A segunda fase do caso explora a dinâmica em relação ao papel dos pesquisadores e as interacções entre pesquisa e intervenientes em processos políticos, quando juntos estão contribuindo para a exploração e o desenvolvimento de soluções num contexto político com múltiplos intervenientes (Capítulos 7 e 8). O Capítulo 9 apresenta as conclusões principais.

[68] *Depoldering* pode ser descrito como retornar um pedaço de terra recuperada (um dique) ao mar ou rio.

O Capítulo 3 é o primeiro capítulo empírico e explora o papel da pesquisa no contexto do programa 'Espaço para o Rio' nos Países Baixos. O objectivo deste capítulo é analisar dinâmicas que influenciam a mobilização e o uso da pesquisa nos processos políticos nos contextos de demandas conflitantes. Neste sentido, o estudo identifica os factores chaves que influenciam a forma como e até que ponto os diferentes tipos de pesquisa abrem ou fecham o espaço para os intervenientes induzirem o curso e o resultado dos processos políticos. Com base na análise de dados secundários e entrevistas com os representantes dos intervenientes principais, o processo político foi reconstruído e os 11 eventos críticos que resultaram na decisão do '*depoldering*' De Noordwaard foram identificados. Dentro de cada evento, o papel da pesquisa é analisado. Isso fornece a base para a identificação de factores chaves que influenciam o papel da pesquisa nos processos políticos nos contextos de demandas conflitantes. O Capítulo 3 conclui que o significado da 'pesquisa eficaz' depende acentuadamente da percepção e os objectivos dos intervenientes, mas também que a pesquisa e os pesquisadores são estrategicamente incluídos e excluídos da arena política. Além disso, a contribuição e o papel da pesquisa têm um alto grau de relacionamento com a fase no processo político, e os pesquisadores podem desempenhar papéis diferentes nestes processos. Notavelmente, as abordagens de pesquisas holísticas que combinam a investigação do processo político (por exemplo, análise de procedimentos legais) com pesquisa sobre o conteúdo da política (por exemplo, apresentar uma alternativa para '*depoldering*' podem criar um espaço para influenciar os processos políticos. Ademais, o planeamento estratégico de pesquisa que inclui uma combinação de argumentos socioculturais, biofísicos, económicos, políticos e legais pode criar um espaço de mudanças nos processos políticos. O capítulo conclui que a contribuição da investigação para os processos políticos podem beneficiar-se de abordagens de pesquisa mais orientadas para a acção, onde a pesquisa e os pesquisadores fazem parte dos processos políticos.

O Capítulo 4 introduz o segundo estudo de caso sobre a sustentabilidade de biocombustíveis em Moçambique. O capítulo oferece uma visão actual do desenvolvimento de biocombustíveis em Moçambique e explora como é que esta realidade corresponde ao potencial sugerido para a produção de biocombustíveis no país. A abordagem da pesquisa baseia-se na ideia de que para compreender a evolução dos desenvolvimentos de biocombustíveis em Moçambique, exige-se uma análise integral dos factores socioeconómicos, biofísicos, políticos e legais. O capítulo inclui uma análise da legislação de biocombustíveis e desenvolvimentos políticos, análises de dados existentes sobre o potencial biofísico para a produção de biocombustíveis em Moçambique. Ademais, o capítulo discute factores sociais e económicos, e apresenta um inventário detalhado e análise do sector de biocombustíveis emergente no país, incluindo a análise de 17 propostas de investimento de biocombustíveis que foram formalmente apresentadas ao governo moçambicano. A conclusão principal infere que a evolução de biocombustíveis ocorre principalmente em áreas próximas de boas instalações de processamento, infra-estrutura e armazenagem, onde a mão-de-obra (qualificada) está disponível, e onde há acesso a bens e serviços. Os mapas utilizados para visualizar a distribuição geográfica da actividade de biocombustíveis em Moçambique serviu como um ponto de partida para discutir a sustentabilidade de biocombustíveis com diferentes grupos de intervenientes. Além do mais, os resultados da investigação demonstram a necessidade de harmonizar os objectivos dos investidores e do governo, uma vez que a maioria dos projectos não se concentram em áreas rurais remotas, e – na ausência de mercados internos – o enfoque principal é a produção de biocombustíveis para os mercados internacionais.

O Capítulo 5 explora as oportunidades e os desafios que influenciam o 'espaço de inovação' para a produção e o uso de biocombustíveis por pequenos agricultores e comunidades rurais; resultando em recomendações políticas. Promovida pelo governo moçambicano, realizaram-se experimentos com a planta oleaginosa 'jatrofa' na comunidade de Nhambita em 2005. Nhambita é uma pequena comunidade rural perto de Gorongosa, no centro de Moçambique. Os resultados iniciais foram promissores, mas fracasso da colheita e a ausência de mercados organizados levou ao cepticismo entre os pequenos agricultores. O capítulo aclara que entender o potencial e o desempenho da produção e utilização de biocombustíveis por pequenos agricultores, requer compreensão das interacções entre os factores socioculturais, biofísicos, económicos, políticos e jurídicos em diferentes escalas e níveis de análise ao longo do tempo. O capítulo baseia-se em teorias e métodos de diferentes disciplinas e os dados foram colectados por uma equipe multidisciplinária. A análise demonstra que as estratégias agrícolas heterogéneas e as suas sinergias a nível da comunidade precisam de ser avaliadas com cuidado antes de promover a produção de biocombustíveis por pequenos agricultores. Ademais, desenvolvimentos políticos e jurídicos a nível nacional e internacional, por exemplo o desenvolvimento de critérios de sustentabilidade de biocombustíveis, influenciam o espaço local onde os biocombustíveis são produzidos e utilizados. O capítulo conclui que uma avaliação *ex-ante*[69] integrada pode fornecer percepções sobre as oportunidades e limitações para diferentes tipos de pequenos agricultores. Percepções deste tipo podem fornecer a base para a criação dum ambiente propício para a produção e uso sustentável de biocombustível por pequenos agricultores e comunidades rurais. Também é necessário promover o desenvolvimento de mecanismos de políticas adequadas para prevenir que os biocombustíveis se tornem numa ameaça para os pequenos agricultores, em vez de criar novas oportunidades.

O Capítulo 6 examina como a análise *ex-ante* de interacções entre diferentes escalas e níveis podem contribuir para o desenvolvimento de políticas. Este capítulo descreve e analisa como é que a dinâmica entre diferentes escalas (por exemplo escala espacial, escala temporal, escala administrativa ou escala institucional) e níveis (por exemplo local, nacional ou nível supranacional administrativo) influencia o 'espaço de solução' em processos políticos. Isto é feito posicionando o debate político sobre a sustentabilidade de biocombustíveis em Moçambique em debates regional (SADC) e internacionais (UE) sobre a sustentabilidade de biocombustíveis. Primeiro, alguns esquemas internacionais para a produção sustentável de biocombustíveis são analisados, assim como as semelhanças e as diferenças entre estes esquemas, e os objectivos subjacentes são comparados com os objectivos do governo moçambicano. Segundo, o capítulo explora a forma como as experiências dos projectos comerciais de biocombustíveis e de pequena escala em Moçambique (Capítulos 4 e 5) podem influenciar o desenvolvimento duma política nacional que promove a produção sustentável de biocombustíveis no país. O capítulo também descreve a análise de interacções entre

[69] Avaliação *ex-ante* é levada a cabo antes da implementação.

diferentes escalas e níveis dentro o processo político sobre a sustentabilidade de biocombustíveis no Brasil, e em outros sectores Moçambicanos onde se aplicam esquemas de certificação ou de sustentabilidade (por exemplo o sector florestal sustentável). Estas análises informam o debate político sobre a sustentabilidade de biocombustíveis em Moçambique, e particularmente, como é que a política poderia lidar com as dinâmicas e as interacções entre diferentes escalas e níveis. O capítulo conclui que a análise *ex-ante* da dinâmica entre diferentes escalas e níveis pode contribui para: (1) consciência crescente das interacções entre escalas e níveis, e as suas implicações para a política; (2) identificar semelhanças e diferenças entre as escalas e níveis, e desenvolver capacidade adaptiva para lidar com estes; e (3) identificar intervenientes e os seus objectivos relacionados às diferentes escalas e níveis, e desenvolver a criação dum ambiente onde pode ser realizada a colaboração entre os diferentes grupos de intervenientes. De um ponto de vista metodológico, o capítulo conclui que a análise *ex-ante* da dinâmica entre diferentes escalas e níveis, como parte duma abordagem de pesquisa orientada para a acção, pode contribuir para o desenvolvimento das políticas que estão mais sensitivas às dinâmicas entre diferentes escalas e níveis. No entanto, é importante que se tome em conta os processos que determinam quais escalas e níveis formam parte da análise. Estas decisões são muitas das vezes politicamente orientadas e podem influenciar quais os grupos de intervenientes são considerados legítimos para defender os seus interesses no debate político.

O Capítulo 7 estuda o papel dos pesquisadores nos processos políticos nos contextos de demandas conflitantes, e nomeadamente a relação entre o papel de 'gestão de conhecimento' e o papel de 'gestão de inovação' nos processos políticos. Descrevendo e analisando o papel dos pesquisadores como gestores de conhecimento e gestores de inovação no debate político sobre a sustentabilidade de biocombustíveis em Moçambique, este capítulo explora, quais os papéis, ou uma combinação destes, podem aumentar a contribuição efectiva da pesquisa nos processos políticos. Com base duma descrição dos eventos de pesquisa no processo político ao longo do tempo, o capítulo descreve a forma como os pesquisadores orientados a acção podem desempenhar uma variedade de papéis; por exemplo a gerar novos conhecimentos e percepções, facilitar aprendizagem mútua em redes de intervenientes, mas também fazer lobbies políticos e engajar fundos. O capítulo conclui que o papel de gestão de conhecimento e o papel de gestão de inovação reforçam-se mutuamente e são inextricavelmente ligados; a gestão de conhecimento pode formar a base para o engajamento nas actividades e papéis de gestão de inovação, que por sua vez pode contribuir para um clima favorável para uma gestão de conhecimento mais eficiente nos processos políticos. A incorporação de pesquisadores activos em processos políticos, uma abordagem de pesquisa orientada para a acção, e reflexão sistemática podem permitir que os pesquisadores determinem continuamente que (combinações de) estratégias e papéis de gestão de conhecimento e gestão de inovação poderiam melhorar a qualidade do processo político. Para concluí-la de modo satisfatório, abordagens flexíveis e orientadas para processos são essenciais.

O Capítulo 8 examina ideias sobre a divisão de tarefas e responsabilidades entre pesquisa/pesquisadores e intervenientes nos processos políticos nos contextos de demandas conflitantes. Essas ideias sobre a divisão de tarefas e responsabilidades são conceituadas como *boundary arrangements*. Em português a melhor descrição seria: maneiras de organizar a fronteira entre a pesquisa e intervenientes em processos políticos em relação à divisão do tarefas e responsabilidades. Exemplos de *boundary arrangements* são informar, aconselhar, troca de informações, aprendizagem conjunta, mas também como diferentes grupos de intervenientes tentam influenciar pesquisa e como a pesquisa visa influenciar as decisões de intervenientes. O capítulo parte da perspectiva de que a compreensão do papel da pesquisa em processos políticos de múltiplos participantes requer examinar além da interface entre a pesquisa e o processo político, mas precisa-se uma análise a nível das múltiplas interfaces entre a pesquisa e os diferentes grupos de intervenientes. O capítulo descreve cinco episódios no debate político sobre a sustentabilidade de biocombustíveis em Moçambique. Dentro de cada episódio, os *boundary arrangements* das diferentes interfaces entre a pesquisa e os intervenientes são analisados em relação ao contexto político, as actividades da pesquisa relacionadas ao conteúdo político e processo político, e a dinâmica dos intervenientes dentro e fora da arena política. A análise demonstra que diferentes *boundary arrangements* no interface entre pesquisa e diferentes grupos de intervenientes podem coemergir e coexistir. *Boundary arrangements* em um interface específico entre pesquisa e um grupo de intervenientes são afectados por acontecimentos em outros interfaces entre a pesquisa e intervenientes. A direcção em que os *boundary arrangements* se desenvolvem é uma interacção complexa entre a percepção dos intervenientes sobre a credibilidade, legitimidade e relevância da pesquisa e mudanças dentro do contexto político ao longo do tempo. Diferentes *boundary arrangements* em relação ao conteúdo da política (natureza do problema da política) e processo político (a organização do debate político) podem coexistir em um interface entre a pesquisa e intervenientes. Além disso, os *boundary arrangements* mostram padrões de dependências históricas em termos de credibilidade, legitimidade e relevância para os diferentes intervenientes ao longo do tempo.

O Capítulo 9 conclui a tese. Nos contextos de demandas conflitantes, a pesquisa e a elaboração de políticas são duas actividades que em muitas das vezes são realizadas simultaneamente. Em tais situações, abordagens de pesquisa orientadas para a acção e orientadas para o processo podem fornecer os pesquisadores tempo e flexibilidade para fazer parte do processo político. Isto pode estabelecer confiança entre os diferentes intervenientes, e permitir os pesquisadores de interagir com diferentes grupos de intervenientes na descrição e explicação dos problemas, e juntos explorar e conceber soluções. Entendimento profundo sobre os processos políticos são cruciais para aumentar a contribuição da pesquisa. Isto fornece uma melhor compreensão da dinâmica dos processos políticos e de como, quando e de que forma ou papel a pesquisa e os pesquisadores podem contribuir para a criação dum espaço para os intervenientes nos processos políticos. Com base nas concepções dos dois estudos de caso, um quadro para configurações de pesquisa dinâmica é introduzido no Capítulo 9. O quadro foi elaborado com base nas conclusões desta tese e visualiza a relação entre os factores chaves (por exemplo a fase política, a dinâmica entre diferentes escala e níveis, grupos de intervenientes, os diferentes papéis dos pesquisadores ou os *boundary arrangements* entre pesquisa e intervenientes) que influenciam o papel da pesquisa nos processos políticos nos contextos de demandas conflitantes, como estes estão relacionados, e

como podem mudar durante a pesquisa e processos políticos. O quadro tem como objectivo sensibilizar e estimular o pensamento reflexivo entre os pesquisadores sobre o papel da pesquisa nos processos políticos nos contextos de demandas conflitantes. Ao fazê-lo, o quadro pode contribuir para configurações de pesquisa mais flexíveis e interactivas que possam permitir os pesquisadores de adaptar abordagens de pesquisa às mudanças do contexto político e às mudanças das configurações dos intervenientes no processo político. A tese conclui que semelhantes abordagens flexíveis e adaptáveis são necessárias nos processos políticos. Resumindo, o sistema académico deveria atribuir mais valor à relevância social da pesquisa e continuar a estimular pesquisa orientada para a acção.

SAMENVATTING

Dit proefschrift bestudeert de rol van onderzoek in beleidsprocessen die worden gekenmerkt door conflicterende belangen en concurrerende claims (*competing claims*). Het begrip *competing claims* is in toenemende mate relevant, zowel in zogenaamde ontwikkelingslanden als in meer ontwikkelde landen. *Competing claims* ontstaan vaak rondom het gebruik en management van natuurlijke hulpbronnen, zoals land en water. Natuurlijke hulpbronnen bezitten kenmerken (beperkt voorradig, winbaar, cultureel gedefinieerde betekenis en vaak ongelijk verdeeld) die vaak leiden tot situaties waarin conflicterende belangen en concurrerende claims ontstaan. *Competing claims* contexten worden gekenmerkt door de betrokkenheid van een veelheid aan belanghebbenden, en de problemen beslaan vaak verschillende beleidsniveaus (lokaal, nationaal, regionaal en internationaal). Daarnaast zijn *competing claims* problemen multidimensionaal, uitermate complex en omgeven door onzekerheid.

Hoewel onderzoek vaak als doel heeft beleidsontwikkeling te ondersteunen, laat de praktijk zien dat onderzoeksresultaten vaak de politieke arena niet bereiken, anders worden gebruikt of geïnterpreteerd dan de bedoeling was, of strategisch of selectief worden gebruikt door belanghebbenden als ammunitie om vooringenomen politieke standpunten te legitimeren. Het doel van dit proefschrift is om beter inzicht te krijgen in de dynamiek die de rol van onderzoek binnen beleidsprocessen in *competing claims* contexten beïnvloedt. Dit vormt de basis voor aanbevelingen om de bijdrage van onderzoek aan beleidsprocessen in *competing claims* contexten te verbeteren. De studie hanteert een actiegerichte onderzoeksbenadering, en combineert theorieën en methoden uit verschillende wetenschappelijke disciplines. De studie is gebaseerd op een sequentiële case studie benadering die bestaat uit twee case studies. De eerste casus omtrent 'Ruimte voor de Rivier' in Nederland is verkennend en gebaseerd op de reconstructie van het beleidsproces dat leidde tot het ontpolderen van de Noordwaard; een agrarisch gebied in het westen van Nederland (Hoofdstuk 3). Deze studie onthult de belangrijkste factoren die beïnvloeden hoeveel 'ruimte' onderzoek kan creëren voor belanghebbenden in beleidsprocessen. Deze factoren worden gedetailleerder bestudeerd in de tweede casus over het beleidsdebat omtrent de duurzaamheid van biobrandstoffen in Mozambique. Deze casus bestaat uit twee fasen. De eerste fase beschrijft en verklaart biobrandstofontwikkelingen in Mozambique, en bestudeert welke onderzoeksvragen, methoden en/ of theorieën de potentie hebben onderzoek te genereren dat wordt gezien als geloofwaardig, legitiem en betekenisvol door verschillende groepen belanghebbenden in het beleidsproces (Hoofdstukken 4, 5 en 6). De tweede fase van de casus onderzoekt de dynamiek van rollen die onderzoekers kunnen vervullen ter ondersteuning van beleidsprocessen en de interacties en samenwerkingsvormen tussen onderzoek en verschillende groepen belanghebbenden tijdens het verkennen en ontwerpen van beleidsoplossingen (Hoofdstukken 7 en 8). Hoofdstuk 9 geeft de belangrijkste conclusies.

Hoofdstuk 3 is het eerste empirische hoofdstuk van dit proefschrift en bestudeert de rol van onderzoek in de context van de planologische kernbeslissing 'Ruimte voor de Rivier' in Nederland. Het doel van dit hoofdstuk is het analyseren van de dynamiek die het mobiliseren en het gebruik van onderzoek in beleidsprocessen in *competing claims* contexten beïnvloedt. De studie identificeert factoren die beïnvloeden hoe en in welke mate onderzoek ruimte kan creëren voor belanghebbenden om invloed uit te oefenen op het verloop en de uitkomst van beleidsprocessen. Op basis van de analyse van secundaire data zoals beleidsdocumenten en krantenartikelen, en interviews en reflecties met belanghebbenden is het beleidsproces gereconstrueerd en zijn 11 kritische gebeurtenissen geïdentificeerd die hebben geleid tot het besluit De Noordwaard te ontpolderen. Binnen elk van de kritische gebeurtenissen is de rol van onderzoek geanalyseerd. Dit vormt de basis voor het identificeren van belangrijke factoren die de rol van onderzoek in beleidsprocessen beïnvloeden. Hoofdstuk 3 concludeert dat ideeën over 'effectief onderzoek' sterk afhankelijk zijn van de percepties en doelstellingen van belanghebbenden in het beleidsproces en dat onderzoek en onderzoekers strategisch toegang wordt verleend en ontzegd tot beleidsprocessen. Bovendien is de bijdrage en de rol van onderzoek in beleidsprocessen sterk gerelateerd aan de fase waarin het beleidsproces zich bevindt. Het hoofdstuk concludeert ook dat onderzoekers vaak verschillende rollen vervullen in beleidsprocessen. Een holistische onderzoeksbenadering en onderzoek dat een analyse van het beleidsproces (bijvoorbeeld de analyse van de juridische procedures) combineert met een beleidsinhoudelijk analyse (bijvoorbeeld een beleidsalternatief voor het ontpolderen van De Noordwaard) heeft de potentie om ruimte te creëren in beleidsprocessen. Daarnaast kan het strategisch timen van onderzoek dat een combinatie van sociaal-culturele, biofysische, economische, politieke en juridische argumenten bevat het potentiële aandeel van onderzoek in beleidsprocessen in *competing claims* contexten vergroten. Tenslotte zou de bijdrage van onderzoek kunnen profiteren van een meer actiegerichte onderzoeksbenadering waarbij zowel het onderzoek als de onderzoekers zijn ingebed in beleidsprocessen.

Hoofdstuk 4 introduceert de tweede casus over het beleidsdebat met betrekking tot de duurzaamheid van biobrandstoffen in Mozambique. Het hoofdstuk geeft een up-to-date overzicht van ontwikkelingen op het gebied van biobrandstoffen in Mozambique en onderzoekt in welke mate de realiteit van deze ontwikkelingen overeenkomt met de veronderstelde potentie voor de productie van biobrandstoffen in het land. De onderzoeksbenadering is gebaseerd op het idee dat het begrijpen van biobrandstofontwikkelingen in Mozambique een integrale analyse van sociaal-economische, biofysische, politieke en juridische factoren vereist. Het hoofdstuk analyseert biobrandstofwetgeving en politieke ontwikkelingen, bestaande data over het biofysisch potentieel voor biobrandstofproductie in Mozambique, en de belangrijkste sociale en economische factoren die de ontwikkelingen in de biobrandstofsector beïnvloeden. Daarnaast biedt het hoofdstuk een gedetailleerd overzicht van de opkomende biobrandstofsector in Mozambique, inclusief de analyse van 17 investeringsvoorstellen voor biobrandstofprojecten die formeel werden voorgelegd aan de Mozambikaanse overheid. De belangrijkste conclusie is dat biobrandstofontwikkelingen vooral plaatsvinden in gebieden waar een goede infrastructuur aanwezig is, waar toegang is tot verwerkings- en opslagfaciliteiten, waar (geschoolde) arbeid beschikbaar is en waar toegang is tot diensten en goederen. De kaarten die gebruikt werden om de geografische spreiding van de biobrandstofactiviteiten in het land te visualiseren, dienden als uitgangspunt voor discussies over de duurzaamheid van biobrandstofproductie in Mozambique met verschillende groepen belanghebbenden. Bovendien tonen de onderzoeksresultaten de noodzaak aan voor het tijdig harmoniseren van de doelstellingen van investeerders en de overheid, aangezien de meerderheid van de projecten zich niet richt op vestiging in afgelegen rurale gebieden, en – gezien de afwezigheid van een binnenlandse markt voor biobrandstoffen – zich vooral richten op de productie van biobrandstoffen voor internationale markten.

Hoofdstuk 5 draagt bij aan inzichten en aanbevelingen voor beleid inzake de duurzame productie van biobrandstoffen door kleine boeren en rurale gemeenschappen. Centraal staan factoren die 'ruimte voor innovatie' mogelijk kunnen maken of kunnen beperken. Gepromoot door de Mozambikaanse overheid werden in 2005 proeven met het oliegewas 'jatropha' gestart in Nhambita; een kleine rurale gemeenschap nabij Gorongosa in het midden van Mozambique. De eerste resultaten waren veelbelovend, maar mislukte oogsten en de afwezigheid van georganiseerde markten leidden tot scepsis onder de boeren. Het hoofdstuk introduceert het idee dat het begrijpen van de mogelijkheden en beperkingen van biobrandstofproductie door kleine boeren en rurale gemeenschappen de analyse van interacties tussen sociaal-culturele, biofysische, economische, politieke en juridische factoren op verschillende schalen en niveaus vereist. Bovendien moeten dit soort ontwikkelingen door de tijd beschreven en geanalyseerd worden. Het hoofdstuk is gebaseerd op theorieën en methoden uit verschillende wetenschappelijke disciplines, en de data werden verzameld door een multidisciplinair onderzoeksteam. De analyse laat zien dat heterogene landbouwstrategieën van kleine boeren en hun synergiën op gemeenschapsniveau zorgvuldig moeten worden geanalyseerd voordat de productie van biobrandstoffen door kleine boeren of gemeenschappen wordt gepromoot. Bovendien beïnvloeden nationale en internationale politieke en juridische ontwikkelingen, zoals de ontwikkeling van duurzaamheidscriteria voor biobrandstoffen, de lokale ruimte voor biobrandstofproductie en gebruik. Het hoofdstuk concludeert dat een *ex-ante* (van tevoren) integrale analyse inzicht kan verschaffen in de mogelijkheden en beperkingen voor verschillende typen (kleine) boeren om biobrandstofgewassen te produceren. Dergelijke inzichten kunnen de basis vormen voor het creëren van een gunstig klimaat voor de duurzame productie van biobrandstofgewassen door deze boeren, en het gebruik van biobrandstoffen in rurale gemeenschappen. Daarnaast is het noodzakelijk dat er adequate beleidsmechanismen worden ontwikkeld die voorkomen dat de productie van biobrandstoffen een bedreiging gaan vormen voor kleine boeren, in plaats van nieuwe mogelijkheden te creëren.

Hoofdstuk 6 onderzoekt hoe de *ex-ante* analyse van complexe interacties tussen verschillende schalen en beleidsniveaus kan bijdragen aan beleidsontwikkeling. Dit hoofdstuk beschrijft en analyseert hoe de dynamiek tussen schalen (bijvoorbeeld ruimtelijk, tijd, bestuurlijk of institutioneel) en niveaus (bijvoorbeeld lokaal, nationaal of supranationaal bestuurlijk niveau) de oplossingsruimte in beleidsprocessen beïnvloedt. Dit wordt gedaan door het beleidsdebat over de duurzaamheid van biobrandstoffen in Mozambique te positioneren in regionale (SADC) en internationale (EU) debatten over de duurzaamheid van biobrandstoffen. Op de eerste plaats worden enkele internationale schema's voor duurzame biobrandstofproductie geanalyseerd en worden de overeenkomsten en verschillen tussen deze schema's en de onderliggende doelstellingen vergeleken met de doelstellingen van de Mozambikaanse overheid. Op de tweede plaats wordt gekeken hoe ontwikkelingen op het gebied van bestaande commerciële en kleinschalige biobrandstofprojecten in Mozambique (Hoofdstukken 4 en 5) de ontwikkeling van een nationaal beleidsinstrument ter stimulering van duurzame biobrandstofproductie in Mozambique beïnvloeden. Het hoofdstuk beschrijft ook de analyses van interacties tussen verschillende schalen en niveaus binnen beleidsprocessen voor duurzame biobrandstoffen in Brazilië en andere Mozambikaanse sectoren waar certificerings- of duurzaamheidsschema's in gebruik zijn (bijvoorbeeld duurzame bosbouw sector). Deze analyses bieden waardevolle inzichten voor het beleidsdebat over duurzame biobrandstoffen in Mozambique en dan met name hoe beleid zou kunnen omgaan met de dynamiek en interacties tussen verschillende schalen en niveaus. Het hoofdstuk concludeert dat de *ex-ante* analyse van schaaldynamiek bijdraagt aan: (1) bewustzijn van de interacties tussen schalen en niveaus, en de gevolgen daarvan voor beleid; (2) het identificeren van overeenkomsten en verschillen tussen schalen en niveaus, en het ontwikkelen van aanpassingsvermogen om daar mee om te gaan; en (3) het identificeren van belanghebbenden en hun schaal- en niveau-gerelateerde doelstellingen, en hoe een gunstig klimaat voor een collaboratieve samenwerking tussen verschillende groepen belanghebbenden kan worden vormgegeven. Vanuit een meer methodologisch oogpunt kan geconcludeerd worden dat de *ex-ante* analyse van schaaldynamiek als onderdeel van een actiegerichte, sociaal wetenschappelijke onderzoeksbenadering een belangrijke bijdrage kan leveren aan meer schaal- en niveaugevoelige beleidsontwikkeling. Echter, het is belangrijk dat er aandacht wordt besteed aan de processen die bepalen welke schalen en niveaus wel of geen onderdeel uitmaken van de analyse, aangezien dit soort keuzes onder andere de legitimiteit voor groepen belanghebbenden om hun belangen in het beleidsdebat te verdedigen beïnvloedt.

Hoofdstuk 7 bestudeert de rol van onderzoekers in beleidsprocessen in *competing claims* contexten, en in het bijzonder de relatie tussen kennismanagementrollen en innovatiemanagementrollen. Door het beschrijven en analyseren van de rol van onderzoekers als kennismanagers en innovatiemanagers in het beleidsdebat over de duurzaamheid van biobrandstoffen in Mozambique, exploreert dit hoofdstuk welke onderzoekersrollen of combinaties van onderzoekersrollen de effectieve bijdrage van onderzoek aan beleidsprocessen in *competing claims* contexten zouden kunnen vergroten. Aan de hand van een beschrijving van onderzoekersrollen in het beleidsproces door de tijd heen, wordt duidelijk hoe actiegerichte onderzoekers een veelheid aan rollen kunnen vervullen, variërend van het genereren van nieuwe kennis en inzichten, het faciliteren van gezamenlijk leren, het bouwen en verbinden van netwerken van belanghebbenden, maar ook lobbyen en het werven van fondsen kunnen daar onderdeel van uitmaken. Het hoofdstuk concludeert dat kennismanagementrollen en innovatiemanagementrollen elkaar versterken en zelfs onlosmakelijk met elkaar zijn verbonden; kennismanagementactiviteiten en -rollen kunnen de basis vormen voor het uitoefenen van innovatiemanagementactiviteiten en -rollen, die – vervolgens – kunnen bijdragen aan een gunstig(er) klimaat voor efficiënter kennismanagement in beleidsprocessen. De actieve inbedding van onderzoekers in beleidsprocessen, een actiegerichte onderzoeksbenadering en systematische reflectie kunnen onderzoekers in staat stellen om continu te bepalen welke (combinatie van) kennismanagement- en innovatiemanagementstrategieën of rollen de kwaliteit van het beleidsproces zouden kunnen verbeteren. Om dit te kunnen doen zijn een flexibele en procesgerichte onderzoeksbenadering van essentieel belang.

Hoofdstuk 8 bestudeert ideeën over de verdeling van taken en verantwoordelijkheden (zogenaamde 'grensarrangementen') tussen onderzoek en groepen belanghebbenden in beleidsprocessen in *competing claims* contexten. Het hoofdstuk start vanuit het idee dat de analyse van grensarrangementen op het niveau van de onderzoek-beleid interface te statisch is om de complexe rol van onderzoek in beleidsprocessen in *competing claims* contexten goed te kunnen begrijpen. Er wordt daarom gekozen voor het analyseren van grensarrangementen tussen onderzoek en verschillende groepen belanghebbenden (onderzoek-belanghebbende interfaces). Het hoofdstuk beschrijft vijf episodes uit het beleidsdebat over de duurzaamheid van biobrandstoffen in Mozambique. Binnen elke episode worden de grensarrangementen tussen onderzoek en overheid, onderzoek en private sector, en onderzoek en maatschappelijke organisaties geanalyseerd. Dit gebeurt in relatie tot de beleidscontext, de onderzoeksactiviteiten gerelateerd aan beleidsinhoud en beleidsproces, en de dynamiek tussen belanghebbenden binnen en buiten de beleidsarena. De analyse toont aan dat verschillende typen grensarrangementen tussen onderzoek en verschillende groepen belanghebbenden naast elkaar kunnen bestaan. Grensarrangementen tussen onderzoek en een specifieke groep belanghebbenden worden beïnvloed door de grensarrangementen tussen onderzoek en andere groepen belanghebbenden. Bovendien, de richting waarin grensarrangementen ontwikkelen door de tijd is een complex samenspel tussen de geloofwaardigheid, legitimiteit en relevantie van het onderzoek voor verschillende groepen belanghebbenden en de veranderende beleidscontext. Verschillende ideeën over de verdeling van taken en verantwoordelijkheden met betrekking tot beleidsinhoud (aard van het beleidsprobleem) en het beleidsproces (hoe het beleidsdebat te organiseren) kunnen naast elkaar bestaan op eenzelfde onderzoek-belanghebbende interface. Verder vertonen grensarrangementen patronen van pad-afhankelijkheid. Dit betekent dat de geloofwaardigheid, legitimiteit en betekenis van grensarrangementen voor de verschillende groepen belanghebbenden worden beïnvloed door eerdere grensarrangementen.

Hoofdstuk 9 sluit het proefschrift af. In *competing claims* contexten vinden onderzoek en beleidsontwikkeling vaak tegelijkertijd plaats. In dergelijke situaties kan een actie- en procesgerichte onderzoeksbenadering onderzoekers de tijd en flexibiliteit bieden zich te verankeren in beleidsprocessen. Dit draagt bij aan het opbouwen van vertrouwen tussen de onderzoeker en verschillende groepen belanghebbenden om samen problemen te beschrijven en te verklaren, en samen oplossingen te verkennen en te ontwerpen. Diepgaande inzichten in beleidsprocessen zijn cruciaal voor het verbeteren van de bijdrage van onderzoek aan beleidsontwikkeling. Het zorgt voor een beter besef van de dynamiek in beleidsprocessen en hoe, wanneer en in welke vorm of rol onderzoek en onderzoekers kunnen bijdragen aan het creëren van ruimte voor belanghebbenden in beleidsprocessen. Op basis van inzichten uit de twee case studies, wordt in Hoofdstuk 9 een instrument voor dynamische onderzoeksconfiguraties geïntroduceerd. Dit instrument is ontwikkeld op basis van de bevindingen uit het proefschrift en visualiseert de relatie tussen de belangrijkste factoren die de rol van onderzoek in beleidsprocessen in *competing claims* contexten beïnvloeden; bijvoorbeeld beleidsfase, schaaldynamiek, groepen belanghebbenden, onderzoekersrollen en grensarrangementen. Daarnaast biedt het instrument inzicht in hoe de verschillende factoren verwant zijn, elkaar beïnvloeden en kunnen veranderen gedurende onderzoeks- en/ of beleidsprocessen. Het instrument is ontwikkeld om bewustzijn te creëren en reflexief denken over de rol van onderzoek in beleidsprocessen te stimuleren. Op die manier kan het instrument bijdragen aan meer dynamische onderzoeksconfiguraties die onderzoekers kunnen ondersteunen bij het aanpassen van onderzoek aan de veranderende beleidscontext en de veranderende dynamiek tussen belanghebbenden in beleidsprocessen. Het proefschrift concludeert ook dat een soortgelijke flexibele en adaptieve benadering nodig is in beleidsprocessen, zodat ook tijdens latere fases in beleidsprocessen nog relevante onderzoeksbevindingen kunnen worden meegenomen. Tenslotte zou het academische systeem meer waardering moeten toekennen aan de maatschappelijke relevantie van onderzoek om zo ook actiegericht onderzoek verder te stimuleren.

ABOUT THE AUTHOR

CURRICULUM VITAE

Marc Schut was born on 4 July 1979 in Doetinchem, the Netherlands. He grew up in a small rural village called Varsselder Veldhunten, where he spend his young years playing soccer and building huts with his friends.

After completion of his lower secondary education at *Bluemers Mavo* in Silvolde and higher secondary education at *Isala College* in Silvolde, he started vocational education on gardening, horticulture and landscaping at Helicon Education in Nijmegen. After graduation in 2000, he continued his studies at Stoas University for Applied Sciences and Teacher Education in 's-Hertogenbosch. In the final year of the study, he did an internship in South Africa, where he discovered his interest in development and innovation processes. His final internship and BSc thesis were undertaken with the Dutch Ministry of Foreign Affairs (DGIS) in The Hague where he conducted a study on vocational training projects in developing countries.

In November 2006, Marc obtained his *Cum Laude* MSc in Management of Agro-ecological Knowledge and Social Change (MAKS – nowadays Master of Development and Rural Innovation) at Wageningen University. He conducted his fieldwork for the MSc thesis in Ecuador, South America. During the six months of fieldwork, he analysed the performance of Farmer Field Schools by different organisations in central and northern Ecuador. His analysis explored the contribution of Farmer Field Schools to paradigm shifts in crop protection management, rural development and agricultural extension.

After short assignments for the Farmer Field School Foundation and teaching at Stoas University, Marc started his PhD research in August 2007 with the Communication and Innovation Studies Group of Wageningen University. On the basis of case studies in the Netherlands and Mozambique his research contributed to a better understanding of the dynamics that influence the role and impact of research to policy processes in competing claims contexts. During two years of fieldwork in Mozambique, he contributed as policy advisor to developing a national policy framework for sustainable biofuels, the first of its kind in Africa. Marc remained involved as coordinator of a project that seeks to further operationalise and implement the policy framework for sustainable biofuels in Mozambique.

Since January 2012, Marc is working as postdoctoral researcher in the PARASITE project of Wageningen University. Within this project, he studies the institutional dynamics of crop protection and weed management in smallholder rice production in different African countries.

Besides his work, Marc is a fanatic triathlete and he likes gardening, reading and music. More information about the author can be found on: http://www.marcschut.org.

PUBLICATIONS AND PRESENTATIONS

Research articles in scientific peer reviewed journals:

Schut, M., C. Leeuwis and A. van Paassen (2010). Room for the River – Room for Research? The case of depoldering De Noordwaard, the Netherlands. Science and Public Policy 37(8): 611-627.

Schut, M., M. Slingerland and A. Locke (2010). Biofuel developments in Mozambique. Update and analysis of policy, potential and reality. Energy Policy 38(9): 5151-5165.

Schut, M., C. Leeuwis, A. van Paassen and A. Lerner (2011). Knowledge and innovation management in the policy debate on biofuel sustainability in Mozambique: what roles for researchers? Knowledge Management for Development Journal 7(1): 45-64.

Schut, M., A. van Paassen, C. Leeuwis, S. Bos, W. Leonardo and A. Lerner (2011). Space for innovation for sustainable community-based biofuel production and use: lessons learned for policy from Nhambita community, Mozambique. Energy Policy 39(9): 5116-5128.

Research reports:

Klosterman, J., F. Geerling-Eiff, M. Schut, E. van Slobbe, C. Terwisscha van Scheltinga and E. Wielinga (2009). Samen breien aan gebiedsontwikkeling. Verkenning van de theorie over het gebruik van wetenschappelijke kennis in gebiedsprocessen. Den Haag, LEI, Wageningen University and Research Centre, Wageningen, the Netherlands.

Schut, M., S. Bos, L. Machuama and M. Slingerland (2010). Working towards sustainability. Learning experiences for sustainable biofuel strategies in Mozambique, Wageningen University and Research Centre, Wageningen, the Netherlands in collaboration with CEPAGRI, Maputo, Mozambique.

Bos, S., W. Leonardo, A. Lerner and M. Schut (2010). Assessing the potential of bioenergy production in smallholder farming systems: The case of Nhambita community. Maputo, GTZ-ProBEC, Maputo, Mozambique and Wageningen University and Research Centre, Wageningen, the Netherlands.

Book chapters:

Pleijte, M., M. Schut and R. During (2011). Reflexivity in action research: two spatial planning cases. In: Knowledge in action. The search for collaborative research for sustainable landscape development. A. van Paassen, J. van den Berg, E. Steingröver, R. Werkman and B. Pedroli. Wageningen, Mansholt Publication Series, Wageningen Publishers. 11. pp: 221-243.

Sherwood, S., M. Schut and C. Leeuwis (2012). Learning in the Social Wild: Encounters between Farmer Field Schools and Agricultural Science and Development in Ecuador. In: Adaptive Collaborative Approaches in Natural Resources Governance: Rethinking Participation, Learning and Innovation. H.R. Ojha, A. Hall and R. Sulaiman. London, UK., Routledge.

Conference papers:

Schut, M. (2008). Mobilization of knowledge in competing claims context. A research proposal for studying: “Space for change in complex societal negotiation processes over natural resources”. International Farming Systems Association (IFSA), 6-10 July 2008, Clermont-Ferrand, France. pp: 23-33.

Schut, M., N. Cunha Soares, C. Leeuwis and A. van Paassen (2011). The research-policy interface of biofuel sustainability in Mozambique. 10th African Crop Science Society Conference: From Soil to Soul. Crop Production for Improved African Livelihoods and a Better Environment for Future Generations, 10-13 October 2011, Maputo, Mozambique. pp: 223-224.

Online publications:

Sherwood, S., M. Schut and C. Leeuwis (2011). Erosion of Farmer Field Schools in Ecuador. Politics of Agricultural Science and Development Practice. Research Into Use (RIU) Programme. Department for International Development, U.K. Available at: http://www.researchintouse.com/learning/learning23final.html.

Presentations at international conferences:

IFSA Symposium. “Mobilization of knowledge in competing claims context.” Clermont Ferrand, France. 6-10 July 2008.

Freude am Fluss Conference. “‘Disputed knowledge’: obstacle for participatory planning?” Nijmegen, the Netherlands. 22-23 October 2008.

Africa Bioenergies Conference. “Blending perspectives on sustainability.” Addis Ababa, Ethiopia. 16-18 June 2009.

Scientific Seminar Biofuels Eduardo Mondlane University. “Keeping it real.” Maputo, Mozambique. 10-12 September 2009.

LEI Scientific Symposium: Research and biofuels; contributing to sustainable biofuel developments. “Boundary-work in developing a framework for sustainable biofuel production in Mozambique.” The Hague, the Netherlands. 8 April 2010.

Bioenergy Markets Africa. “Towards sustainable biofuel developments in Mozambique.” Maputo, Mozambique. 11-13 May 2010.

African Crop Science Society Conference. “Biofuel sustainability in Mozambique.” Maputo, Mozambique. 10-13 October 2011.

COMPLETED TRAINING AND SUPERVISION PLAN

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Wageningen School of Social Sciences (WASS)

Name of the activity	Department/institute	Year	ECTS[70]
A. CERES-specific part			
CERES orientation	CERES	2008	5
CERES presentation tutorials 2008	CERES	2008	5.5
PhD competence assessment	WUR/ CERES	2007	0.3
Research methodology I; from topic to proposal	MGS	2007	4
A practical course on the methodology of fieldwork	CERES	2008	2
"Bioenergy initiatives in Mozambique."	CERES Summerschool	2009	2
"Boundary arrangements at the research-policy interface of the policy debate on biofuel sustainability in Mozambique."	WASS research day, Wageningen	2011	0.5
Research proposal	CERES	2008	6
B. General part			
The art of writing	WUR	2007	1.8
Working with EndNote 9	WUR	2007	0.3
C. Discipline-specific part			
Analysing farming systems and rural livelihoods in a changing world	Harare, Zimbabwe	2008	3
D. Presentations and conferences			
"Mobilization of knowledge in competing claims context."	IFSA Symposium, Clermont Ferrand, France	2008	2
"'Disputed knowledge': obstacle for participatory planning?"	Freude am Fluss Conference, Nijmegen	2008	2
"The role of research in competing claims context."	INREF, Massingir, Mozambique	2008	2
"Blending perspectives on sustainability."	2nd Africa Bioenergy Conference, Addis Ababa	2009	1
Scientific seminar on biofuels. "Keeping it real."	Maputo, Mozambique	2009	1
Competing claims on natural resources. "Keeping it real."	INREF, Mushumwe Pools, Zimbabwe.	2010	2
"Boundary-work in developing a framework for sustainable biofuel production in Mozambique."	Symposium: Research and biofuels, LEI, The Hague	2010	0.5
"Towards sustainable biofuel developments in Mozambique."	Green Power Conferences, Maputo, Mozambique	2010	0.5
"Positioning of SADC countries in the biofuel sustainability debate: Experiences from Mozambique."	SADC Biofuel Taskforce Meeting, Maputo, Mozambique	2010	0.5
Masterclass: "Biofuel developments in Mozambique."	Evert Vermeer Foundation, Wageningen, the Netherlands	2010	0.5
"Biofuel sustainability in Mozambique."	African Crop Science Society Conference, Maputo, Mozambique	2011	0.5
Total			**42.9**

[70] One ECTS on average is equivalent to 28 hours of course work.

FUNDING

The research described in this thesis is part of the strategic research programme 'Sustainable spatial development of ecosystems, landscapes, seas and regions' that is executed by Wageningen University and Research Centre and funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation.

Additional funds for the research have been acquired from the 'Competing Claims-Competing Models' programme by Wageningen University and Research Centre and the Dutch Ministry of Foreign Affairs (DGIS), and the project 'Operationalizing and implementing the biofuel sustainability framework for Mozambique' that is executed by Wageningen University and Research Centre in collaboration with the Mozambican government, and funded by NL Agency which forms part of the Dutch Ministry of Economic Affairs, Agriculture and Innovation.

Any findings, recommendations or opinions expressed in this thesis do not necessarily reflect the views of any of the parties that provided funding for the study.

Printing: Print Service Ede
This thesis is printed on FSC-certified paper

Cover design: Joris Ketelaar – 14over (http://www.14over.nl)

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