Project no. GOCE-036955

LUPIS

Land Use Policies and Sustainable Development in Developing Countries

Specific Targeted Project
Integrating and Strengthening the European Research Area

D14.9: A cross-country comparative report integrating the results from impact assessment in WP7-WP13

Due date of deliverable: March 2011

Submission date: 25 August 2011

Start date of project: February 1, 2007　　　　**Duration: 50 months**

Organisation name of lead contractor for this deliverable: LEI

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Authors of this report and contact details:

Name: Irina Bezlepkina   Partner acronym: LEI
Address: PO Box 29703, 2502 LS Den Haag, The Netherlands
E-mail: irina.bezlepkina@wur.nl

Name: Floor Brouwer   Partner acronym: LEI
Address: PO Box 29703, 2502 LS Den Haag, The Netherlands
E-mail: floor.brouwer@wur.nl

Name: Huib Silvis   Partner acronym: LEI
Address: PO Box 29703, 2502 LS Den Haag, The Netherlands
E-mail: huib.silvis@wur.nl

Name: René Verburg   Partner acronym: LEI
Address: PO Box 29703, 2502 LS Den Haag, The Netherlands
E-mail: rene.verburg@wur.nl

Name: Ingrid Nesheim   Partner acronym: UiO
Address: P.O.Box 1116 Blindern, NO-0317 Oslo, Norway
E-mail: ingrid.nesheim@sum.uio.no

Name: Pytrik Reidsma   Partner acronym: WU
Address: P.O.Box 430 NL-6700 AK Wageningen, the Netherlands
E-mail: pytrik.reidsma@wur.nl

Name: Seema Purushothaman   Partner acronym: ATREE
Address: No. 659, 5 th A Main, Hebbal BP 5035,
Bangalore 560 024, Karnataka, India
E-mail: seemap@atree.org

Name: Sheetal Somashekar Patil   Partner acronym: ATREE
Address: No. 659, 5 th A Main, Hebbal BP 5035, Bangalore 560 024, Karnataka, India
E-mail: sheetal@atree.org

Name: Hannes König   Partner acronym: ZALF
Address: Eberswalder Strasse 84D, 15374 Müncheberg, Germany
E-mail: hkoenig@zalf.de

Name: Johannes Schuler   Partner acronym: ZALF
Address: Eberswalder Strasse 84D, 15374 Müncheberg, Germany
E-mail: jschuler@zalf.de

Name: Abdeladhim Mohamed Arbi,   Partner acronym: IRA
Address: Laboratoire d'Economie et Sociétés Rurales
IRA Médenine, Route de Jorf, Km 22,5, 4119 Médenine, Tunisia,
E-mail: abdeladhim01@yahoo.fr

Name: Mongi Sghaier

Address: El Fje, Route Jorf, Km 22,5 , 4119, Médenine Tunisia

E-mail: s.mongi@ira.rnrt.tn

Partner acronym: IRA

Name: Youssouf Cissé

Address: BP 258 - Rue Mohamed V, Bamako - Mali

E-mail: cisse_y@yahoo.com

Partner acronym: IER

Name: Jean Philippe Tonneau

Address Campus international de Baillarguet,
TA C-91 / F, 34398 Montpellier, Cedex 5, France,

E-mail: jean-philippe.tonneau@cirad.fr

Partner acronym: CIRAD

Name: Shuyi Feng

Address: Weigang No. 1, 210095 Jiangsu province, P. R. China

E-mail: shuyifeng@njau.edu.cn

Partner acronym: NJAU

Name: Patrick Gicheru

Address: PO Box 14733, Nairobi, Kenya

E-mail: cdnarl@iconnect.co.ke

Partner acronym: KARI

Name: Stella Makokha

Address: POB 14733, Nairobi, Kenya

E-mail: stellamakokha@yahoo.com

Partner acronym: KARI

Name: Le Chen

Address: PO Box 29703, 2502 LS Den Haag, The Netherlands

E-mail: le.chen@wur.nl

Partner acronym: LEI

Name: Nina Novira

Address: Bulaksumur, Yogyakarta, Indonesia 55281

E-mail: nina.novira@gmail.com

Partner acronym: GMU

Name: Utia Suarma

Address: Bulaksumur, Yogyakarta 55281, Indonesia

E-mail: lupisindonesia@gmail.com

Partner acronym: GMU

Name: Saulo Rodrigues-Filho

Address: CDS-UnB, Universidade de Brasília,
Campus Universitário, Gleba A, Brasília, DF CEP 70910-900, Brazil

E-mail: srodrigues@unb.br

Partner acronym: FUB

Name: Marcel Bursztyn

Address: Gleba A, Reitoria Brasília, DF CEP 70910-900, Brazil

E-mail: marcel.cds@gmail.com

Partner acronym: FUB

Disclaimer:

Table of contents

General part

Objective within the project

This document presents a report that is meant to synthesize the achievements within the project on the application of methodologies and tools.

While a certain degree of local variation in the tools is necessary, the report aims at comparability between country studies. This comparability between the seven case studies is done based on the Driver Pressure State Impact Response (DPSIR) framework when comparing the types of problems and drivers that play a role around implementation of land use related issue (Part II). The case studies are also compared regarding the application of a Framework for Participatory Impact Assessment (part III). General conclusions regarding the scope of Impact Assessment and its design in each of the seven case studies in LUPIS project provide yet another angle for comparing the research outcomes among the case studies.

Executive summary

Problem

Land use changes in developing countries are considered critical to sustainable development; and land use policy is an important tool to control land use conversion. In order to address land use change, it is essential to understand the impact of land use policy on sustainable development. The selection of optimal policies requires a good understanding of the key driving forces in the area, including human activities, such as immigration and agricultural intensification and underlying factors, such as human population dynamics, or economic growth that underpin the proximate causes and either operate at the local level or have an indirect impact from the national or global level. The institutional context determines whether the selected polices can be effectively and successfully implemented. To understand this complexity of interacting factors, an integrated approach is required, drawing on various disciplines and assessing the combined effects of socio-economic, environmental and institutional factors. Meeting the challenges facing sustainable development in developing countries requires a proper understanding of the linkages between rural development, poverty reduction, (particularly food security and enhancing livelihood quality) and environmental management.

For the ex-ante analysis of land use policies for sustainable development in developing countries assessment procedures are provided. These make use of a generic and flexible analytical framework that enables understanding of the effect of different land use policies on sustainable development. This analytical framework covers all the necessary steps in an ex-ante impact assessment - from problem identification to communication of assessment results. It has been applied in seven case study countries in Africa, Asia and Latin America, differing considerably with regard to the economic, environmental and social dimensions.

Case studies

In seven case studies the sustainable development problem is put in its environmental, economic and social dimensions.

The case study in Tunisia concerns the complex interaction between socio-economic development and environmental degradation. Increasing human needs and agricultural development have led to very

high pressures on the fragile natural resources of the basin. Land degradation is becoming increasingly serious due to increased sedentarization, land fragmentation and growth of the agricultural sector. The case study focuses primarily on two environmental policies: 'Water and soil conservation strategies', and the 'Policy of saving water and incentives to irrigation'.

The case study in Kenya is concerned with an increasing population leading to uneconomic land fragmentation and land degradation. Poor growth in the agricultural sector has been attributed to land degradation, increased droughts and floods, inadequate markets and marketing infrastructure. The main policy assessed is that concerning land tenure, whereby private land rights are distributed at the expense of the customary land tenure holders.

The case study in India covers selected districts in Northern Karnataka and illustrates how the social, or poverty, dimension of sustainable development interacts with the economic and environmental. India has experienced rapid economic growth in recent years, and like many other parts of the country Karnataka has witnessed a commercialization of agriculture in terms of input application, choice of crops and marketing of products. The inherent risks involved in inputs for intensive commercial crops are high, especially for small-scale farmers.

The case study on Taihu Lake in China exemplifies the conflict between two dimensions of sustainable development: economic development and conservation of the environment. Since the 1980s, the water in the major rivers running into Lake Taihu, and in the lake itself, has become seriously polluted, and the nitrogen and phosphorus eutrophication of water have become major environmental problems. This case study focuses especially on the agricultural sector, and policies to improve water quality in the lake and sustainable development more broadly.

The case study in Mali concerns the irrigation scheme, the 'Office du Niger', and irrigation scheme created for rice production. Droughts in the Sahel area and particularly in Mali have caused people to migrate to the Office du Niger. The increasing population has led to competition over land, deforestation and water pollution. Extension policies and privatization of land have been implemented by the government with the aim of enhancing food security. Policies to be assessed are related to the scarce natural resources and the coexistence of pastoralists and farmers in the area.

The main problem in the case study of Indonesia addresses uncontrolled land-use change from agriculture to non-agricultural use in the province of Yogyakarta special region (D.I.Y.). The rapid urbanization and migration into the area have become threats to both the environmental and the social dimensions of sustainable development. The case study discusses the feedback mechanisms behind this change in land use and addresses several related policies: planning policies, development policies and agricultural policies.

The Brazilian case study concerns deforestation in the Amazon region related to the paving of the full length of the 1,780 km federal highway BR-163 that crosses part of the states of Mato Grosso and Pará. The motivation for this investment is to promote economic development in rural areas, but it has major side effects on biodiversity loss and CO_2 emissions. The demand for commodities as a driver of this development is discussed, along with the impact of weak governance in relation to conservation and sustainable use policies; colonization and land reform programmes; and infrastructure projects.

Driving forces, Pressure, State, Impact and Responses (DPSIR) framework

The interrelated causes of the situation are analysed by identifying key drivers, and selected land use policies of particular relevance. Indicators are selected for the assessment of land use policies. Prioritized land use policies are discussed in relation to its potential impact. The first stage in the analysis of the case studies is based on the Driving forces, Pressure, State, Impact and Responses (DPSIR) framework. This presents the trade-offs that exist between the three dimensions of SD: in many cases economic development on one side and environment and social equity on the other. These trade-offs, related to the potential or actual conflict between development and the environment, also

appear as trade-offs between the interests of present and future generations. Selecting the appropriate policy option then requires making value trade-offs, based on the views of stakeholders and experts.

The Driver Pressure State Impact Response (DPSIR) story lines, policy priorities and value trade-offs are identified by stakeholders and experts in National Policy Forums. Important drivers of land use change impacting main land use problems among the case studies were economic growth, technological development, immigration and agricultural intensification, in addition to existing policies. Of the latter the most important were related to domestic support through various forms of subsidies or access to credit, land tenure polices and liberalization policies. In the policy prioritisation, the value trade-offs made by the National Policy Forums emphasize the environment rather than increased economic production. It is recognized that the environment needs to be improved to maintain and improve economic production in the long term, both in agriculture and in other sectors.

Framework for Participatory Impact Assessment (FoPIA)

In five of the seven case studies the Framework for Participatory Impact Assessment (FoPIA) has been used to conduct stakeholder-based impact assessments. Starting with the scenario development in which alternative options of policy implementations were rationalized, the Land Use Function (LUF) concept of FoPIA was employed to assess policy impacts in the light of SD and to compare results across regions. The regional importance attached to LUFs by stakeholders from different regions was varied. Assessment of the business as usual scenario revealed that without policy intervention mainly the environmental LUFs will be degraded in the future while economic and to some extend also the social LUFs will experience positive developments. This result pointed at the initial justification of the intended and respective policy interventions, which indeed targeted at environmental performances. However, most policies only tackled the specific environmental land use problem and the analysis of this study explored possible trade-offs of policy impacts on all three, the social, the economic and the environmental LUFs. Main similarities and differences of regional policy impacts and underlying factors are discussed. The FoPIA proved to be a useful tool, both for illuminating complex regional human-environment interactions and for supporting the communication and social learning process amongst interdisciplinary stakeholder groups.

Lessons

Although the case studies are very varied, some general conclusions emerge regarding the design and use of tools to assess the impacts of land use policies.

To ensure local knowledge and anchoring, stakeholders should be consulted. Such consultation includes regular interaction between policy makers and the researchers involved. Such interaction increases both the quality and the policy relevance of the research. It is essential to design and implement policies that are forward looking, taking into account the challenges that are often felt at regional level between economic development, with its claims on the physical and natural environment, and the broader social context. In many poor countries existing research currently underestimates the importance of the ecological and social dimensions that shape, and are shaped by, economic development. To overcome such constraints, research capacity to perform impact assessments is urgently needed.

Participatory approaches provide a source of new ideas for policy options. Such participatory approaches require a careful selection of participants. If this is not done in a proper manner, the impact assessments would at best result in biased outcomes, and could even provide incorrect claims about the links between land use policies with sustainable development. Focus groups, for example, are suitable to analyse the policies for implementation by the actors. As part of such focus groups, factors critical to the successful implementation of policies could be identified as well as strategies to cope with them in real-world situations.

A prerequisite for an integrated impact assessment is a multidisciplinary approach. It is necessary to draw on a range of disciplines, from both natural and social sciences. It is important that researchers work together over an extended period of time, in order to clarify and resolve differences in perspective, and even terminology, as a basis for undertaking a coherent and integrated study which is accessible to policy-makers.

Major data constraints are often faced when preparing an integrated assessment. Serious limitations in data availability should not prevent researchers from understanding the issues at stake and exploring the room for policy intervention; expert knowledge can often be used in place of statistics. Regular interaction between researchers and policy makers is indispensible to explore promising intervention strategies.

The impacts of policies are felt at different scales. While the impact of measures are felt mainly by individual actors, in the case of economic and social domains, pressures on the environment (and the impact of measures to reduce them) are often observed at regional level. Policy measures need to be taken that cope with such pressures across the different spatial levels.

In selecting policy options, and in assessing their impact, it is important to be realistic about the willingness and ability of government to implement them, and to build this into the assessment methodology.

Specific part

1. Part I: Overview of results of impact assessments in WP7-WP13

1.1 WP7 (Tunisia): Assessing impact of water and soil conservation policy on sustainable development in the Oum Zessar watershed

This section is based on D7.2 (Sghaier *et al.*, 2011).

1.1.1 Problem

This case study focuses on water and soil conservation policies in the Arid Regions in Tunisia. How do these policies contribute to the three dimensions of sustainable development? The pressure on natural resources, and particularly on land resources, is becoming very high in the South east of Tunisia. This is induced by increased human needs and the development of agriculture. It leads to land degradation and a significant decrease of crop yield to the detriment of the socio-economic situation of local population. Several water and soil conservation policies have been implemented by the government at the regional level to deal with the land degradation problem.

The assessment of policies is concerned with water pricing, water reform and Water and Soil Conservation (Table 1). The goals of the impact assessment are as follows :

Irrigated water prices: impact of variations on the farm income and the level of the input use. The assessed scenario consists of the increase of irrigation water price annually by 13% on the public and private irrigation systems towards 2015.

Water reform: impact of a recent investment in ground water desalination on tourism and redirecting medium quality water formerly used in tourism to agriculture. The baseline consists of maintaining the current situation concerning the water allocation plan. The first scenario consists of the increase by 50% of water availability and the second scenario consists of the increase by 100% of water availability.

Water and Soil Conservation policy: impact on the natural resources allocation and farm income . A reference scenario was developed that considered an implementation of SWC measures at 85%. This scenario follows the original implementation. The second scenario assumed a fall in the current implementation rate of SWC measures to 70%, and the third scenario considered a full implementation of SWC measures at 100% coverage of the watershed area.
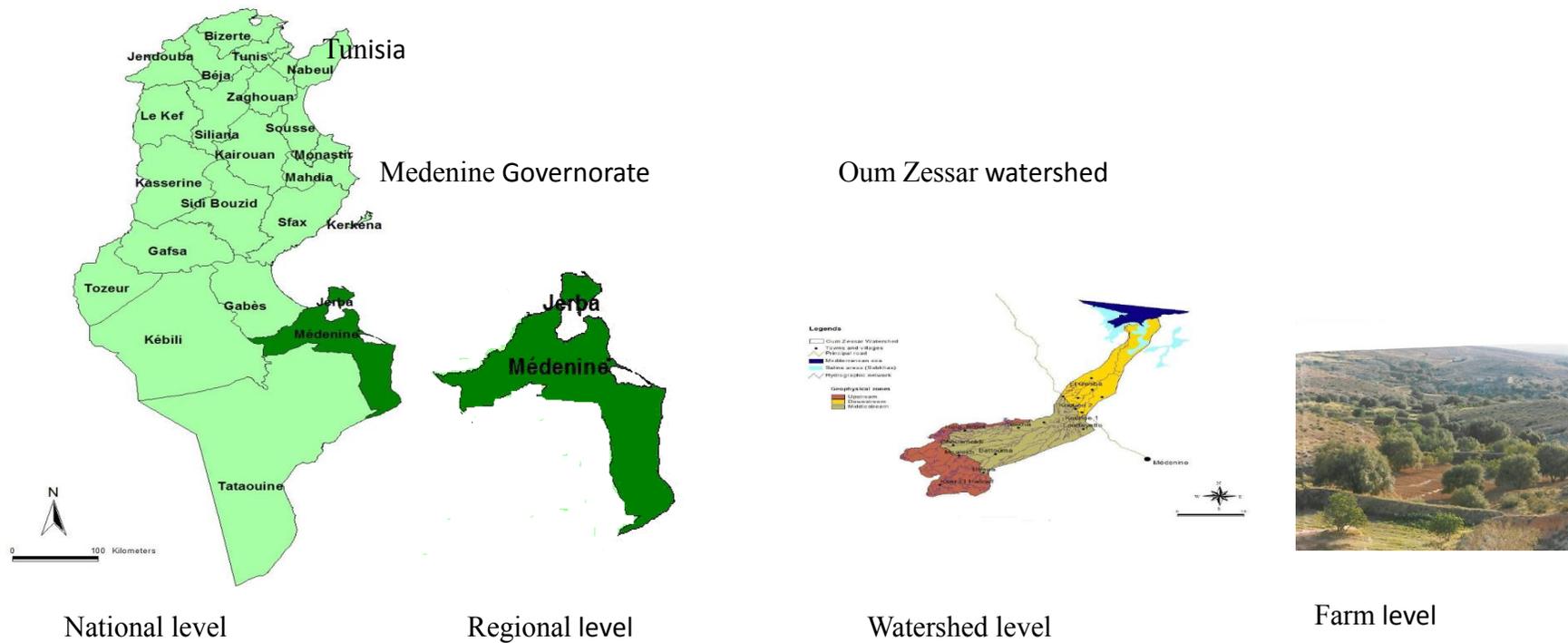
National level   Regional level   Watershed level   Farm level

Figure 1: Three nested spatial scales in the study area

Table 1: Policies and scenarios in the case study of Tunisia

Policies		Baseline scenario	Scenario 1	Scenario 2
Water saving	Water pricing	The current situation will be maintained	increase of water pricing at the public irrigated system by 13%	increase of water pumping cost at the private irrigated system by 13%
	Water reform	The current situation will be maintained	increase of water availability by 50%	increase of water availability by 100%
Water and soil conservation policy		The current situation will be maintained (an implementation of SWC measures at 85%)	A fall in the current implementation rate of SWC measures to 70%	A full implementation at of SWC measures at 100% coverage of the watershed.

For the analysis three nested scales are considered: provincial scale (Province of Medenine), watershed scale (Oum Zessar watershed in the Province of Medenine) and the farm scale level (Figure 1).

The province of Medenine is located at the south-east of Tunisia with an area of 0.92 million ha. The province is mainly covered by agriculture (91 % of the total surface). It is an arid zone with annual rainfall not exceeding 200 mm distributed over approximately 30 days. The case study area has thus rather extreme climatic conditions. In these conditions human pressure on agricultural land has a large impact on the natural environment and ecosystems.

Oum Zessar watershed is located in the North of the province of Medenine and its area covers almost 37,000 hectares. It has a strategic importance as its water table is used for drinking water by the governorates of Medenine and Tataouine. It has also a high socio-economic importance with its agricultural sector. The watershed can represent the whole zone of the South East of Tunisia.

1.1.2   Impact Assessment results

The water pricing policy meets the principal objective, i.e. the environmental conservation in the short term. The soil erosion shows a decrease by 13% at target 2015 and the water use shows a decrease by 18%. The policy thus contributes positively to the environmental objectives. However, the social and economic dimensions are negatively affected by the increase of the water price. The farm income decreases by 8% for water price increases by 13%. Given the complementarity between water and land factor, the decrease in water uses leads to less land use. By consequence the water price increase influences negatively the rural employment (approximately -2% of labour use by hectare).

The impact of providing more non-conventional water to economic activities was identified as an important question for the Medenine region. The results of the analysis show an increase in GDP in the region of 0.09 % and 0.16% respectively with increasing water availability by 50% and 100%. Total investment expenditure increases by 0.16% for scenario 1 and 0.29% for scenario 2. The production of domestic irrigated agriculture increases by 0.37% and 0.65%, in scenarios 1 and 2 respectively. In terms of social impact scenario 2 leads to few labour use increase by almost 1% at the regional level. Besides the economic and social benefits, the use of non-conventional water can alleviate the pressure exerted on the groundwater.

The results for the Water and Soil Conservation Policy assessment show that, firstly, the social and to a lesser extent also the economic dimensions benefit most under the policy. This means that

environmental factors highly influence the performance of the selected social and economic indicators. Secondly, a full implementation of the SWC for the entire watershed may lead to the highest sustainability contribution, whereas an implementation at 85% has already almost similar positive effects, while having less negative impacts on ecosystem processes. The decision may be to balance between implementation at 85% and 100% of Water and Soil Conservation.

1.1.3   Implications

The integrated ex-ante policy impact assessment cross-scale leads to a rich and diverse picture of impact.

At the farm level, higher water prices seem to have an overall positive impact on water use and soil erosion (decrease). The impact is negative with respect to the development of farm income and employment.

At the watershed level, water and soil conservation measures show positive results in terms of off-farm activities, increase of labour use and life expectancy.

At the provincial level, water reform has an overall positive impact on regional GDP and employment. The environmental impact depends on the source of water (groundwater or non-conventional resource) and on the degree of agriculture intensification.

The results of the study serve as a dashboard of sustainability to regional stakeholders and policymakers. This is especially useful for policy-orientation and decision making. However, the results should be interpreted with caution given the various assumptions and limitations of the work.

1.2 WP8 (Kenya): Assessing impact on sustainable development of land subdivision on land degradation policies in Narok district

This section is based on D8.2 (Chen et al.).

1.2.1   Problem

This case study assesses land use options for sustainable development in Kenya. The Narok District is chosen as the study area, because of land use conflicts among market oriented crop farmers, traditional livestock keeping and wildlife.

Traditionally, the Maasai moved their livestock from place to place, depending on the availability of pastures, water and incidence of diseases. Land in these areas was held communally, and all the Maasai had the right to pasture, but the livestock was individually owned. In the late 1960s, the Group Ranch Scheme was launched by the Kenyan government to avoid overstocking and overgrazing and increasing productivity of pastoral lands through increased off-take. Under this regime, communal lands were divided into smaller units (group ranches) which were registered in the names of group representatives (3 to 10 members). The scheme restricted the free movement of livestock. However, the Maasai continued their traditional grazing system. Over the years, group ranches came under considerable pressure especially from the well-educated members on the community to subdivide the group ranches into individual units. The Kenyan government initially opposed the sub-division but accepted group ranch sub-division in the 1980s. Members of the group ranches were issued title deeds to individual plots. The majority of the land is allocated to the group ranch committee members, their friends, relatives, and wealthy herders. Attempts by the Maasai to continue rearing large numbers of livestock for subsistence on their small individual plots with limited mobility has increased land

degradation. Individual land owners have subdivided and sold or leased their land for cultivating cash crops, mainly maize and wheat. The agricultural intensification has increased the use of pesticides and other chemicals. Agricultural expansion also has led to human wildlife conflicts and claims on natural resources such as land and water.

Narok District covers an area of 15,087.8 km^2. It is situated to the south western side of the country (see **Figure 2**) and lies to the southern part of the Rift Valley Province. It is divided into two main physical divisions: the highland zone that is over 2300 meters and lowland zone that is between 1000 and 2300 meters ASL. The highlands have rich volcanic soils suitable for intensive agricultural production. Large-scale farmers inhabit the highlands areas. The lowlands have high potential for livestock rearing. Nomadic pastoralist and small-scale subsistence cultivators inhabit the lowland areas. The area has poor quality soils and the rains are unreliable.
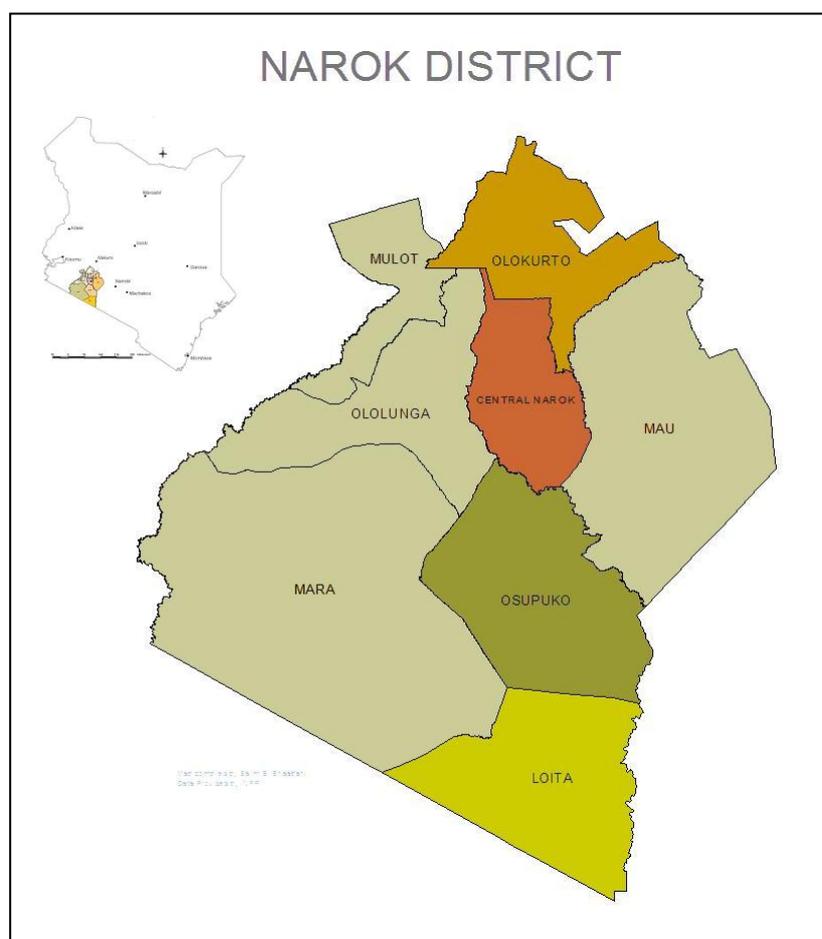
Figure 2: Location of Narok District in Kenya and its Administrative Divisions

Since the subdivision, crop cultivation concentrates in the northern part of the district, wildlife conservancies in the south-western part of the district and livestock production in the central and southern parts of the district. Livestock intensification has led to overgrazing and arable intensification has led to soil erosion.

With a view to address the future of the Narok District, three land use scenarios have been developed (see Table 2): (i) prevalence of crop farming (S1. Cropping), (ii) prevalence of livestock rearing (S2. Livestock), and (iii) prevalence of eco-tourism (S3. Ecotourism).

Table 2: Scenarios in the case study of Kenya

Drivers & assumptions	S1. Cropping	S2. Livestock	S3. Eco-tourism
Population growth	2.6% (annually)		
Economic development	4.0% (annually)		
Land used for agriculture	60%	50%	20%
Land used for livestock	30%	40%	40%
Land used for wildlife	10%	10%	40%

All three scenarios are based on the same set of drivers, i.e. population growth and economic development. Population growth was assumed to be 2.6% annually and economic growth was assumed to be 4.0% annually. Moreover, it was assumed that due to the uncertainty of confiscation of trust land, more group ranches will be subdivided by 2030.

1.2.2   Impact Assessment results

Under the cropping scenario (S1), which serves also as the baseline, the subdivided land that is suitable for cultivation will be converted to arable land. Livestock production remains stable and wildlife decreases sharply.

The livestock scenario (S2) leads to an increase in livestock production. More land is used for livestock production and less land for arable production. Land reserved for wildlife remains the same as in the baseline.

In the eco-tourism scenario (S3) land with high density and varieties of wildlife is joined by individual owners to promote exclusive safari tourism. The exclusive safari is aimed at a small group of individual tourists and charges a high price to avoid the mass-market tourists. Such type of tourism is in the form of a conservancy. In this case more land is used for conservancies and less land is used for cultivation comparing to S1 and S2.

The eco-tourism scenario contributes the most to the environmental dimension of sustainability. The cropping scenario is most favourable for the economic dimension, whereas the livestock scenario contributes most to the social dimension. Overall, the ecotourism scenario contributes the most to sustainable development in Narok district.

1.2.3   Implications

The project follows up on the needs to find means of facilitating action by individuals and groups of farmers to pursue sustainable land management practices. Fostering indigenous knowledge-science linkages and local initiatives provides the cornerstone for sustainable land management on which all programmes aimed at sustainable agricultural production must be constructed. The government should empower households and communities with tools and data for making informed choices on land management.

The realization of any of the scenarios depends greatly on a harmonized and consistent policy environment, e.g. consistency between the wildlife policy and the land tenure system. The implementation of the Draft National Land Policy (i.e. reallocation of land resources) will have profound implications on poverty reduction. Once this policy is implemented, the likelihood of the

three scenarios is very low – land is likely to be reallocated that will interrupt the current economic development.

But does the eco-tourism scenario have a good chance under the current policy environment? Contrary to the situation in Namibia, individual and communal landowners have no ownership or user rights over wildlife in Kenya. Wildlife resources are state property. However, about 65% of Kenya's wildlife is found on private and communal land (e.g. group ranches). The fact that wildlife is owned by the state ignores the interaction of different land uses in ecosystems and habitats. The institutional inconsistency creates an ambiguous policy environment that entitles the government to capture revenues from eco-tourism once it decides to do so. If this happens, the emerging eco-tourism market will come to an end in its infancy. To counter this, property rights over wildlife should be devolved to individual landowners.

The case study has shown that there are many policies and Acts of Parliament regulating land management issues in Kenya in general and Narok in particular. However, these are mainly sectoral in nature. In some cases, the policies in various sectors related to land management duplicate one another or at times are antagonistic. There is a need to harmonize and/or streamline the activities of these sectors if sustainable land management is to be realized. The Environmental and Co-ordination Act (1999) and the on-going national land policy formulation are positive initiatives in this respect.

1.3 WP9 (India): Assessing impact on sustainable development of implementing of organic farming policies in Karnataka state

This section is based on D9.2 (Purushothaman et al., 2011).

1.3.1 Problem

India has a high population pressure on land and other resources to meet its food and development needs. The natural resource base of land, water and biodiversity is under severe pressure. The massive increase in population (despite the slowing down of the rate of growth) and substantial income growth, require significant increases in the production of grains, livestock, fish and horticultural products. This case study focuses on the promotion of organic farming in the state of Karnataka, of which Bangalore is the main city. Karnataka is one of the four southern states of India (see Figure 3 and 4). Agriculture in the state of Karnataka is at crossroads as reflected in ecological, economic and social problems faced by farmers. Despite the state pioneering policy formulations and implementation to mitigate problems, the share of agriculture in the state domestic product (GSDP) has fallen drastically in the past few decades. Since about 2/3rd of the population depends on agriculture for their livelihood, the sector is vital for the overall development of the state. The socio-ecological linkage to the agricultural economy is a crucial missing link to be explored. Socio-ecological problems in the agrarian sector appear as symptoms of distress: farmers' suicides, increase in fallow lands, loss of soil fertility, decreasing ground water levels, water salinity, stagnating yields and slow agricultural growth (annual growth below 1.5%). Non profitability and high risk involved in agriculture as a source of living, loss of agricultural biodiversity, marginalisation and subdivision of land holdings loom large in the backdrop of policies, investments and institutions to tackle the crisis.

Figure 3: Map of India showing Karnataka[1]

Figure 4: Agro-climatic zones in Karnataka[2]

Karnataka State Policy on Organic Farming: (KSPoOF 2004 policy) was implemented from 2006-07 to reduce debt, improve soil productivity, water use efficiency, food security, and mitigation of drought in small farms. KSPoOF claims that its approach is sustainable in terms of both agriculture's contribution to biodiversity and biodiversity's contribution to agriculture (http://raitamitra.kar.nic.in/kda_booklet.pdf). Organic farming as defined in this policy requires less external inputs and relies more heavily on the natural and human resources that are available in the farms (see Table 3). Thus, it aims at reducing farmers' financial burdens and engages them in activities on their farms, curbing migration to urban areas. Such policies of the state aim to extend benefits of sustainable agriculture to farmers as well as consumers. Within a span of two years the overall number of beneficiaries (farmers registered under the policy) has grown fivefold.

Table 3: Organic farming versus conventional farming

	Organic Farming	Conventional Farming
Description	No use of chemical inputs Use of organic inputs	Use of chemical inputs No use of organic inputs

The case study deals with the sectoral policy of promoting sustainable agriculture and assesses its impact on sustainability of small and marginal farmers of the region. The policy meets the requirements of continuity into the future and of impacting agricultural land use and sustainability. The study intends to assess agricultural sustainability, looking at the ecological, economic and socio-cultural dimensions of sustainability. The study compares the sustainability of intensive, conventional

---

[1] Source: 'Karnataka.' *Wikipedia, The Free Encyclopaedia*. 19 Mar 2008, 15:41 UTC. Wikimedia Foundation, Inc. 25 Mar 2008.

[2] Karnataka Agriculture - A Profile, Department of Agriculture, GOK, 2000.

small scale agriculture with that of organic farms (comparing 2009 with 2006) in different villages of Karnataka, and project these changes towards 2015.

The policy scenarios to be analysed for sustainability of small farms in Karnataka till 2015 with the introduction of organic practices (from KSPoOF) include:

- with policy: combination of policies that favor organic farming
- without policy: with policies that favor conventional / intensive farming

Two districts in the state of Karnataka are selected for the study. Bijapur is the district in a dry region with low average rainfall and comparatively less resources than the district of Udupi which falls in the rainfall abundant region of the state.

1.3.2 Impact Assessment results

In Bijapur, the 'with policy' scenario shows a higher level of sustainability than the 'without policy' scenario. The 'without policy' scenario is better than the 'current' situation; the contribution from ecological dimension to overall sustainability dominates other dimensions in both the scenarios. Contribution from the economical dimension remains more or less the same in both scenarios. The socio-cultural dimension contributes more to sustainability in 'with policy' scenario compared with 'without policy' scenario.

On the other hand in Udupi, overall sustainability suffers a setback with policy. However, without the policy the situation is even worse. Nevertheless, the contribution from the economic dimension of sustainability is negative, due to the already negative rate of change in this dimension.

In both the districts, 'with policy' scenario looks relatively better, but the reasons differ – ecological in Bijapur and Socio-cultural in Udupi. With respect to the policy's expected achievements, apart from ecological sustainability, tackling economic factors in Udupi and socio-cultural factors in Bijapur seems vital.

Considering increased government and private investment in water management projects, the study envisages an increase in irrigated area in future, irrespective of the presence or absence of policies favouring organic farming. The area under commercial crops (CC) may decrease by 10% with policy, because one of the objectives of the policies favouring organic farming is to reduce the cultivation of intensive commercial crops that demand expensive marketed inputs to be applied. Also the proportion of area under commercial crops in Udupi (64%) is already higher than in Bijapur (48%). With respect to cropping intensity, since irrigation is expected to expand in future, this will rise along with it, irrespective of presence or absence of policies favouring organic farming.

Considering the objectives of the organic farming policy in the state, home grown food consumption and freedom from overdue loan are excepted to grow in future with 'with policy' scenario. Landholding (average 2.1 acre in Bijapur and 3.3 acre in Udupi) will not have any change in future in both the scenarios, again due to independence of this variable from the policies under consideration. Literacy is expected to grow due to efforts from government as well as voluntary agencies to raise awareness about importance of education. One of the major differences between two scenarios has been the application of organic and inorganic inputs, based on objectives of the organic farming policy. It is expected that organic input application will grow by 30% in future in 'with policy' scenario, and decrease by 30% in 'without policy' scenario. Similarly, application of inorganic input is expected to decrease by 30% in 'with policy' and increase by 30% in the 'without policy' scenario.

The results obtained from various methods used for impact assessment gave more-or-less convergent results for two districts. The study revealed that in Bijapur, policies favouring organic agriculture and sustainable farming practices prove beneficial to the environment in terms of improved soil and water quality and agro-biodiversity. Economic and socio-cultural impact assessment gave some divergent results with different methods. Multi-criteria assessment showed that such policies may result in

financial stagnation, whereas the comparative statics approach reveals less improvement in socio-cultural and economic dimension of sustainability, while the ecological dimension shows significant improvement.

On the other hand, in Udupi impact of such policies on the environment was minimal, irrespective of the method of assessment. However, the other dimensions- economic and socio-cultural, are benefited by such policy reforms.

The policy has been successful, as the popularisation of organic farming by NGOs has been successful. In the current situation, many farmers practice mixed farming, as completely converting to organic farming takes time, due to lack of adequate amount of farm yard manure.

1.3.3   Implications

Several lessons can be drawn from this case study:

- Small farmers perceive food security and occupational satisfaction as more important functions of their agricultural land holding than profit maximisation.
- Small farmers prefer to follow labour intensive, sustainable practices, producing inputs required for cultivation.
- Organic farming and sustainable agriculture practices are beneficial in terms of soil and water quality and agro-biodiversity.
- Support for small farmers must incentivise sustainable agricultural practices in order to reduce poverty and to ensure food security.
- The continuity of new farming practices in resource poor situation like Bijapur is favoured by effective local governance and cohesive community.

Indian agriculture policies often focus on enhancing productivity and farm income. Minimisation of cost and risk appear to have a low priority. The KSPoOF is one of the few policies that consider other aspects that have caused the agrarian distress in the last decades. The results of the study show that farmers in the less endowed regions like Bijapur would like to first ensure food security and good health, while farmers from Udupi emphasized the importance of the link to markets. Thus, food security appears to be necessary condition for small farmers to become market oriented and raise commercial crops. To ensure food security in small farms, organic farming works better, with reduced costs and risks. This implies that incentives for organic farming become crucial for small farms even if the state wants them to be market oriented.

1.4 WP10 (China): Assessing impact on sustainable development of implementing of water pollution control policies in Taihu Lake Basin

This section is based on D10.2 (Feng et al., 2011).

1.4.1 Problem

Economic growth has been a major aim of the Chinese government in recent decades. This has led to increasing economic welfare for most of the population, but it increasingly conflicts with social cohesion and environmental quality. Urban sprawl is increasing, while agricultural land use is becoming more intensive, leading to reduced areas for natural ecosystems and broader impacts on the environment, such as air and water pollution. Water pollution is one of the most crucial environmental problems in China. These problems are exemplified in Chinese lakes.

One of the regions that is confronted with high population pressure, high economic development, but serious water pollution, is Taihu Lake Basin. Taihu Lake is the third largest fresh water lake in China (see Figure 5).

Figure 5: Location of the Taihu Lake Basin

The beautiful lake and mountain landscape views attract a large number of Chinese and foreign visitors to come sightseeing. It is not only a tourist destination, but also an important drinking water source for large and medium-size Focus regions in the basin. The lake also serves many other purposes, such as storage of flood water, transport, irrigation and aquaculture. In recent decades, with the rapid population increase and economic development, the water in major rivers running into the lake, and in the lake itself, have become seriously polluted, and the nitrogen and phosphorus eutrophication of water has become a major environmental problem.

The Taihu Lake Basin is an economically important region in China. Water pollution and eutrophication have significantly affected regional sustainable development. Agricultural products from this region now risk being contaminated by polluted water and can hardly satisfy people's increasing demand for quality food and reach international quality standards for export. Industries, such as textiles and brewing, are now facing a shortage of high quality water, which is affecting further development of processing industries in this region. More important, water pollution and eutrophication reduce people's access to safe drinking water and are detrimental to human health.

Pollution control in Taihu Lake Basin has until now focused on industrial point source pollution. Less attention has been paid to agricultural non-point source pollution. Though rapid urbanization and industrialization have resulted in considerable loss of cultivated land, intensive arable farming, livestock breeding and aquaculture are still of great importance. Agricultural non-point source pollution, caused by inorganic fertilizers and pesticides from arable farming, the emission of animal waste from livestock breeding and inputs of feedstuff and inorganic fertilizers in aquaculture, have become the most important causes of water pollution and eutrophication in Taihu Lake Basin.

The major objective of this case study is to analyse policy options which may reduce water pollution and in the meantime stimulate sustainable development at large. Policies to reduce pollution from the agricultural sector include measures for arable farming and for livestock.

Table 4: Policy options for reducing water pollution from agriculture

	Option	Description
1	Conversion from arable land to trees	This policy aims to create an ecological green belt in areas close to rivers and the lake. Farmers who have land in these areas get compensation payments, but can no longer grow crops on these lands. Planting trees along the rivers and around the lake reduces the total farmland area where fertilizers are applied, and hence the nutrient emission. These ecological green belts also reduce nutrient leaching towards rivers and lake.
2	Stimulation of the use of site-specific nutrient management	State and local government have provided subsidies for site-specific recommendations on nutrient management based on soil samples. Generally used fertilizers in Taihu Lake Basin usually contain too much nitrogen and too little potassium. Also, too much nitrogen is often applied at first application, while the uptake is not very high in the beginning of the growing season, and hence nutrient leaching occurs. A better formula for fertilizers and a better timing will reduce nutrient pollution, and may also have positive side-effects on input costs, crop yields and income.
3	Stimulation of mechanical rice transplanting	Subsidies are provided to farmers and specialized mechanical service providers if they want to purchase agricultural machinery, such as machines for rice transplanting. Mechanical instead of hand transplanting of rice can reduce labour use, reduce pesticide use and increase yields and income.
4	Stimulation of the use of biogas digesters in livestock breeding farms	Farmers and livestock breeding farms are subsidized to build biogas digesters. The amount of the subsidy differs by location and by the scale of the biogas digester. The use of biogas digesters in livestock breeding farms can reduce nutrient pollution. As a positive side-effect, biogas digesters can generate energy and thus reduce energy costs, and can accordingly increase income for livestock breeding farms.

The case study consists of ex ante impact assessments of land use policies implemented in Taihu lake basin, including (i) multiple land use sectors (arable, perennial, livestock and fish), (ii) multiple

dimensions of sustainability (economic, environmental and social), and (iii) multiple scales (farm, sector and region).

1.4.2   Impact Assessment results

The effects of policies on water pollution and sustainable development have been studied for Wuxi, Changzhou and Zhenjiang cities. The results indicate that in general, compared to other policy scenarios, the combination of formula fertilizer (option 2) and biogas digester (option 4) contributes highest to regional sustainable development. Taking Wuxi city as an example, compared to base year (2008), indicators such as crop production, rice yield, chemical fertilizer use, pesticide use in all policy scenarios have displayed a negative effect on sustainable development, while indicators such as net farmer income, labor use, fertilizer K/N ratio and nitrogen input have a positive impact on sustainable development. Equivalent emission decreases greatly with option 4 and the combination of options 2 and 4, but increases in option 2. This indicates that even though formula fertilizer has pollution removal effect, pollution emissions from the livestock sector are more serious. Formula fertilizer can improve soil quality, which is good for crop production and for the improvement of environment, while biogas digester is very important for pollution alleviation.

For livestock and poultry farms the choice of three frequent ways in handling livestock manure are assessed: sale, return to the field as organic fertilizer and biogas production. Results indicate that the area of livestock farm and administrative requirements such as correction or relocation have positive effects on the choice of biogas production, but negative effects on the choice of sale as organic fertilizer. Livestock farms specialized in pig and cattle production tend to apply biogas production in handling their manure, while livestock farms having difficulties in accessing to loan are less likely to do so. Times of oral propaganda have a positive effect on the choice of sale and return to the field as organic fertilizer, but have no effect on the choice of biogas production. Therefore, if the government wants to effectively promote biogas digesters, large-scale livestock enterprises should be the policy target. Economic incentives such as preferential loans and subsidies instead of oral propaganda should be provided. For those livestock farms that violate emission standards, administrative measures such as correction and relocation instead of oral propaganda should be enforced.

Although promotion of site-specific nutrient management (SSNM) can improve environmental, economic and social land use functions, stimulating its adoption is not straightforward. SSNM is more knowledge and labour intensive than conventional management, whereas labour availability is limited. In policy scenarios, environmental impacts are projected to decrease compared to 2008, partly due to the adoption of SSNM. However, the main reason is the decreasing labour availability towards 2015 which causes a switch from double to single cropping. This, however, leads to lower food production. Abolishing fertilizer subsidies for farmers that do not adopt SSNM, in combination with training appears to be the best way to stimulate SSNM adoption for improving the different land use functions. Stimulating mechanical transplanting of rice reduces labour use and can become profitable when subsidized, but will not reverse the trend towards single cropping and has little influence on nutrient pollution. The regional policy of creating riparian buffer zones along water bodies appears to be promising, as it can strongly reduce nutrient leaching from farm land to rivers and lakes.

1.4.3   Implications

Due to rapid industrialization and urbanization in Taihu Lake Basin, agricultural modernization has been the main policy objective in this region. Agricultural development is moving towards large scale, machinery and technology intensive agriculture. This raises questions about the impact of agricultural modernization on agricultural non-point source pollution.

In Taihu Lake Basin, the central and provincial level governments have made great efforts in solving water pollution issue. Many strategic plans have been designed and pollution reduction targets have been set. It is important to assess how these strategic plans (goals of government) should be achieved. That is how to structure and layout different crops to achieve the water pollution targets.

This case study has shown several problems of policy effectiveness: biogas digesters seem to be under used, the trees converted from farmland are not properly managed, and so on. Policy makers are concerned about why these good (in terms of environmental objectives) and costly (huge subsidies) policies did not achieve good results. Future research should address options to increase the effectiveness of such policies.

1.5 WP11 (Mali): Assessing impact on sustainable development of implementing of plans towards expanding land under irrigation in the Office du Niger

This section is based on D11.2 (Cissé et al., 2011).

1.5.1   Problem

The Office du Niger (ON) in Mali is one of the oldest sub-Saharan hydro-agricultural installation projects. Since 1947, the Markala dam has allowed for the irrigation of managed land by gravitation through raising the water level of the Niger. Initially, the irrigation of 1 million hectares was planned. The potentially irrigable rice land available today is estimated to be 250,000 ha, while less than 100,000 ha is cultivated. The expansion of rice land is one of the strategic stakes in the Office du Niger Master Plan, which calls for the creation of a 120,000 ha newly irrigated zone located in the vicinity of the existing primary irrigation canal. The Malian government is appealing to new investors (private, public, national and non-national) to develop irrigation infrastructures in new areas. Thus, the cost of the irrigation scheme's development is to be recovered by renting lands to agribusiness societies. This is an important change from the first phase of the Office du Niger irrigation scheme, when the government of Mali, in association with international donors, developed a strategy to consolidate family farming.

Officially, the two existing models, enterprise farming and family farming, are not in competition. Less than 10% of the irrigable lands will be converted into an ON zone. There should be space for everyone, and farmers would not lose their land. However, the official perspective does not take into account two elements: water scarcity and pre-existing land scarcity.

When the irrigation of very large areas may be guaranteed during flood periods, this is not the case when the water level of the Niger is low or when the irrigated channels are being maintained. In the latter case, the floods are reduced or cancelled purposely to facilitate the task. Only 12% to 17% of the total areas is used for growing rice off season and vegetable crops. When water levels are low, some upland areas that have already been converted cannot be irrigated because the floods cannot reach these areas which are also far away from the main channel.. Due to demographic growth, the size of land initially allocated to individual families in the early period of the "Office du Niger" has decreased during the last twenty years. Land was allocated based on the number of active labourers in the families. The latter become larger through time or broke down because of internal conflicts. In these cases, the available land is split into small pieces, raising the need for more space.

Land irrigation of the dead delta was made possible thanks to the regulation dam of Markala located on the Niger River approximately 275 km from Bamako (The capital of Mali) and 35 from the city of Ségou. The dam raises the water level approximately 5.5 m to gravitationally put water into the Falas which, in their turn, feed a complex hydraulic network of several thousands of works and kilometers of channels. This network was conceived at the beginning to irrigate a potential of more than 2 million hectares; the currently developed area covers only approximately 87662 ha in 2007 (see Figure 6 below).
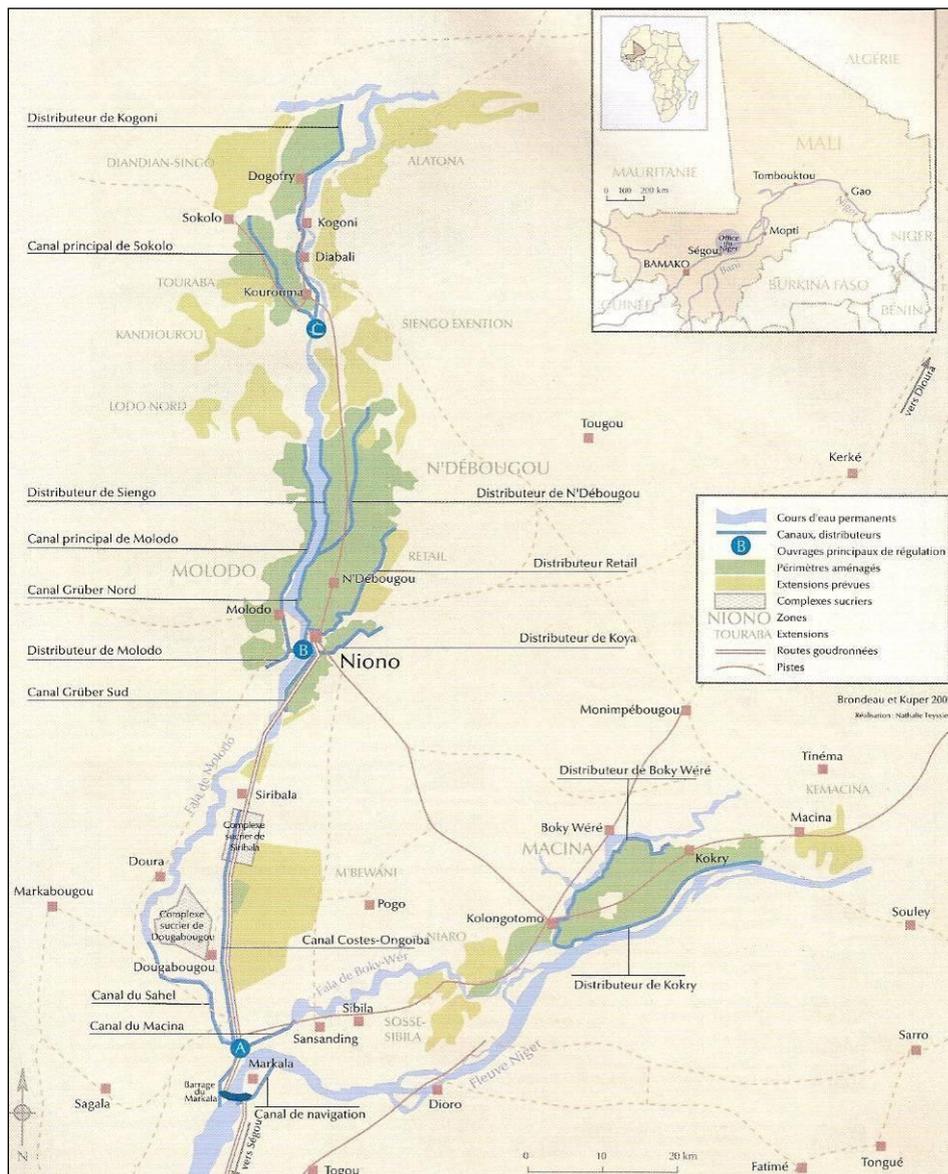
Figure 6: The developed land of the "l'Office du Niger" (Cirad / Karthala, 20

Land is available but used in priority for rice production. Therefore, land expansion applies to forests and pastures bringing about the scarcity of woods and pasturelands which is a serious problem. The main question raised by many stakeholders is as follows: How will the supply of wood and pasture resources be managed under the new land expansion policy? In the case study various policy options have been distinguished (see Table 5).

Table 5: Policy options for the management of wood and pasture resources

	Policy option	Description
1	Regulation by the market	Rural wood markets are functioning and are relied upon for the provision of wood resources. Rice grower-stockbreeders in the Office du Niger area consume wood resources available in the communal territory
2	Uncontrolled situation	Creation of a new rice perimeter, thus reducing the area of the natural resource lands. A population growth rate of 3% is assumed.
3	Intensification and regulation of forest and livestock management	This option is based on i) the impact of planting trees inside and outside the irrigated perimeters to compensate for trees removed during the expansion of rice lands and ii) the impact of beef-fattening and selling activities on the size of herds and the income of farmers
4	Systems of production intensification for livestock fattening	Farmers in irrigated areas allocate 25% of their rice plot for the production of off-season fodder crops, with a yield of 10 tons/ha over 3 months, with 3 harvests.
5	Development of lands devoted to pastures in non-irrigated areas	Villages in non-irrigated areas fetch wood products from a wider radius, while the towns and villages in the irrigated areas would also fulfil their wood needs from the non-irrigated areas. Drinking water availability for livestock supplied through re-digging some of the existing water points and turning them into permanent water sources.

Stakeholders found that the joint scenario of 4 and 5 not only feasible but also more sustainable because it helped decongest the area by developing the upland areas for breeding purposes and the rational management of flocks. Rationalised management makes breeding a business instead of a social privilege based on the size of one's herd. According to the stakeholders, land resources are scarce in the irrigated areas for activities other than rice production. Therefore, the size of herds must be kept under control. An optimal herd size is preferable to a large size. On political and administrative grounds alone, this policy option seemed to be more acceptable to all parties, as it was not contradictory to any of the government's action plans. The policy put forward by the state of Mali and the administrative role the Office du Niger Authority had to be taken into account.

1.5.2   Impact Assessment results

For wood resources, the simulation scenarios propose two different systems for the harvesting of wood and two ways of increasing the supply of wood. The first harvest system allows wood cutters from the irrigating villages and the city to go wherever they want. The second system, called the secured system, allows dryland area villages to collect wood for themselves and the irrigating villages and city within a large area around their villages.

Whatever the harvesting system, the resource is depleting very rapidly. The second possible action is to increase the supply of wood by planting. Two scenarios are distinguished: a compensatory scenario in which trees are planted on 10% of the land area dedicated to new irrigation schemes, or a "plantation" scenario in which trees are planted to fulfil the needs of the population. This second scenario corresponds to the emergence of private plantations growing wood. The simulation results show that the compensatory approach can slow down resource depletion; the results are even better if the wood is also available to city inhabitants. However, if the problem must be solved locally, without the introduction of external wood, then the best solution is to adjust the tree plantation production to demand.

For fodder production, the simulation scenarios have the same basis: farmers keep part of their livestock on their farm and let the remaining part move on the area with the herd. Then, modifications are tested by increasing the resources available for the animals. The first simulation selects part of the area and raises the production of fodder for the herd. The second simulation has the farmers in the

irrigated areas grow crops on their irrigated land and keep more animals on the farm. An additional modification improves water availability: permanent rather than temporary ponds or wells will allow the herd to go farther and harvest fodder from larger areas. The simulation results show that permanent ponds are efficient for some time (5 years) and then gradually experience problems as the population grows. Would the number of livestock remain the same? Would the permanent ponds be enough for the herd's needs? The problem is the fodder for animals living on the farm itself; the fodder production is efficient for the herd. In the model, the problem is solved for the herd. However, the problem remains for the in-farm animals. A beef-fattening scenario also solves the problem for the herd.

As farmers grow crops to feed their animals, they also need more fodder for their animals at home as they are not fed only by the crops. Thus, the problem of the local consumption of fodder increases.

1.5.3 Implications

The Office du Niger is evaluated only on the quantity of rice grown in this area. The underlying idea encourages the exclusion of any other use of the land that could decrease rice production. However, the issues of rangelands and wood supply for fuel have to be managed in interaction with agriculture. In addition, the state agencies and technical services tasked with raising agricultural production have fewer and fewer means with which they can fulfil their duties. The number of extension agents has decreased from 3,000 to 300. These agencies and technical services must rely on individual private initiatives to achieve their objectives. However, these initiatives must be controlled. In addition, the technical services staff want their expertise to be used and applied to these problems.

Trees need to be planted. However, the problem comes down to land tenure and economic profit. At the individual level, farmers who settle in this area aim to grow rice and other types of cash crops. Planting trees on small areas is not profitable. The farmer must profit immediately and grow rice to fulfil the objective of the Office du Niger. When farmers consider planting trees on part of their land, they first consider fruit trees. The second problem is that of land tenure: growing trees is possible only if land is allocated for long time. The Office du Niger claims that for a long time, access to the land was easy. It was simply a matter of requesting land for a given project. It appears that a large area was allocated, and for the last two years (2009-2010), the Office du Niger cancelled many contracts (280,000 ha in 2010). The Office du Niger also claims that for the last couple of years, any additional irrigated scheme plan had 10% of its surface area set aside for trees. The land is allocated, but trees are not grown. There is a lack of control due to the small number of staff available. What concerns large-scale tree plantations, the profitability is greater for other types of wood production. Wood is sold for "bois d'oeuvre", which is more profitable. Only the by-products of the plantation are sold as fuel wood.

The Office du Niger wants to decrease the number of animals and restrict their movement in the area. Livestock experts want to apply new methods and technologies. However, this creates various problems. Increasing the production of fodder requires that it be made at a long distance. Farmers and the Office du Niger do not want to have large quantities of animals close to the irrigated scheme ("animals and irrigated schemes don't go together"). Those areas lead to problems of access, tax issues, and local conflicts over alternative uses of the land. Fattening animals in-farm raises the problem of availability of fodder. Crops are not sufficient, and the surrounding areas are rapidly overharvested. Because animals cannot move under this approach to management, fodder must be provided to the animals. In addition, this management approach raises many technical problems that are beyond the scope of this study.

1.6 WP12 (Indonesia): Assessing impact on sustainable development of implementing of land conversion control policies in the province of Yogyakarta

This section is based on D12.2 (Novira et al., 2011).

1.6.1 Problem

Indonesia is facing major problems concerning land conversion. Forests are to a large degree converted to plantations, and agricultural fields are converted to settlements and business areas. Indonesia consists of five main islands. Among these islands, Java Island is the most developed island due to the potential of both natural and human resources.

The Yogyakarta Special Region (Daerah Istimewa Yogyakarta, or DIY, see Figure 7Table 7**Error! Reference source not found.**) is a fast growing province in Java.
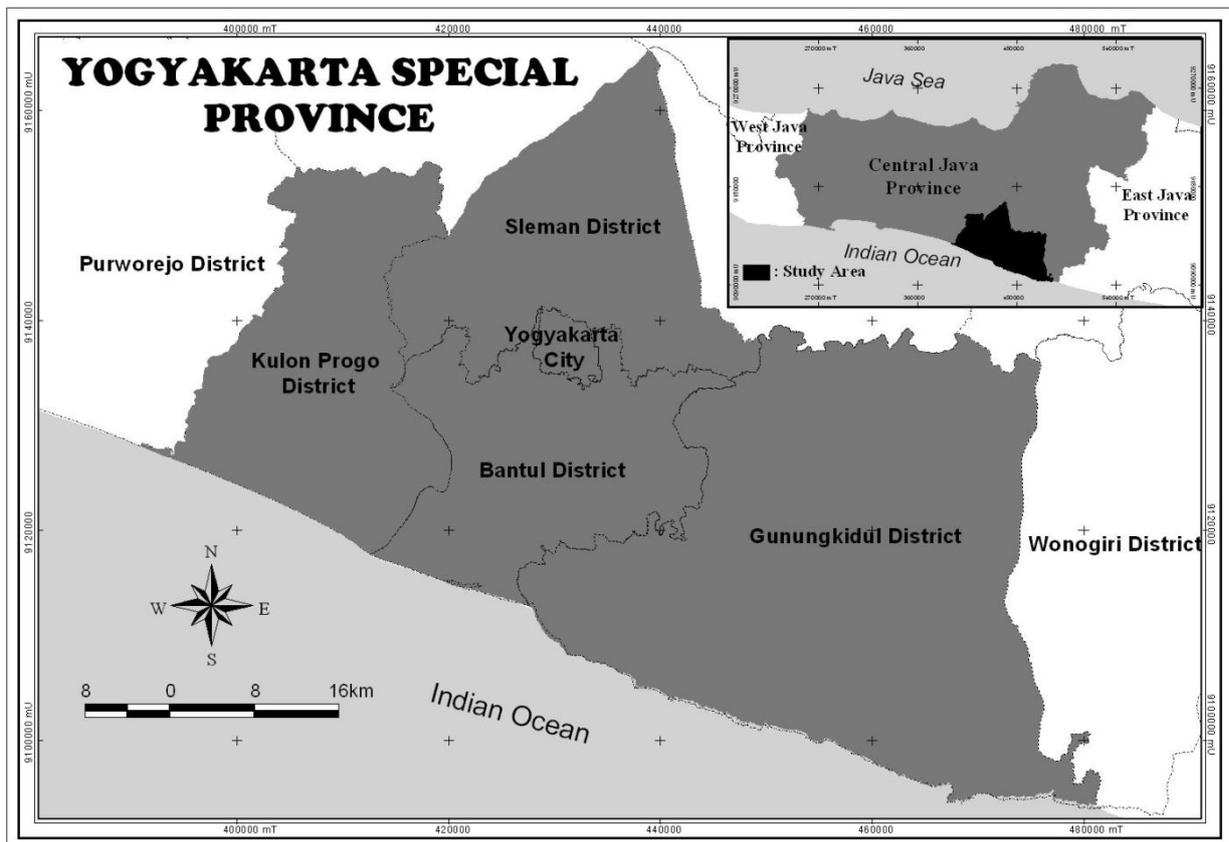
Figure 7: The case study area in Yogyakarta, Indonesia

Source: **Adapted from Digital Indonesian Earth Surface Map, 1998.**

The rapid economic growth, the high standards of education services and the images of DIY as a good and convenient place to live in, have attracted more and more people to migrate into the area. On the other hand, migration has been the motor for a fast growing economy. In DIY, urbanization is the main driver of land conversion from agricultural use to settlement and business area. The rapid

urbanization and migration into the area has become a threat to both the environmental and the social dimensions of sustainable development. Urbanization is linked to land conversion; deforestation and reduced agricultural land. And there has been a tremendous decrease in water availability in DIY, and a lack of waste management pollutes the water. With regard to the social dimension, a high immigration of socially well-off people causes conflicts with the local residents.

This case study focuses on the conservation of spatial planning policy, the forest protection policy and the sustainable rice field policy Nr 41/2009 (Table 6).

Table 6: Scenarios in the case study of Indonesia

Scenario	Name	Explanation
S0	Business as usual	The baseline scenario consists of trends into the future. The projection year is 2025. Driving factors considered are population growth, economic growth, infrastructure development and Natural disaster. The main external driver expected to affect the land use change is the global economy.
S1	Spatial planning scenario	Spatial planning Act (PERDA DIY Nr. 5 Year 1992): Recommends appropriate land uses for various parcels of land, specified in a grand master plan map at a scale of 1:5000
S2	Forest protection scenario	National Act of Foresty Nr. 41/1999 defines the conservation forest as an area functioned for protecting biological diversity and ecosystem for flora and fauna. Conservation forests are divided into three different categories such as sanctuary reserves, nature conservation areas, and hunting areas.
S3	Sustainable rice field scenario	Sustainable Rice Field Act (Act Nr. 41 Year 2009) established to protect national food security through proper management and decision-making.

1.6.2   Impact Assessment results

The land conversion in DIY is dominated from the agricultural area (paddy field) to settlement. The land use change is mostly located in Sleman and Kulonprogo Regency. The conversion is affected by the flat topography and adequate groundwater availability for domestic use. High land demand for settlement forces the development reaching the agricultural area. Converting the agricultural land to settlement brings more advantages than maintaining the agricultural land as it is.

The projection of land use change of 2025 under scenario S1 and S3 shows a similar pattern as the reference. The selection of the policies to control the land use transition was not powerful enough to create significant differences from the baseline.

The business as usual scenario will decrease the food security level and provision for non-land based activity compared to reference condition. The second scenario results in a similar pattern as the first scenario. The simulated condition is almost in the same position as the reference condition when last

scenario implemented. Compared to the other scenarios, conserving the agricultural area seems to be the best solution to maintain food security.

The most effective policy for limiting land use changes seems to be the Sustainable Rice Field Policy (Act Nr 41/2009). Land is considered as a private good. In the case of paddy field, land use type that is widely converted, since it is privately owned, the owner can decide with his land. Whether to sell it, to convert it, or to utilize it still as paddy field is the owner's decision. This makes any policy trying to regulate land conversion problematic. The Act Nr 41/2009 on Sustainable Rice Field is expected to overcome this problem. However, some problems persist in the implementation. The area which will be proposed for sustainable rice field is not yet determined. There is no exact area mentioned in the Act Nr 41/2009. In the National Level, the implementation of the Sustainable Rice Field Policy has not yet been clear until this day. Further supporting regulations must be formulated. These are not yet present until today, thus this act is not yet implementable.

The implementation of land conversion tariff turns out to not be able to decrease land conversion, since the tariff is too low when compared to the income potentially generated by the land when it is converted. Realizing this, the local government has reacted in issuing a substitute. The land conversion tariff policy will be substituted with The Government Regulation Nr 13/2010 on Land Conversion. This substitute is expected to be more effective compared to the Land Conversion Tariff policy. This regulation was just being implemented in the beginning of 2011, thus evaluation could not be performed yet.

1.6.3 Implications

Many law enforcement interventions and policy of land use change have been set up by the local and national government. The aim was to overcome the land use malfunction and to manage the developer and industrial related needs. The set up policy tends to be double-edged. It supports the environmental sustainability and yet becomes the "enemy" of the economic sector. There will be trade-off between the idealism and the market needs.

The population growth was initially assumed as a significant driver of land change in many regions. However, the result of the case study indicates that the policy also plays an important role in the land use change. In the economic point view, the land use change related policy may be a constraint for the national development. Policy program for infrastructure support, taxation, privatization, and reforestation would provoke the land conversion.

In case of DIY, policies concerning land use change were slightly contradictory. Land conversion tariff of Bantul Regency does not protect the agriculture area as tight as of Sleman Regency. In addition to that, Perda Nr 41/2009 prohibits the land conversion due to agricultural sustainability. Thus, developers invest their capital to southern part of Yogyakarta. This situation economically advantages the local government and endangers the paddy field sustainability.

Land use planning is necessary to enable the government to provide the required space for the implementation of development activities. Essentially, land use planning is the spatial dimension of development planning. The second point to be clearly understood is that land use planning is prepared in response of the presence of development plans. Therefore, a land use plan can only be prepared if the development plan has been established. The third point is that land use planning in the framework of spatial planning is one of the bases of land management. A sound land use and spatial plan will not only give maximum benefit in using land, but also provide foundation for the environment protection and maintenance, so as to support a sustainable development. Land use practices are usually not in accord with the plan or maybe planning is not available. That is why there should be a proper decision for re-planning and rearrangement of the existing land use and land tenure which does not match its potential and the need for development.

1.7 WP13 (Brazil): Assessing impact on sustainable development of implementing of land and forest conservation policies in the BR-163 region

This section is based on D13.2 (Rodrigues Filho et al., 2011).

1.7.1 Problem

The Amazon biome is the single largest continuous tropical rainforest, and one of the richest stock areas of biodiversity on Earth. This area is highly threatened by deforestation, causing genetic erosion and a great amount of greenhouse gas emissions. The states of Mato Grosso and Pará in Brazil are facing a conflict between agricultural expansion (largely due to an increase in the international demand for commodities) and conservation of the Amazon rainforests, important for carbon storage.

The issue and the problems chosen to be studied in this case study are related to the impacts of the paving of highway BR-163 in the north of Mato Grosso (MT) and the south of Pará (PA) in Brazil (see Figure 8). The highway was partially paved as an effort made by the Mato Grosso state government to provide accessibility to the market for local soybean farmers. This has already caused intense migration into the area, deforestation, land grabbing and speculation, provoking a fast and radical change in land use, and intensifying social conflicts. However, 956 km are still not paved and the overall conditions are precarious. Increasing trade in soybeans under the influence of globalization has made it attractive for the government to pave the still unpaved part of the highway BR-163.

So far, however, many of the political actions aimed at preserving the environment – in their vast majority limited to mechanisms for deforestation control -, seem to have been less than effective.

The study focuses on two main policies: the Brazilian Forest Policy Code (from year 1965), a revised Forest code (now partially approved in the Parliament (May 2011), but not yet approved by the Senate) and the Creation of Protected Areas (Law 9,985, of July 18, 2000). In each case two alternative levels of implementation as the basis for the scenarios are considered: one based on an optimistic assessment of governance effectiveness, "high governance", the other on a realistic assessment, "low governance" (see Table 7). As the international economy is determinant for the Brazilian commodity market and hence also for the outcome of these scenarios, low or high international economic growth are also included as variables in this scenario setup.

The complete paving of BR-163 was taken as a premise in all scenarios, once the still non paved stretches between the border of MT/PA and Santarem – about 900km – are forecasted to 2012. It is estimated that the road paving will reduce 35% of costs in transport of production, therefore causing strong implications in the land use dynamics of the region.
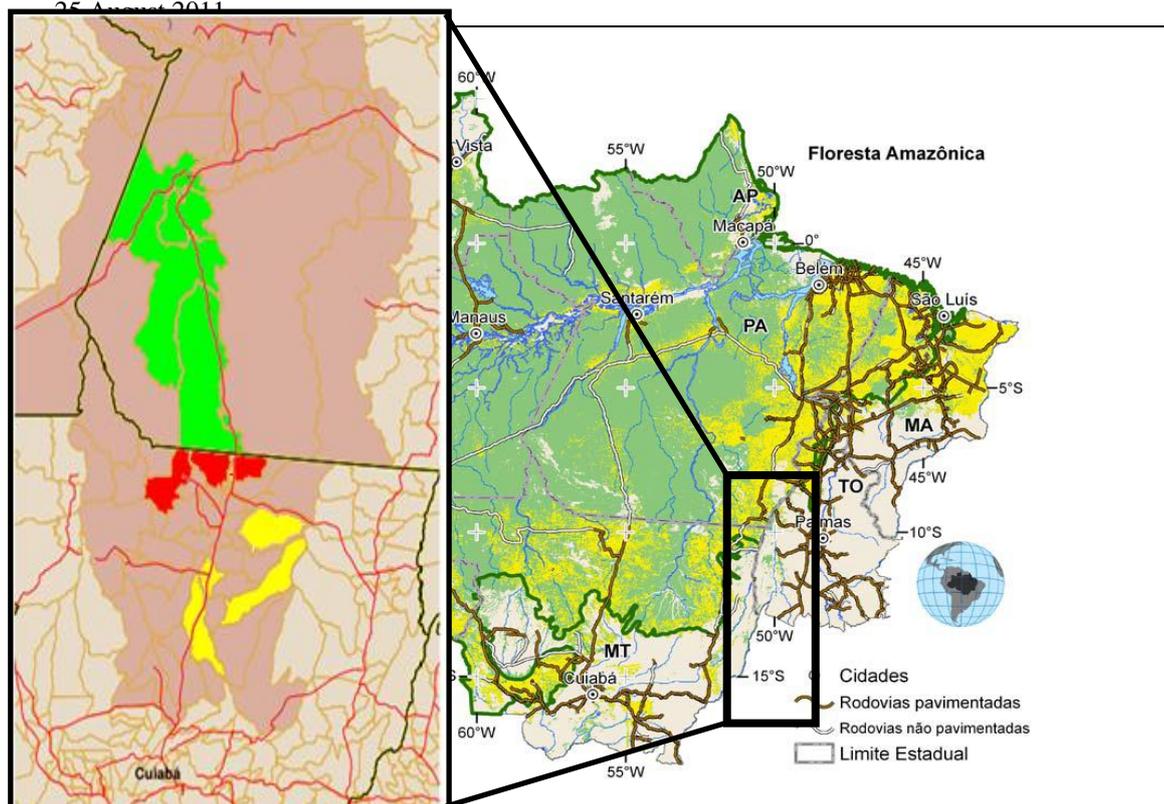
Figure 8 The study area along road BR-163 from Cuiabá in Mato Grosso to Santarém in Pará

Notes: Yellow: the municipalities *Feliz Natal*, *Marcelândia*, *Sinop* and *Sorriso* in the South region, Red: the municipalities *Alta Floresta*, *Guarantã do Norte* and *Novo Mundo* in the Central region, Green: the *Itaituba*, *Novo Progresso*, *Rurópolis* and *Trairão* in the North region.

Table 7: Scenarios and assumptions in the case study of Brazil

Scenario	*Political – Institutional Drivers*		*Economic Growth*
	Policies	*Governance*	
Baseline	Forest Code Conservation Units	Low	Low
	Forest Code Conservation Units	Low	High
Revised Baseline	Revised Forest Code Conservation Units	Low	Low
	Revised Forest Code Conservation Units	Low	High
Governance	Forest Code Conservation Units	High	High
	Forest Code Conservation Units	High	Low
Revised Governance	Revised Forest Code Conservation Units	High	High
	Revised Forest Code Conservation Units	High	Low

1.7.2   Impact Assessment results

The low price scenario shows that the policy scenarios hardly affect the areas under agricultural use (pasture, soy) or other crops in all regions. In the north, the pasture area most remarkably changes, with the largest amount of area in the "governance scenario" by 2020. In both the central and south region the effect of the revised Forest code on additional deforestation becomes clear in the areas of other crops; those areas increase compared to the policy scenarios with high forest code.

The policy scenarios affect the area of protected forest (forest code or conservation units). The forested areas defined as "protected" will affect future agricultural area only when the area available for production is limited. In the low price scenario both in the south and in the central region, the forest areas become limiting and in 2020 no forest is left to deforest. Therefore, agricultural land use areas cannot increase much in these regions, meaning that here the defined policy scenarios have little effect on forest or agricultural area.

The small effects on agricultural land uses have consequently small effects on the indicator performances, since many of those are dependent on some form of economic activity (mostly agricultural related). Hence only small differences are expected with regard to the social and economic dimensions, but larger effects for indicators in the environmental dimension.

In the low price scenario the governance policy scenario shows a decrease in soy income (-3.3%) while the revised baseline and the revised governance policy scenario show respectively a 6.7% and 2.3% increase in soy income. Beef income shows a very modest increase in both revised policy scenarios compared to the baseline.

In the high price scenario the pattern differs largely from the low price scenario. In all policy scenarios a decrease in beef income can be observed, while in the governance policy scenario and revised baseline scenario also a decrease in soy income can be found. The differences with the baseline policy scenario are smaller than in the low price scenario, because more other crop area is already in use to meet the demand for soy. Moreover, the governance policy scenario leads to a potential decrease in beef and soy income due to a high forest code protection value, the revised baseline scenario to an increase in beef income but a decrease in soy income compared to the baseline, while the revised governance policy scenario shows the opposite.

The different patterns between policy scenarios and between the high and low price scenario in additional beef or soya income are the result of the regional differences in available land of other crops in the north, central and south region. While under the high price scenario less other crop area is available due to soy conversion under the world price demand, the effects of protection of conservation units also become clear. Since a full protection level of 100% will lead to a lesser amount of forest that can be deforested, the lower protection level of 95% in the two baseline policy scenarios have a larger amount of 'free forest'. Since the amount of forest is very limited in the central and south region, this addition of 'free forest', albeit low in amount, becomes available for forest conversion and agricultural expansion.

The results show that if the Brazilian Forest Policy Code was reformed in such a way, to expand the agricultural frontier over forests in those states, the estimated increase in deforestation would be of 47% until 2020. Revision of Forest Code strongly increases deforestation and CO_2 emissions. With equal policy preferences the high governance policy scenario (effective protection of Forest Code) scores highest at both low and high price scenario. In low governance policy scenarios economic indicators have more impact. In the low price scenario policy preferences do not strongly affect policy ranking. In the high price scenario there is a strong trade-off between economic and environmental dimension.

1.7.3   Implications

The reform of the Forest Code, which is strongly debated in the Brazilian National Congress in 2011, displays the difficulties to overcome the dilemma between development and environment in developing countries such as Brazil. There is a consensus between environmentalists and "ruralists" about the need to update the Forest Code, currently suffering from certain anachronisms that no longer reflect Brazil's agrarian reality and potentialities. Nevertheless, the reform proposal steered by the ruralist lobby at the National Congress is a clear setback that can result in an augmentation of the already alarming deforestation levels in the Amazon and Cerrado biomes.

Complementary policies other than the current command and control strategy should also be envisioned. In this context, economic instruments that foster the conservation and intensification of production practices - such as the payment for environmental services – are not only possible but also attractive pathways.

The already degraded areas in Brazil's national territory, estimated at 50 million hectares at present, could be devoted to the agribusiness sector if properly managed through soil-recovering techniques. Tax reduction and more sustainable options privileging the intensification of production and native vegetation conservation, together with higher tributes to predatory techniques, constitute efficient mechanisms for the convergence between environmental preservation and economic development. If properly implemented, resources such as the Climate Fund and the Amazonian Fund are important mechanisms to overcome the above-mentioned dilemma.

The national policy on climate change (Law 1.187/2009) has become an important instrument to establish clear targets to reduce carbon and GGE´s Brazilian emissions. It states that more than 80% of the targets will be realized through the reduction of deforestation in the Amazonia and Cerrado, as well as by the intensification of agribusiness. Considering that the BR-163 axis is the Brazilian region whereas the agribusiness expansion towards the forest and Cerrado was the highest, this area would be a priority target of actions managed by a national climate programme.

Although a great number of public policies have been conceived in Brazil to address the challenge of environmental governance in the study area, they are obviously jeopardized by local institutional conditions, which are severely weakened. Agricultural development policies implemented in Northern Mato Grosso and Southern Pará coexist with conservation policies. The latest are at stake, however, due to the inefficient state institutions and low governance levels, often associated with corrupt officials. A great deal of public policies remains only on paper.

The role of consumers should be also highlighted. Most of the agribusiness production surrounding the BR-163 highway region have European (e.g. Netherlands and Great Britain) and Asian markets (e.g. China) as final destinations. Any possibility of a delicate balance between development and sustainability depends on Brazil's administrative and political decisions. But such a balance is also challenged by international markets and by countries that rely heavily on the commodity production of Southern countries to maintain their consumption patterns. Such actors could play a vital role in the design of more sustainable production chains.

As for the existing environmental management policies in Brazil, two measures should be urgently implemented: the improvement of technologies for the remote monitoring of land use changes and the strengthening of environmental institutions, including an environmental surveillance system. In this regard, the Ecological Economic Zoning (EEZ), both statewide and regional, could make a positive difference. Unfortunately, so far EEZ in Mato Grosso and Pará has been implemented as a mere technical tool rather than as a support instrument for political decision-making in territorial planning.

2 Part II: DPSIR framework to analyse causal chains and SD trade offs; policy options in seven case studies Africa, Asia and Latin America

This Chapter is based on (Nesheim *et al.*, in review).

2.1 Introduction

Human actions during the last 50 years have altered ecosystems to an extent and degree unprecedented in human history. Health and wealth have on average improved, but the benefits are unequally distributed and further improvement may be limited by an insufficient supply of key ecosystem services (MEA, 2005). The degradation of approximately 60% of land and ecosystem services cause significant harm to human well-being and represents a loss of the natural assets or wealth of a country (UNEP, 2010). Hence, the need to enhance sustainable development (SD) is more urgent than ever; specifically in developing countries where poverty and land degradation are often interlinked. It is, however, essential to understand the system characteristics, including the complex feedbacks between drivers and impacts and address this fundamental issue with appropriate policies. The successful implementation of land use polices has in the past often been hampered by the fact that we simply do not know enough about their impact on sustainable development across developing countries (Birdsall, et al., 2005, Leichenko, et al., 2010). There is a need to identify and analyze causal linkages between local, national, and international factors and their economic, environmental, social and institutional impacts, to promote a common understanding by experts, stakeholders and decision makers.

Seven case studies in Kenya, Mali, Tunisia, China, India, Indonesia, and Brazil have been selected to represent different biophysical and socio-economic conditions and challenges. The Driver, Pressure, State, Impact and Response (DPSIR) framework (OECD, 1993) was used as a tool to analyze drivers and impacts in the case study areas (Reidsma, et al., 2011). Based on this, trade-offs can be identified, and relevant policies can be selected for the promotion of sustainable development (SD). When recommending a policy to be pursued, some SD objectives are necessarily encouraged or promoted at the expense of others. Policy decisions are not only based on "factual trade-offs" between the economic, environmental and social dimensions of SD, i.e. measured impacts, but also on "value trade-offs", i.e. the importance given to the different dimensions. In this paper we aim to explore links within the DPSIR story lines, policy priorities and the value trade-offs, as indicated by stakeholders and experts in these seven case studies.

2.2 Methodology: DPSIR framework to analyze causal chains

The DPSIR framework was used to analyze the causal relationships between the various economic, environmental, social and institutional aspects within each case study (OECD, 1993, Helming, et al., 2008, Reidsma, et al., 2011). The DPSIR framework has been widely applied in Impact Assessment studies; Scopus (ww.scopus.com) reveals 300 publications on "DPSIR" and assessment" over the period 2002-2011 (see Figure 9). The approach has been popular in comparative analysis of assessment tools (Helming, et al., 2011) as well as in land use change assessments (Helming and Pérez-Soba, 2011, Morris, et al., 2011). Helming and Pérez-Soba (2011) write that the approach has been widely used for jointly conceptualizing research problems and integrating disciplinary viewpoints. Tscherning et al. (2011) discuss the different positive and negative implications of the DPSIR framework with reference to research that supports policy making.
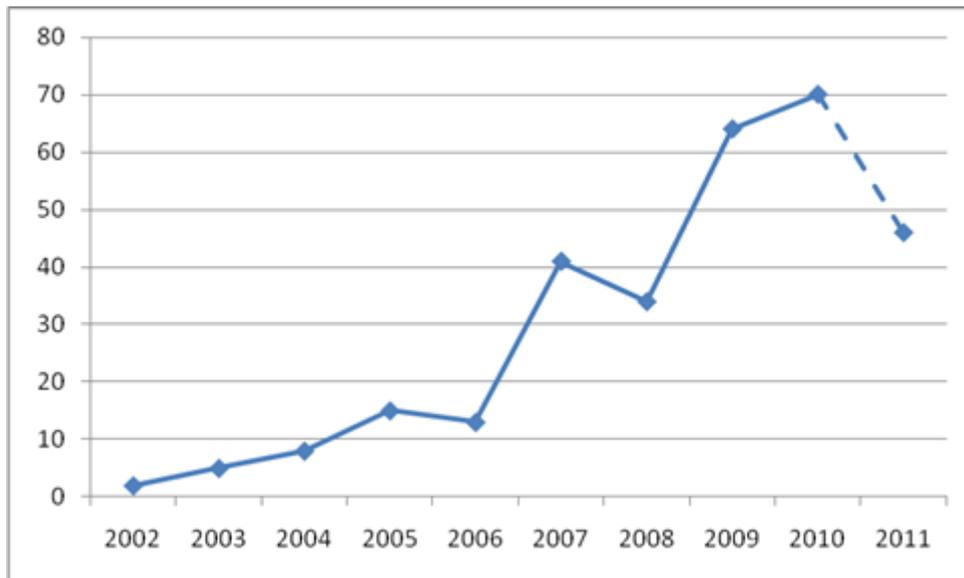
Figure 9: Number of annual publications referring to "DPSIR" framework and "assessment" as cited in Scopus (www.scopus.com)

The components of the framework distinguish between driving forces of change, pressures on land use, state of the natural and socio-economic environment, and the impacts on sustainable development. The use of this conceptual framework based on causality between interacting components of social, economic and environmental systems has important benefits by providing clear and concise communication to decision makers (see also Kohsaka, 2010, Rounsevell, et al., 2010). On the other hand, the same framework has been criticized for being too simplistic, ignoring non-human drivers and discursive interpretations (Rekolainen, et al., 2003, Svarstad, et al., 2008). In order to clarify the functionality of the drivers, we classified them into a group of underlying drivers including social, political, economic, demographic, technological and cultural factors, such as economic growth, technological development, international factors and climate change, and a group of proximate drivers which includes human actions linked to economic sectors (e.g., agriculture, forestry, industry) and policy drivers (Geist and Lambin, 2002). The distinction between underlying and proximate drivers was seen as important to understand which aspects are difficult to modify / change as they are out of control of the case study stakeholders, and which drivers can be modified (proximate drivers such as existing policies, human actions such as immigration and agricultural intensification). The proximate drivers are the ones that directly influence land use change, which is represented by the Pressure component. We also adapted the DPSIR framework so as to cover not only the environmental dimension as in the original form of the framework (OECD, 1993), but to include also the social and economic dimension. This was performed by providing an indicator framework including three indicators related to the so called "Land Use Functions (LUFs)" within each of the three sustainable development dimensions (Paracchini, et al., 2011, Reidsma, et al., 2011). The State refers to the level of an indicator, whereas the Impact component refers to the change in an indicator and the importance given to this change for sustainable development.

The drivers, pressures, states and impacts, and the causal links including feedback mechanisms have been identified based on literature reviews and interaction between researchers, decision makers and civil society in science-policy dialogues. Such dialogues were organized three times during the research period, and each session lasted from one to six days. They started with discussions on the problems in the case study area, their drivers, and the major impacts. These discussions were translated into DPSIR story lines by the research teams, which were later verified in a subsequent science-policy meeting. The story lines presented do not aim to be fully comprehensive; we rather

present what was perceived by the stakeholders and experts as the most important mechanisms of change in each case.

In this paper we first present a brief introduction of each of the LUPIS case studies. Second, the different DPSIR components are analyzed (Table 1) with regard to similarities and differences among the case studies. Third, we present relevant policies selected during science-policy interactions based upon their potential to improve the situation (Table 2); these policies were evaluated as part of the policy review (Bonin, et al., 2011). Links among underlying and proximate drivers, and the impacts, and the concept of a trade-off plays a central part in analyzing and seeking to respond to the challenge of sustainable development. We discuss in this paper the policy priorities made by the policy forum in relation to value trade-offs and the overall objectives of sustainable development.

2.3 The LUPIS case studies and the main land use problems

In Kenya, the case study area is Narok District where the problem is land degradation and land use conflicts linked to land fragmentation and a changing land tenure situation. Narok had extensive rangelands and group ranges used by agro pastoralists, pastoralists and wildlife, but much of this land has been divided into individual land holdings during the last two decades (Serneels and Lambin, 2001). Land subdivision has attracted those with little land elsewhere to migrate to Narok for crop production, causing land scarcity and related land use conflicts between crop farmers, pastoralists and wildlife. The conversion of land tenure has had far-reaching environmental and socio-economic implications, in particular on the pastoralist and wildlife. On the socio-economic side, the subdivided units and parcels lead to a reduction of the livestock, which accounts for a significant proportion of household incomes (Thompson, et al., 2009). On the environmental side, the subdivision of land has caused a decline in pastoral land and overgrazing. Loss of land cover (grass, bushes and trees) has further reduced pasture availability for livestock, exposed the soil to erosion and loss of fertility (Pingali, 1989).

The case study area in Mali, the Office du Niger, provides an example of problems related to overlapping pastoral, agricultural and forestry areas (Meaux, 2004). The Office du Niger, a public owned enterprise, is one of the oldest sub-Saharan hydro-agricultural projects, based on the Markala dam and developed in order to meet the increasing demand for rice nationally and in West Africa as a whole. The area presently produces more than 45% of the national rice, and is thus of major importance for food self-sufficiency in the country. The Land expansion and privatization policy and the Policy of investment aim to meet the increasing demand for rice. These policies will be implemented through the expansion of lands by at least 200 000 ha for rice production in the Office du Niger before the year 2020. However, the excessive deforestation resulting from land development work for rice production is not being followed by systematic reforestation. The area is presently characterized by an increasing trend in numbers of people and areas of rice production and by a decreasing trend in wood and pasture resources with serious environmental and social problems (Brondeau, 2000, Gicheru, et al., 2011).

The Médénine governorate in Tunisia provides a case study area that is representative of land degradation in the country. Land vulnerable to desertification is estimated at 83% of the whole country (Ministère de l'Environnement et de l'Aménagement du Territoire MEAT, 1998). The area is characterized by sedentarization and accelerated land privatization (since 1971), involving land fragmentation and increased pressure on the land. The pressure on natural resources, mainly land, is high due to increasing human needs and agricultural development; involving huge agrarian transformation through a rapid expansion of rain fed agriculture by conversion of natural rangelands. There is an increase in human consumption related to population increase, modified lifestyles and

financial investments often dependent upon external sources. There is a high water demand for irrigation, as the cultivated irrigated crops consume a great quantity of water, while the efficiency of irrigation is low. This causes land degradation, a significant decrease of yield and great fragility of soil and vegetation cover. The available water resources used in agriculture compete with claims for use by households, and tourism.

The focus of the case study in China is the Taihu Lake Basin located in the fringe of the Yangtze River Delta. In the recent decades, the area has undergone a rapid population increase, and an enormous intensification of agriculture including increased application of fertilizers and pesticides (SSBC 2007) linked to governmental aims of increased agricultural production and food self-sufficiency (Asai, et al., 2011). The intensified agriculture has resulted in high yields (SSBC 2007) and economic development in the area, but excess fertilizers and pesticides have seriously polluted the lake (Yang and Wang, 2003, Zhang, et al., 2004). Agricultural products from this region now run a risk of being contaminated by polluted water, and industries, such as textiles and brewing, face a shortage of high quality water, which is affecting further development of processing industries in this region (Feng et al. 2011). More important, water pollution and eutrophication reduce people's access to safe drinking water and are detrimental to human health.

In India, the case study is located in one of the southern states of Karnataka, where agrarian distress is a large problem, just like in other states of the country. Agriculture is an important economic activity providing employment to almost two thirds of the state's workers. In the last decades, patterns of agricultural land use have been influenced by commercialization and intensification policies, aiming at increasing agricultural production, and liberalization policies to open the economy for increased trade and competition among farmers. This has however led to a range of problems, including on the environmental side; soil degradation, depletion of water resources and loss of agro-biodiversity, while economic problems include adverse terms of trade, conversion of agricultural lands, increased cultivation cost, volatile prices and indebtedness among farming communities (Jeromi, 2007, Shroff, 2008). The combination of intensification, trade and liberalization policies, have led farmers to take big risks; and combined with lack of social security the outcome for several have been financial and personal crisis. The agrarian distress in India is manifested by the tragedy of nearly 200 000 farmers committing suicide between 1997-2008 (data collected from National Crime Records Bureau).

The case study area in Indonesia, Yogyakarta special region Daerah Istimewa Yogyakarta (DIY) is among the fastest growing provinces in Indonesia situated at the foothills of the active Meerapi Vulcano. The rapid economic growth, the high standards of education services and the images of DIY as a good and convenient place to live in, have attracted more and more people to migrate into the area. However as a result, rapid urbanization has become a threat to the environment. There has been a tremendous decrease in water availability in DIY and a lack of waste management pollutes the water. Furthermore, land conversion reduces agricultural land in DIY, which threatens food security (Marwasta, 2010). With regard to the social dimension, a high immigration of socially well-off people causes conflicts with the local residents (Faturohman, et al., 2004). Government policies to attract investment, through improved infrastructure, have stimulated the growth of DIY. However, the policies issued to control land use change have not been very effective.

The case study of Brazil is conducted alongside road BR-163, that crosses the states of Mato Grosso and Pará; the most deforested states of the Brazilian Amazon. Deforestation of the Amazon has been demonstrated to be closely related to road access (Nepstad, et al., 2001) and concomitant pressure for pasture and soya production due to favourable world commodity prices. Currently, highway BR-163 is partially paved as an effort made by the Mato Grosso state government to provide accessibility to

the market for local soybean farmers. Increasing trade in soybeans under the influence of market expansion has made it attractive for the government to pave the still unpaved part of the highway BR-163, an extension of almost 1000 km. Brazil is the largest soy exporter in the world, and the state of Mato Grosso obtained the leader position of the nation production of soybean in 2008 (MAPA, 2009). Increasing trade coincides with the increase in deforestation of the Amazon region; a tendency observed since 2000 (Brandão, 2005) . Hence the effectiveness of environmental policies that protect the Amazon is crucial. The planned paving has caused intense migration into the area, causing land grabbing and land speculation, intensifying social conflicts (Rodrigues, et al., 2009). Deforestation, especially of the Amazon rain forest, is the main driver of both greenhouse gas emissions and biodiversity loss (Cerri, et al., 2009).

2.4 Results

Table 8 presents in detail the Driver (D), Pressure (P), State (S), and Impact (I) components of the DPSIR framework for each of the seven cases as defined during science-policy dialogues, while the Response (R), of the DPSIR framework is presented as policy options / priorities in table 2.

Table 8: The most important factors for each component of the DPSI framework in the seven case studies. The R (response) relates to the policies identified (Table 2). The State/Impact refers to the main impacted Land Use Functions

Case studies	Drivers		Pressure	State / Impact
	Underlying drivers	**Proximate drivers**		
Kenya, Narok district	Economic growth, population growth, climate change.	Immigration, land privatization.	Land subdivision, overgrazing, deforestation.	Land degradation, reduced biodiversity, reduced water availability, reduced agricultural production, increased economic inequity, increased social conflicts, poverty.
Tunisia, Medenine governorate	Economic growth, technological change, climate change.	Liberalization polices, migration, agricultural intensification.	Intensified agriculture, land subdivision, overgrazing, urbanization.	Land degradation, desertification, reduced biodiversity, reduced water availability, increased agricultural productivity, increased income from tourism, increased food security, reduced agricultural labour use.
Mali, Office du Niger	Economic growth, climate change, technological development.	Agricultural intensification, investments	Agricultural expansion, intensified agriculture.	Land degradation, reduced biodiversity, reduced water availability, increased agricultural production, increased food security, increased economic inequity, cultural conflicts.
China, Thaihu Lake Basin,	Agricultural development, food demand.	Economic growth.	Intensified agriculture.	Reduced water quality, reduced biodiversity, increased agricultural productivity, increased food security, reduced agricultural labor use.
India, Karnataka	Economic growth, technology development, climate change.	Migration, high yield variety seeds, access to credit, irrigation.	Expansion of commercial agriculture, conversion of agricultural land for industries and infrastructure.	Agrarian distress, land degradation, reduced biodiversity, reduced water availability, reduced economic growth from the agricultural sector, increased economic growth from other sectors, increased economic inequity, reduced work quality.
Indonesia, Yogyakarta	Economic growth.	Immigration, investment.	Urbanization.	Reduced water quality, reduced water availability, reduced economic growth from the agricultural sector, increased economic growth from other sectors, reduced food security, increased economic inequity, cultural conflicts.
Brazil, Mato Grosso and Pará	Economic growth, climate change.	Demand for commodities, immigration, infrastructure projects.	Agricultural expansion.	Deforestation, Loss of biodiversity, climate change, increased agricultural production, increased income, increased economic inequity, cultural conflicts.

2.4.1   The main underlying drivers appearing in the case studies

From the case studies it is clear that the main underlying drivers of the land use problems are, in all cases, economic growth, technological development, and natural population growth. Experts and stakeholders mentioned climate change in five of seven case studies (see Table 8).

Economic growth is listed in every case as one of the main underlying drivers, and usually the most important one. But the rate of economic growth varies very considerably. China is the most extreme case; having experienced growth of 9.7% yearly over a period of 30 years (1978-2007), but, also the economies of India and Brazil have grown rapidly in recent years. At the other extreme are Mali and Kenya, which have during the last decades grown at rates that are barely more than the rate of population increase. Economic growth is increasing in the case study areas in Indonesia and Tunisia, though mainly in other land use sectors than the agricultural sector. Tunisia's economic growth is linked to the increasing tourism industry, while in DIY in Indonesia, economic growth occurs largely in the urban sectors linked to immigration by relatively affluent people creating economic activities, which drive further economic development. Interestingly, India and China, the two cases that experienced highest economic growth since the 1990s, show relatively low growth in the agricultural sector. In both countries growth in agricultural production has been linked to increased inputs of fertilizers and pesticides, and, in India, to major irrigation schemes.

Technological development is listed as an underlying driver in three cases; Mali, Tunisia, and India. However, this is likely a significant factor in every country, being closely related to economic growth. The reason it has been specifically emphasized in these three cases, is that it has been a particularly significant cause of land-use change, linked to agricultural intensification (Mahmood and Singh, 2003). In the case studies of Mali and Tunisia recent technological development refers mainly to major irrigation projects, and in India, technological development refers to mainly to high yield variety seeds.

Climate change is listed as a driver in Mali, Kenya, Tunisia and India. It is surely no coincidence, however, that it is the three countries in Africa – Tunisia, Mali and Kenya – that identify this as a main underlying driver of land-use problems, as these areas show a historical (1970-2004) trend of increasing temperature and declining precipitation (IPCC, 2007). Climate change in these areas reduces the natural capacity for agricultural production. This underlying driver accelerates land degradation, and increases human vulnerability, reducing the prospects of sustainable development. Climate change also acts as a driver in Brazil, not only within the country, but also in a different manner through international relations, since international efforts to mitigate global warming are especially important in densely forested countries (IPCC, 2007, UN REDD programme, 2010).

2.4.2   The main proximate drivers appearing in the case studies

In the LUPIS case studies, the main proximate drivers identified are immigration and agricultural intensification, in addition to existing policies of which the main important are related to: domestic support through various forms of subsidies or access to credit, land tenure polices, and liberalization policies. Note that the government can be seen as a driver both by virtue of what it does and what it fails to do.

Immigration is identified in the case studies as being an important driver, in many cases exceeding natural population growth. It can lead to increased conflicts and environmental degradation, but in many cases also economic growth. People migrate in search for better livelihoods, and the prospects of economic growth; this is often rural-urban migration, as in Indonesia, but can also be rural- rural migration, triggered by government decisions to open the frontier through settlement schemes (Brazil),

or to introduce changes in land tenure structures (Kenya, Mali). The underlying reasons for the government decisions to liberalize land tenancy laws, and colonize low populated areas such as the Amazon often include the desire to secure territorial claims and national political support to attract international capital and to facilitate market opportunities. Rural-urban migration on the other hand - important in Tunisia, India, Indonesia and China - is often found to be linked with liberalization and modernization of agriculture. The latter generally results in the need for fewer workers, as machines replace humans for certain tasks; and a liberalization policy increases competition among farmers, which may increase rural-urban migration. 'Pull' factors are higher employment and income possibilities, better health care and education facilitates and also an urban way of life – as highlighted by the Indonesian policy forum.

Agricultural intensification occurs to some extent in all the case studies, though the intensity varies among cases. In the Chinese case, the extremely intensive use of inorganic fertilizers and pesticides to increase crop productivity has, in combination with a favourable climate raised land productivity. However, the agricultural intensification has also led to leaching of nutrients and pesticides, leading to water pollution and eutrophication affecting biodiversity and people's access to safe drinking water and accordingly human health. India is another case where mismanaged agricultural intensification has hit hard. More than 40 per cent of the states are affected by soil degradation due to water erosion, nutrient losses and compaction and crusting of the soil (Government of Karnataka, 2003). The negative effects of agricultural intensification are also becoming manifest in Mali and Tunisia through salinization and alkalization, causing land degradation and a decrease in yield.

2.4.3   Policy drivers, government credits and subsidies

Subsidies directly influence agricultural land use in Mali, India, China, Tunisia, having an impact on the possibility to provide agricultural inputs like fertilizers, pesticides, seeds and irrigation at discounted prices, and gain increased productivity and increased economic income in return. The two forms of intervention, however, differ in important respects; subsidies encourage an action by providing certain means, as exemplified in the Mali case where the government as part of the "Participatory land development policy" pays for about 80% of the investments necessary to develop the land for irrigated agriculture, while the recipient takes care of the remaining 20%. By contrast, with the provision of credit, farmers incur debts, which they have to pay off. If investments do not succeed, the farmer remains indebted, with the risk of losing the land and means of livelihood.

Land tenure policies: The issue of land tenure has been identified as particularly important in nearly all case studies and seems to be a major issue in developing countries, with important links to the land degradation problem. In the African cases a crucial issue is the privatization of land, especially communal range land, where the stated aim is to bring land into the market and increase economic production. The land tenure issue in Brazil, India Indonesia can be characterized by liberal regulations and weak enforcement of policies. In Brazil, colonists and developers may be able to gain access to Amazon lands by simply clearing forest and placing a few head of cattle on the land (land grabbing).

Liberalization policies: The economies in Mali, Tunisia, Brazil, India (and even China) have been opened up with liberalization policies. The resulting exposure to international competition change production patterns: biased towards a specific segment of crops and hence, due to social and geographical advantages towards specific sections of farmers too. Moreover, liberalization usually leads to agricultural production in areas with low land or labour costs. Hence, commodity production to the world market competes for locally consumed production, leading to food insecurity. Rapid urbanization, increasing use of land for non-agricultural purposes, commercialization of crops, volatility in demand for commercial crops are some issues of land use change connected with it. In the context of liberalization policies, there is a significant increase in support provided for adoption of high value commercial crops. The process of market liberalization in India has had measurable changes in the Indian economy in general. Directly, increased agricultural productivity triggered forest

conversion, and increased land degradation from unsustainable production methods. Indirectly, agro-industrial development displaces the landless and rural poor who were then pushed to marginal agricultural lands or to the forest frontier. Market access is largely conditioned by state investments in transportation infrastructure.

Environmental / conservation policies: All the case studies identify environmental policies to protect the environment, though such policies are particularly emphasized in Brazil, China, Indonesia and Tunisia. The dominant environmental legislation of Brazil and Indonesia is related to land use regulation. Brazil shows impressive environmental legislation and a large area of land is allocated to protected areas for the conservation of forests and biodiversity (11 % of the country's territory). However, the borders of the majority of the country's 60 national parks are not fully respected and surveillance is far from satisfactory (Figueiredo, 2007). Moreover, the Forest Code, aiming to reduce forest conversion on private properties, seems to be an effective policy instrument for forest protection (see Verburg, et al., this issue). In Tunisia and China the aim has been to alleviate the high pressure exerted on the natural resources. In Tunisia by various water and soil conservation strategies with the objectives to protect arable land against erosion, control water flows, and decrease rural migration, while in the Chinese case study the aim is to prevent and control water pollution related to non-point source pollution in Taihu Lake Basin.

2.4.4   Pressure

The pressures identified in the seven case studies may broadly be categorized in four groups: (i) change from agricultural to urban land use, urbanization; (ii) increased land use intensity and increase in commercial crop acreage, intensification of agriculture; (iii) change of natural land to crop land, agricultural expansion; and (iv) overgrazing, overexploitation of water and soil resources (see Table 8). These four groups have been identified across the seven case studies and overlapping occurs, but typically; (i) urbanization and (ii) increased land use intensity are parallel pressures in the case studies, i.e. the Chinese, the Indonesian, the Indian and the Tunisian case, while, (iii) agricultural expansion and (iv) overexploitation of natural resources are also often found together i.e. the Tunisian, the Malian, the Kenyan, and the India case. The latter however, do not necessarily occur together, as overexploitation occurs mainly when there is limitation of land. As this is not the case in Brazil, overexploitation is less of a problem.

2.4.5   State /Impact

Case studies were selected because major impacts influencing sustainable development (SD) are apparent. In the previous sections their major drivers were analyzed. In each case study three Land Use Functions (LUFs) with corresponding indicators were identified for the environmental, economic and social dimension of SD (Table 1) (see also König, et al., this issue). The most important impacts on the environmental, the economic and the social dimension of sustainable development across the seven case studies are presented below.

The main impact on the environmental dimension for all case studies is loss of biodiversity. However, it varies whether this is mainly associated with conversion of land for industries and infrastructure, i.e. Indonesia, India and China, or with expansion of agriculture as in Brazil, Mali, Tunisia and Kenya. Another important environmental impact is water pollution, revealed during the science-policy interactions and supported also in the academic literature for China, India, Indonesia and partly Mali, caused by fertilization and intensified agriculture. The impact land and soil degradation resulting from overexploitation of natural resources, was mainly identified in Tunisia, Kenya, Mali and India. When impacts, such as the water pollution in China and land degradation in Kenya and Tunisia are quite

severe, these impacts also cause reduced biodiversity; i.e. there are causal links within the "I" component of the DPSIR framework.

For the economic dimension, increased economic production occurs in China, Tunisia, Indonesia, India, Brazil, and Mali, however the rate of economic production differs considerably, and for half the cases, increased economic production refers to land based production within the agricultural sector, i.e. Brazil, China and Mali. For Tunisia, Indonesia and India increased economic production refers to other sectors than agriculture, such as in tourism, and other industries. Technological change and former or present investments are two of the more important aspects which the case studies having experienced economic growth have in common. Brazil, which presently experience high land based production, also experiences technological change and a high level of both national and foreign investments. In India and China, factors like high level of technological change, investment in the agricultural sector, and liberalization of prices and markets have been seen as important factors promoting a high level of land based production (Narayanamoorthy, 2007, Fan, et al., 2008). Office du Niger in Mali currently experiences massive investments from both the national government and international actors, such as the Millennium Challenge Account (MCA) agreement with USA, involving investments, up to 122 billion Franc Communauté Financière Africaine (FCFA), through an irrigation project within the Office du Niger area, stimulating land productivity and economic growth for commercial agriculture (US Embassy, 2010). However, in this case the impacts on national GDP are yet to be seen. The case study area in Kenya, Narok district, is the only area where there is little indication of increase in economic production.

For the social dimension the impact can be both negative and positive depending on which social aspect is considered. Increased food security is an impact in several of the case studies, i.e. China, Mali, Tunisia and Brazil, linked to an increased land based economic production, while on the other hand, increased social conflicts are apparent in several case studies associated with increased economic inequity, unemployment and cultural conflicts; i.e. Brazil, Indonesia, Mali, India and Kenya.

2.4.6   Trade-offs and policy priorities (Responses) within the case studies

A trade-off involves losing one quality or aspect of something in return for gaining another quality or aspect, hence a trade-off in the sustainable development discourse involves that some of the identified SD objectives are encouraged or promoted at the expense of other SD objectives (McNeill, et al., 2011). Several trade-offs may be identified among the case studies, but the following were identified as the most important trade-offs.

Increased land based production and increased food security versus improved water quality and availability and protection of biodiversity – is a trade-off in the case studies in China, Indonesia, Tunisia, Kenya and Mali. In some cases, and in particularly in Mali, India and Brazil, there is also a trade-off between increased land based production and social conflicts. Another trade-off that may be identified is economic production in other sectors than agriculture, parallel with intensified commercialized agriculture, versus small scale agriculture, biodiversity, water quality and high agricultural employment. In India, major trade-off exists between policies favouring sustainable agriculture and long standing policy support for intensive farming practices.

Table 9: Policy priorities. Some policies mentioned are already implemented while some are proposals. All policies mentioned are expected by stakeholders and researchers to have an impact on sustainable development.

	Policy priorities
Kenya, Narok district	1. Adapted Land Privatization Policy: restrict land subdivision to no less than 12.5 acres per total livestock units. 2. Alternative Wildlife and Tourism policy: encourage local employment in wildlife management and the tourism industry.
Tunisia, Medenine governorate	1. Policy to promote sustainable pastoral livelihood: promote the development of land devoted to pastures in non-irrigated areas, and animal fattening. 2. Compensatory wood management in irrigated areas: the wood produced will be distributed to the benefit of the inhabitants
Mali, Office du Niger	1. Water and soil conservation strategies (WSC): protect land against erosion, control surface water extraction and use, replenishment of groundwater 2. Subsidy policy and water pricing: improve the efficiency of irrigation systems in the field.
China, Thaihu Lake Basin,	1. Convert arable land to forest land nearby rivers and lake: reduce nutrient pollution from arable sector 2. Stimulate site-specific nutrient management: reduce nutrient pollution from arable sector 3. Stimulate mechanical rice transplanting: reduce labour requirements 4.Stimulate of the use of biogas digesters in livestock breeding farms: reduce nutrient pollution from livestock farming
India, Karnataka	1. State Policy on Organic Farming (KSPoOF, 2004): aiming to promote sustainable agriculture in the state, envisages organic farming with internally generated inputs.
Indonesia, Yogyakarta	1. PERDA DIY Nr. 5 Year 1999: regulates the prevention of land conversion especially from paddy field to other functions. 2. Act Nr. 41 Year: classifies land as protected agricultural land, to be developed to support national food security
Brazil[3], Mato Grosso and Pará	1. Forest code policy 2. The Creation of protected areas

Based on the DPSI storylines, policies were identified within each case (see Table 9), which might contribute to improving the State of the relevant indicators and reduce major Impacts (Table 1). The identified policy options can be seen as reflecting value trade-offs taken in the science-policy interactions. Overall, the value trade-offs taken in the case studies emphasize the environment rather than increased economic production; policies aiming to reduce water pollution (China, Indonesia), to reduce land degradation (Kenya, Mali, Tunisia, India), or to reduce deforestation (Brazil, Mali,

---

[3] In the Brazil case, when forecasting the impact of the proposed policy, two alternative outcomes were considered: one based on the assumption that the policy is fully and effectively implemented, and the other on the assumption of low governance effectiveness, that is, the present situation.

Kenya). It is recognized that the environment needs to be improved to maintain and improve economic production in the long term, both in agriculture and in other sectors. There is a need to restore the natural resources in Kenya and Mali related to degraded pasture lands, and in the Tunisian case related to increased demand for food and reduced water availability. Both Kenya and Mali experience degradation and reduction of pasture lands due to the expanding agricultural lands. It can in fact be argued that the main target of these "socio-environmental policies" is to improve livelihoods of small scale farmers, i.e. to improve the social dimension of sustainable development, while the tool involves the environmental dimension. In India, social land use functions like improving work quality were also specifically emphasized.

2.5 Discussion

2.5.1 The underlying drivers and sustainable development

The occurrence of significant technological change and of former or present investments, here also understood as credit and subsidies are perhaps two of the more important aspects the case studies that have experienced increased economic production have in common, factors which are also emphasized in the academic literature as essential to explain the existence of high economic growth. However, the impact of these drivers on sustainable development have not been entirely positive. (Rapid) economic growth is among the case studies and also in general associated with unsustainable consumption of natural resources, and excessive levels of pollution and increased economic inequity (McNeill, et al., 2011). Moreover, there exist few examples where economic growth has occurred in parallel with environmental protection (Liu and Raven, 2010). Technological development could in principle reduce environmental impact of intensive agriculture by providing new technologies for the effective use of natural resources and for reduced runoff , but the main target of technological development has, so far been the development of high yielding seeds, improved fertilizers and pesticides, etc. Furthermore, though knowledge concerning specific nutrient management, ploughing, and irrigation techniques to reduce runoff to streams and water bodies exist in countries like India and China, such techniques are only to a limited extent utilized. The environmental Kuznets curve, states that economic growth will subsequently be used to counteract environmental degradation (Grossmann and Krueger, 1991, Stern, et al., 1996), i.e. that economic growth can/will in the long run lead to increased overall sustainable development. However, the case studies do little to support this hypothesis, furthermore there are few historical records lending support to this theory (Perman and Stern, 2003, Dinda, 2004, Galeottia, et al., 2006). Yet, environmental policies have been selected during the science-policy dialogues to improve the sustainable development situation in case studies.

2.5.2 Proximate drivers, former and selected land use policies for sustainable development

Migration, one of the more important proximate drivers of land use change (see also, Aguilar-Støen, et al., 2011), exists in the case studies as rural-rural migration, rural-urban, or also urban-rural migration, the three types motivated by different land use policies and linked to quite different story lines. Changes in land tenure policies or liberal land tenure policies motivate rural-rural migration which is known to reduce forest cover (Carr, 2009), a situation found in several of the case studies, i.e. in the Brazilian, Malian and Kenyan case. In Brazil, land rights are regulated such that a squatter acquires the right to use a piece of land by living on it for at least one year and a day, then after five years the squatter obtains ownership of this land (Le Tourneau and Bursztyn, 2010), with serious impacts on forest cover. In the Kenyan case study, in the Narok district, rural-rural migration as part of the shift in land tenure policies from communal to individual landholdings has led to a whole new process of environmental land degradation, as marginal lands including forest lands came to be used intensively at rates far beyond the carrying capacity of these areas (Ogolla and Mugabe, 1996, Amman and

Duraiappah, 2004). In fact, across the Sahel belt, changes in land tenure policies has promoted subdivision of land fragmentation and increased pressure on the land (Homewood, et al., 2004, Lamprey and Reid, 2004, Sghaier, et al., 2011). In India the agenda of land reforms began in 1950's remains unfinished (Purushothaman, et al., 2011). Due to flaws in implementation and redistribution, encroachment of revenue lands, forest lands, lakes and comparatively productive private lands became prevalent. However, instead of tackling the problem of encroachment head-on, successive governments frequently "regularized" illegal and encroached lands encouraging further encroachments.

In contrast to rural-rural migration, rural-urban migration is sometimes associated with reforestation, e.g. in the Chinese case (Rigg, 2006, Lambin and Meyfroidt, 2011), but it also often leads to increased water consumption and increased pollution levels due to insufficient sanitation treatments and increased traffic. In Medenine region (Tunisia), the tourism sector has increased water consumption continuously since 1990, causing a lowering of the artesian aquifer and the over-exploitation of groundwater. Also in Indonesia and in India water pollution problems are linked with urbanization factors (Novira, et al., 2011, Purushothaman, et al., 2011). Lastly, urban-rural migration exists with agrarian policy reforms in Brazil. where the government actively promotes such migration by providing land (Verburg, et al., 2011) this is turn pushes other rural communities further into the Amazon, leading to deforestation.

In the Chinese, Indian, Indonesian and Tunisian cases, a parallel between rural-urban migration and intensified agriculture can be observed; with a link to policies of access to credit, and liberalization policies. Domestic support through various forms of subsidies or access to credit have a considerable impact on all the three dimension of sustainable development, as this tends to lead to changes in economic activities and agricultural practices. In Tunisia, Mali, China and India subsidized fertilizers and high yielding seeds have changed agricultural practices completely in the last decades from traditional farming to more mechanized and high yielding monocultures – and economic growth for some. In India, access to credit has been an important factor facilitating intensified agriculture for increased yields (Purushothaman, et al., 2011). However, liberalized access to credit since the 1990, tied with high interests and high risks, have caused distress situations manifested by the tragedy of farmers' suicides (Jeromi, 2007). In Narok (Kenya), there are few investments, and few possibilities for subsidies. Poor farmers view access to credit with suspicion, as they are afraid of the direct consequences of crop failure and of being indebted. Further exacerbating insecurity aspects are the poor infrastructure and distant markets. In general, credit is used in Kenya by the small rich fraction of the population involved in commercial farming (Narok County Council, 2005).

How are the policies selected during the science-policy interactions, suited to improve the SD situation? Firstly, the impact of any policy is very much dependent upon the willingness and the ability of the government to implement the policies, and secondly, the impact of a policy may be weak if confronted with opposing policies or with opposing underlying drivers; these factors largely explain the failure of former / historic environmental policies. In the case of Brazil, several environmental friendly policies exist, but fail to be effective due to lack of law enforcement, driven by poor monitoring conditions and corruption. The lack of willingness and ability of the government to implement policies has caused in the case of Brazil to select as "policy" effective governance, to emphasize the impact of a potential effective governance relative to the present relatively low effective governance (see, McNeill, et al., 2011, Rodrigues Filho, et al., 2011). For the other case studies, the policies selected use the market and economic incentives, but also capacity building to promote (new) technologies to reduce fertilizer use. This is most typically seen in the Chinese case, where policies are selected to stimulate the use of site-specific nutrient management (SSNM), mechanical rice transplanting and biogas digesters, but also in Tunisia by policies to promote effective irrigation systems. In the case studies in Kenya and Indonesia, the selected policies (tenure regulation and land use change policies) use "command and control" type of instruments to reduce overexploitation of natural resources (Kenya) and protect agricultural land (Indonesia). Mali chose a different approach, using subsidies to improve local environmental and social conditions.

Provided that the policies are in fact implemented, what chances are there of success? An important requirement is perhaps that the policy in question is implemented not as a single initiative, but as part of an integrated "policy package" consisting of various instruments, involving training, support and information. Tools of training and active participation are important related to the adoption of new technologies (Giller, et al., 2008, Asai, et al., 2011). Furthermore, when the policies support multiple objectives; such as SSNM strategies which sustain high yields and reduce nutrient leaching (Feng, et al., 2011), or economic support which reduce soil erosion, protect biodiversity and provide fodder for the livestock (case study in Mali), the chances of success increase. The increasingly scarcity of natural resources is the source of many user conflicts as many resources have multiple uses (Hauge and Ellingsen, 1998, Giller, et al., 2008). Aiming at policies which reduce the trade-offs between income levels and environmental protection by (small scale) farmers is a feasible approach (Nesheim, 2011). It is clear that the often multi-level and multi-scale nature of conflicts over natural resources use requires that solutions cannot be limited to the introduction and management of new technologies (Giller, et al., 2008). History shows that environmental policies often fall short when confronted with market forces, and conflicting polices (Bonin, et al., 2011), hence strategies needs to be comprehensive and serve multi functional land use (Parra-Lopez, et al., 2009).

2.5.3 Trade-offs between the different dimensions of sustainable development

An important question is to what degree SD objectives such as increased economic production, meeting essential needs for jobs, food energy, water and sanitation, conserving and enhancing the resource base, are mutually dependent? Another point for consideration, is who bear the burden of the impact of the trade-offs taken? It may be argued that the different dimensions or aspects among the dimensions of sustainable development are mutually dependent when an impact factor identified for the "I" component in the DPSIR framework becomes a cause for the level of an impact factor in another dimension. To some degree this is the situation in the Chinese case, where soil and water resources are so polluted, that aquaculture and agricultural products loose market value; the state of the environment has an impact on the potential economic production. In such cases approaching an environmental target would mutually reinforce an economic target. However, the degree that this is reflected in the market and felt by the producers, the farmers, varies. In fact, perhaps in particularly in developing countries are such effects rarely reflected in the market as environmental externalities may be less reflected in the market price of a transaction. It can be argued that farmers or producers are only likely to change land use practices, or adopt new technologies, if these at the same time increase, or at least do not reduce, agricultural productivity or reduce agricultural labor use, while in areas of low environmental and social resilience, such as in the Narok district in Kenya, a change in behaviour is perhaps more biased towards the need for increased food security rather than reduced labour input.

Overall, for civil society and local policy makers, the important question concerns: Will environmental restoration lead to increased small scale farmer income, to improved social infrastructure including education and health services, and to growth in national income? While the Millennium Ecosystem Assessment (2005) argued that the declines in the majority of the ecosystem services will eventually lead to reduced human well-being, (Raudsepp-Hearne, et al., 2010) showed that until now these declines have been accompanied by steady gains in human well-being at the global scale. These case studies seem to agree with both, as until now there has been economic growth in almost all of them, which was linked to improvement in several other land use functions, but for the future, local stakeholders believe that restoration of the environment rather than economic growth is required to improve livelihoods.

2.6 Conclusion

This paper has analysed causal relationships between the various economic, environmental, social and institutional aspects of land use within seven case studies using the DPSIR framework. Furthermore, policies prioritized in national science-policy dialogues to reduce major land use problems were evaluated, and general trends compared. The more important drivers among the case studies include economic growth, technological development, migration and agricultural intensification. Rapid economic growth is among the case studies in general associated with unsustainable consumption of natural resources and excessive levels of pollution, and though technological development could in principle reduce environmental impact by providing new technologies, so far this has not been the situation. Migration is an important driver of land use change existing in the case studies as either rural-rural migration or rural-urban migration, stimulated by different land use polices. Domestic support through various forms of subsidies or access to credit have a considerable impact on all the three dimensions of sustainable development, as this tends to lead to changes in economic activities and agricultural practices. In several cases, subsidized fertilizers and high yielding seeds have changed agricultural practices completely from traditional farming to more mechanized and yielding monocultures and economic growth for some.

The dominant policy priorities as selected in the science-policy interactions focus on restoration of the environment to improve the social conditions; none of these emphasized economic development in the region as a first priority. History, however, shows that environmental policies often fall short when confronted with market forces and conflicting polices. Hence, strategies needs to be comprehensive and serve multifunctional land use. The prioritized policies in the case studies aim to reduce the trade-offs between income levels and environmental protection by (small scale) farmers; this is the best approach to promote sustainable development.

This study contributed to learning process between researchers, policy makers and other stakeholders, among and within countries (Lebel et al., 2006; Van Paassen et al., 2007; Giller et al., 2008). Most scientific studies contributing to Impact Assessments focus on quantitatively analysing and comparing options (step 4 and 5; EC, 2009). This study focused on the first steps: identifying the policy problem, defining objectives and developing the main policy (step 1-3). Although the exact impacts of these policies still need to be scientifically evaluated, by defining these together with stakeholders, a more profound basis is established thereby increasing probability of policy implementation.

3 Part III: Participatory impact assessment of land use policies: a cross-country comparison of five cases using the FoPIA approach

This chapter is based on (König *et al.*, in review).

3.1 Introduction

Land use intensification following increasing demands for land based products is considered to be critical to Sustainable Development (SD) (Foley et al. 2005, Turner et al. 2007). Uncontrolled land use changes often lead to overexploitation of natural resources, land clearance, soil erosion and land degradation (Lambin et al. 2003, Metzger et al. 2006). Sound decision-making and policy implementation are critical for SD (De Ridder et al. 2007). However, what is often unclear, and therefore determines the impact assessment problem in this study, is how far policy induced land use changes affect regional sustainability, and what kind of trade-offs will occur between social, economic and environmental SD targets. Policymakers are increasingly demanding for comprehensive and reliable analyses of policy impacts on economic, social and environmental dimensions of SD (Helming et al. 2011a).

There is increasing demand for sound and reliable sustainability impact assessment tools amongst decision makers from land administration and regional ministries (Tscherning et al. 2008), and particularly for tools that can help to better understand causal relationships between policy implementation and its consequences in relation to regional sustainability targets (Kates et al. 2001). Sustainability impact assessment (SIA) is an increasingly accepted way for ex-ante policy assessment and is rapidly permeating different levels of governance (George and Kirkpatrick 2006). A wide range of approaches is available in the field of SIA including both analytical (e.g., quantitative and model based) and qualitative and participation-based methods (Hacking and Guthrie 2002, Rotmans 1998). However, the specific context of policy making together with the specific set of sustainability issues makes every impact assessment unique and prohibits the development of 'one size fits all' methods for impact assessment (Scrieciu 2007). Because of complex interdependencies between the human-nature environments, a suitable mix of contextually adapted approaches and tools should be considered that together can support a sound and informed political decision-making. Thomas and Sporton (1997) pointed at the necessity to look at the grass-roots level to understand the attribution of the causes of major socio-environmental problems. The choice of a particular approach for impact assessments depends on various aspects, such as the specific decision context, regional aspects, preferences of stakeholders and decision makers, and available resources.

Until now, most impact assessments in developing countries have focused on specific and disciplinary aspects and less effort has been put into a balanced impact analysis. There is a current lack of flexible methods for impact assessments that are suited to different contexts in developing countries (Reidsma et al. 2011). In many so-called developed countries, for example, monitoring systems for environmental and socio-economic data have been established already decades ago, thus allowing the application of quantitative, computer-based assessment approaches. However, data limitations still occur, for example, with regards to the availability of land use data (Fu et al. 2006, Schmit et al. 2006) which is particularly the case for contextual data at regional scale that is required to support regional decision processes. In many developing countries, in contrast, the situation often differs widely from the described situation. According to Bacic et al. (2006), however, in many developing countries incomplete information is one of the main constraints to decision-making. Limited data availability also limits the use of analytical computer- and model-based assessments, meaning that softer, more flexible assessment approaches are required (Uthes et al. 2010). With particular regard to impact assessment in developing countries and the above mentioned limiting factors (integration, complexity, data availability and quality) the Framework for Participatory Impact Assessment (FoPIA) appeared to

be a useful and straight forward approach for adoption at regional level. The FoPIA consists of a structured sequence of steps following the whole cycle of impact assessment (scenario development, specification of the regional sustainability context, scenario analysis, impact assessment and valuation (Morris et al. 2011). The FoPIA builds upon the concept of 'Land Use Functions (LUFs)', an innovative approach that equally integrates social, economic and environmental issues into the SIA, taking into account key sustainability priorities provided by the land in a specific regional context (Pérez-Soba et al. 2008). In the case of developing countries, the FoPIA could also be used as a qualitative and flexible impact assessment tool where quantitative approaches and models fail (König et al. 2010, Reidsma et al. 2011).

Stakeholder participation in impact assessment of land use policies is often having a minor role, if at all. This bears the risk of poorly defined case studies, insufficient acknowledgement of regional policy implementation and lack of understanding of the regional characteristics and of complex human-environmental interactions and of specific sustainability issues (Morris et al. 2011). It is recognized that stakeholder participation in decision making processes is needed, to help to achieve an enhanced outcome of policy implementation. Stakeholders are defined individuals or groups, and organizations that are directly affected by decisions and actions, or that have the power to influence the outcomes of these decisions (Freeman 1984). Regarding the term 'participation', Webler et al. (2001) listed following key perspectives: the (i) legitimacy to participate and access to information, (ii) constructive interactions and good facilitation (competence), (iii) access and possibly the power to influence a decision process ('fairness'), (iv) conflicts of interests between insiders and outsiders (power struggle), and (v) the need for leadership and compromise (decisions). In land use analysis, stakeholder participation is required for the identification of context-specific needs and perceptions (Stringer et al. 2006). It has increasingly been recognized that the integration of scientific and local knowledge will lead to more sustainable solutions in sustainable land management (Schwilch et al. 2009). This is particularly the case when studying multiple dimensions of sustainability (Fraser et al. 2006) and analysing possible trade-offs among social, economic and environmental issues (De Groot 2006). Interdisciplinary approaches could help stakeholders to better understand relationships between the human-nature environment towards a shared picture of impact changes (Sandker et al. 2010). Involving stakeholders in land use analysis provides a common platform for sharing different points of view while actively supporting the learning process among groups or individuals (Reed 2008, Stringer et al. 2006), for example, to explore policy induced land use change impacts on SD (Helming et al. 2011b). Stakeholder participation ensures a high degree of transparency which is important, for example, for the acceptance of successful land use planning (Fürst et al. 2010, Tress and Tress 2003). The main challenges of stakeholder participation identified in the literature refer to the stakeholder selection process. Without careful planning, relevant stakeholders might not be able or invited to participate. There are also potential problems such as hierarchical bias within the selected group, and the subjectivity of perceptions or judgments (Fraser et al. 2006, Reed et al. 2009, Walter and Stützel 2009). In addition to this, the availability of time, expenses and scaling-up issues of results are considered problematic in participatory research (Dougill et al. 2006, Stringer et al. 2006). For these reasons, careful planning, a clear structure and good facilitation are all necessary to minimize shortcomings and to maximize the output of stakeholder participation in impact assessment.

This paper examines the utility of the FoPIA approach, by reporting the main findings emerging from a series of regional FoPIA impact assessment studies in five developing countries. Each region had its specific focus, respectively, on large-scale afforestation to reduce soil erosion in China, the transformation of traditional agriculture into conventional and organic farming practices in India, rural-urban land use changes and natural hazards in Indonesia, conflicts between cropping farms, livestock farmers and wildlife conservancy in Kenya, and the expansion of soil and water conserving measures in Tunisia. In this article the results of these studies were linked and compared in order to draw out key lessons.

3.2 Method

Having the aim to conduct and compare independent impact assessments of alternative land use policies in different developing countries, the stakeholder based 'Framework of Participatory Impact Assessment (FoPIA)' was applied in this study. The FoPIA consists of a sequence of steps to conduct impact assessments of alternative land use scenarios, drawing on the knowledge and expertise of participating stakeholders. The implementation of this approach at case study level follows three main steps: the (i) scenario development, the (ii) specification of the sustainability context, and the (iii) impact assessment (Figure 10). Stakeholder participation is at the core of this method and considered in each assessment step. The FoPIA comprises two assessment directions: firstly, a discursive examination of causal relationships and attributions of changes between human activities and regional SD targets, and secondly, the exploration of scenario impacts and possible trade-offs on selected sustainability criteria at regional level. For the FoPIA, a one (sometimes two) day workshop was organized for each case study and facilitated by a moderation team including: one workshop moderator, one translator (if needed), and two persons responsible for the processing of interim-results and reporting.
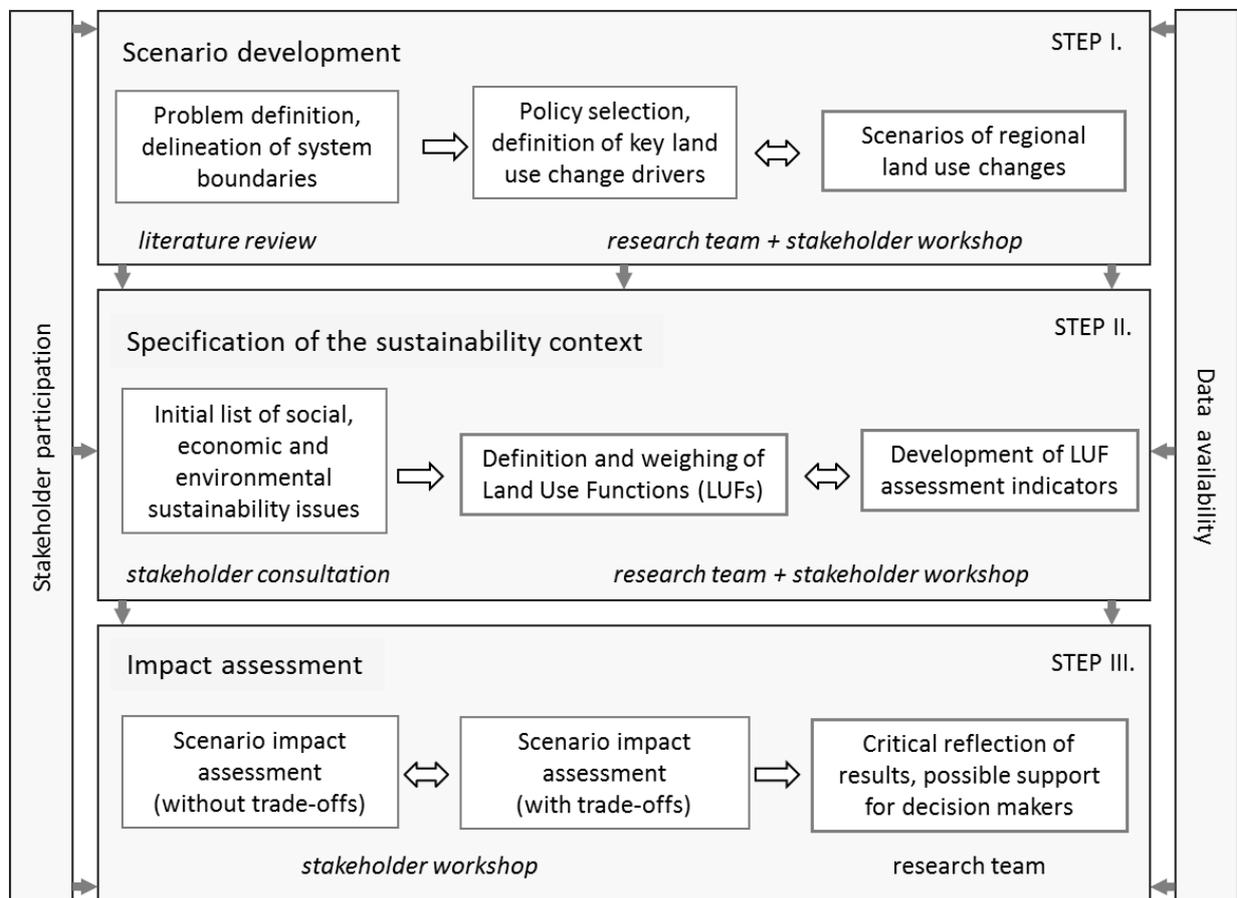
Figure 10: Implementation structure of the FoPIA framework.

3.2.1 Scenario development (Step I.)

Scenarios are one way of looking into the future to explore possible directions and alternative outcomes. In impact assessment, scenarios have become a widely accepted instrument in analysis of SD (Duinker and Greig 2007). For this study, assumptions were made in order to develop alternative region-specific future land management scenarios. The scenario development starts with the definition

of the impact assessment problem and the delineation of the case study boundaries and the selection of one or two policy instruments that aim to address the regional land use problem (see Table 10). The credibility of a scenario is of high importance and determined by the degree to which the stakeholders perceive the scenarios as plausible (Alcamo, 2001). Therefore, scenario assumptions were widely discussed with stakeholders to achieve transparency, understanding and scenario plausibility. All scenarios were exposed to the same general trends with regard to economic development and population growth assuming that these drivers lead to increasing consumption of natural resources and changes in land use patterns, types and intensities. Land use included main land use sectors (i.e. agriculture, forestry, nature conservation, and construction (industry and services, infrastructure/transport)). As a result, scenario narratives were developed for each case study independently, including two policy scenarios and one business as usual, respectively.

In the stakeholder workshop (Part I.), scenarios were presented to the participating stakeholders. The introduction of scenarios was accompanied by a presentation of figures of key drivers of land use changes and expected trends based on expected economic growth development and population growth rates. Particular attention was paid to the regional implementation and implications of land use policies on future land management practices. Stakeholders were given the opportunity to share their implicit knowledge and to propose changes to the initial scenarios.

After group discussion and upon common agreement a final set of scenarios and assumptions was defined.

Table 10: Case study characteristics including, regional land use problems and policy options

Characteristic	China (Guyuan, Ningxia)	India (Bijapur, Karnataka)	Indonesia (Yogyakarta, Java)	Kenya (Narok)	Tunisia (Oum Zessar watershed)
Scale	Region (14.421 km²)	Region (10.541 km²)	Region (3186 km²)	Region (15088 km²)	Watershed (336 km²)
Population density (km²) and growth	142 / km² in 2009 +2.1% annually	172 / km² in 2001	1.079 / km² in 2008 +1% annually	33 / km² in 2008 +2.6% annually	94.3 / km² in 2008 +2.3% annually
GDP per capita and growth	about $US 755 in 2009, approximately +12% annually	about $US 200 in 2001, approximately +11% annually	about $US 1.200 in 2007, approximately +7% annually	about $US 1.600 2009, approximately +3% annually	about $US 3759 in 2008, approximately +3% annually
Climate and rainfall	Semi-arid 483 mm/year (mean)	Semi- arid 578 mm/year (mean)	Tropical 1855 mm/year (mean)	Semi-arid to humid 500 1800 mm/year	Arid 160 to 220 mm/year
Main land use activity	Mainly small-scale subsistence agriculture (90.8%), forestry (7.5%) and build-up (1.7%)	Mainly small-scale subsistence agriculture (93%), others (7%)	Small-scale agriculture (70.2%), agroforestry (16.7%), forest (9.1%), built-up (4%)	Cropland (57%), livestock rearing (28%), wildlife protection area (5%)	Dry land and irrigated agriculture (91%), pastoral activities (9%)
Main land use problem	Soil erosion, water scarcity and droughts, land degradation	Rural poverty, droughts and groundwater exploitation	Rural-urban land conversion, natural hazards	Conflicts between livestock, crop farmers and wildlife	Water scarcity, droughts and land degradation
Policy instrument and target	Large scale afforestation on steep slopes to combat soil erosion (SLCP = Sloping Land Conversion Program)	Promotion of organic farming practices to adapt to locally dry conditions (using a mix of well suited local crops) and to reduce market dependencies	Spatially targeted forest and paddy field conservation to reduce impact of natural hazards and secure supply of water and food, respectively	Group ranch subdivision policy; land privatization to resolve land use conflicts among different interest groups	Soil and water conservation (SWC) to reduce soil erosion and improve water harvesting through construction of Jessours and Tabias (dams)
Policy scenario assumptions (BAU = business as usual)	BAU: no SLCP; SLCP P1: implementation at 4.6%; SLCP P2: additional implementation at +3.4%	Promotion of organic farming (no use of chemicals); promotion of conventional farming (use of chemicals); and one 'mixed' BAU scenario	BAU: continuation of rural-urban land conversions without policy intervention; forest protection and paddy field conservation scenarios	Promotion of market oriented crop farming (BAU); promotion of livestock farming; promotion of eco-tourism (wildlife protection)	Promotion of SWC technics by constructing small dams at 70% (BAU), 85% or 100% spatial coverage in the watershed, respectively
Scenario time horizon Scenario outlook (based on expert knowledge)	2010 to 2020 (10 years) Urban land and economic forestry will continue to increase in Guyuan while arable land will decrease at the same time. With the SLCP, soil erosion and land degradation will be reduced.	2010 to 2015 (5 years) It is expected that many farmers will establish a mix of organic (low input) and conventional farming practices as they have to complement supply of manure with chemical fertilizer	2010 to 2025 (15 years) Illegal land conversion from farm land into settlements is likely to continue in sub-urban areas of Yogyakarta City. Subsidies might promote paddy field cultivation in the rural area to provide food and welfare to the region	2010 to 2030 (20 years) Crop farming became the dominating land use sector in Narok. With economic development the livestock sector might grow towards high quality beef production. Eco-tourism could be one solution to protect wildlife.	2010 to 2015 (5 years) Depending on financial resource availability, SWC measures are expected to be implemented at full coverage in the watershed.

3.2.2 Specification of the sustainability context (Step II.)

Land Use Functions

Putting the concept of SD into the regional context, the FoPIA makes use of so-called "Land Use Functions (LUFs)" after Pérez-Soba et al. (2008). The fundamental premises of the LUF concept builds upon the idea that, firstly, land use constitutes the main pressures on SD in rural regions, and secondly, SD can only be achieved if social, economic, and ecological aspects are equally considered (Schößer et al. 2010). LUFs are defined as 'goods and services' summarizing those sustainability criteria that can be used to represent sustainability in a balanced way (Paracchini et al. 2011). They are a pragmatic way for stakeholder-driven sustainability impact assessment of land use changes and allow comparisons between different regions (Helming et al. 2011a). In impact assessment, LUFs facilitate the identification of those social, economic, and environmental functions of the land that may be damaged or enhanced under a given land use scenario (Morris et al. 2011). In the second step of the stakeholder workshop, the research team presented a common set of nine LUFs which were adapted from the EU SENSOR project after Pérez-Soba et al. (2008) to each stakeholder group. This predefined list included three economic LUFs (land based production, non-land based production, infrastructure), three social LUFs (provision of work, food security, quality of life), and three environmental LUFs (maintenance of ecosystem processes, provision of biotic and provision of abiotic resources).

In a first step, stakeholders, in each case study region, were given the opportunity to reflect and comment on each LUF and to propose changes in their definitions of LUFs (Table 2). Based on a predefined set of LUFs as developed for the European context after Pérez-Soba et al. (2008), stakeholders in each non-European country under consideration had the opportunity to adapt or modify these LUFs towards the regional context. Modifications have been made for the social dimension of LUFs in which "food security" was introduced and replaced the LUF "cultural identity" in all regions expect in the case of Tunisia. Among the social LUFs, food security appeared to be a general concern of local people. In the case of Tunisia, food security was not considered to be a major sustainability issue whereas cultural identity, in the form of traditional knowledge, instead, was argued to be an important asset for rural people struggling to survive in this particularly dry region. The social LUF "human health" was modified and redefined to "quality of life" in order to consider regional factors affecting rural life in general; i.e. human health but also income available to improve the living standards of rural people. The definition of economic and environmental LUFs was largely accepted and adapted from the proposed set of LUFs as used under the European context. After open discussion and upon common agreement among participants, a final list of LUFs was defined.

In a second step, stakeholders assigned weights of 'perceived importance' to each LUF by taking into account regional needs and SD targets (0 = less important up to 10 = most important). The same weight could be assigned to more than one function. After the assignment of individual weights, average weights were calculated and presented back to the group. This step was carried out to stimulate discussions around the main differences and similarities in regional functions and to obtain a holistic picture about regional sustainability.

Land Use Functions assessment indicators

The main purpose of LUFs was to address changes in sustainability within a broader context, supporting the communication of the SD concept among interdisciplinary stakeholder groups and to allow comparison among different regions. In addition, each LUF was assigned a corresponding indicator in order to have a precise measurement for the scenario impact assessment (see Table 11).

The indicator selection process was realized in two steps: firstly, the international research team developed a list of generally suitable indicators together with local partners from research institutions in the five regions based on literature review, experiences and data availability.

Table 11: Land use functions and assessment indicators.

SD dimension	Land Use Function (LUF)	LUF definition	LUF assessment indicator and occurrence (n); C=China, I=India, Id=Indonesia, K=Kenya, T=Tunisia
1. ECO 1	Land based production	Provision of land for economic production from land including agricultural and forest products.	- economic production from land (2) C, Id - agricultural yield (1) I - on-farm income (2) K, T - build-up activities (2) C, Id
2. ECO 2	Non-land based activities	Provision of space where residential, social and productive human activity takes place.	- off-farm income (1) K - regional investments (1) T - access to financial services (1) I
3. ECO 3	Infrastructure	Quantity and/or quality of roads as means to connect rural regions with outer regions.	- road density and quality (4) C, Id, K, T - access to markets (1) I
4. SOC 1	Provision of work	Employment opportunities for activities based on natural resources.	- regional employment (4) C, Id, K, T - quality work (1) I
5. SOC 2	Quality of life	A 'good' living standard in rural regions related to factors that should improve the quality of life.	- human health (2) I, K - life expectancy (2) Id, T - income for luxury goods (1) C
6. SOC 3	Food security	Access to and availability of sufficient quantity and quality of food.	- food availability (3) C, Id, K - food from farm (1) I
	Cultural identity	Landscape aesthetics and quality and values associated with local culture.	- use of traditional and local land use techniques (1), T
7. ENV 1	Provision of biotic resources	Provision of habitat and biodiversity and factors affecting the capacity of the land to support regional biodiversity.	- habitat and biodiversity (3) C, I, K - vegetation cover (1) T - protected land (1) Id
8. ENV 2	Provision of abiotic resources	The role of land in regulating the supply and quality of soil and water.	- water availability (3) Id, K, T - soil quality (erodibility/structure/moisture) (2) C, I
9. ENV 3	Maintenance of ecosystem processes	The role of land in the regulation of ecosystem processes, the regulation of natural processes related to the hydrological cycle, and ecological supporting functions such as soil formation.	- natural vegetation cover (2) C, T - soil health (2) I, K - clean water (1) Id

For the indicator selection, the following four criteria were applied:

- the indicator should be relevant and sensitive to the corresponding LUF and policy
- the indicator should be as precise as possible and measurable
- the indicator should be clear and understandable to stakeholders

- the indicator should not be redundant (i.e. covered by another indicator).

Secondly, the corresponding list of these indicators was presented to local stakeholders (stakeholder workshop, Part II.) and intensively discussed among participants. Stakeholders were given the opportunity to comment on each indicator and to propose changes or adjustment upon common agreement of the group. Thereby, local perceptions about indicator relevance and understanding were taken into account and resulted in a final list of LUF assessment indicators.

3.2.3 Impact assessment (Step III.)

In the third part of the FoPIA workshop, the stakeholders assess the impact of each of the three scenarios on the identified Land Use Functions. Of note is that the FoPIA does not only produce quantitative results for analysis of LUFs and indicator scoring. Numbers were also used to promote discussion and social learning among stakeholders.

Impact assessment of Land Use Functions

During the impact assessment, stakeholders were asked to explore and agree upon the main processes of changes that could result from alternative policy options. For this purpose, a scoring scale from - 3 to + 3 was used to assess negative or positive impacts, respectively, with the following scores: 0 = no impact; - 1 and + 1 moderate impact; - 2 and + 2 high impact; and - 3 and + 3 extremely high impact (cf. Morris et al. 2011). The scoring scale could also be adjusted to the regional context, for example, given a range from -2 to +2, which was applied in the case of India in order to make the method applicable to the understanding of rural farmers. On completion of the individual scoring, average impact scores for each scenario on each assessment indicator were calculated and presented to the group as bar charts and spider diagrams. To initiate a discussion among participants, the moderator highlighted contrasting positive and negative scenario impact scores given by individual participants (scoring extremes). This step was important to make the participants reveal their arguments for the different scorings. It therefore helped to make implicit knowledge of the experts explicit and to exchange different views of anticipated scenario impacts. All arguments were collected by the moderation team and, after open discussion; a second scoring round was undertaken in which experts could adjust the scores of the first scoring round as needed. Final results were presented back to the stakeholder group who were given the opportunity to reflect and comment on the final outcome.

Impact assessment for Sustainable Development

In a second step of the impact assessment, impact assessment results (scores) and LUF weights were aggregated along the three dimensions of sustainability (economic, social, environmental) using following equation:

$$wi_d = \sum_{f=1}^{n} w_{f,d} * i_{f,d}$$ (equation 1)

With: wi = weighted impact, w = weights assigned to each land use function (scoring), i = average impacts as assessed by the experts on each land use function (impact assessment), d = sustainability dimension (economic, social, ecological), f = land use function function (n = 9).

This aggregation was made to allow for a weighted interpretation of the impacts according to the priorities assigned to each LUF, and to better understand the trade-offs associated with each scenario. This allowed for comparison of alternative scenarios, a ranking of the scenarios, based on which, possible implications for land management and decision support could be discussed and differences among regions compared.

3.3 Results

3.3.1 Analyzing the regional importance of Land Use Functions

Analysis of the regional importance in LUFs revealed differences of LUFs across all regions (Table 12). The most different weights across regions were assigned to the two economic LUFs of "non-land based activities (ECO 2)" and "infrastructure (ECO 3)". Compared to other LUFs, these two LUFs were assessed to be of high importance in Indonesia while stakeholders in China, India, Kenya and Tunisia assessed them to be of low importance. This reflects the different priorities between rural regions in which land-based activities are dominant (China, India, Kenya, Tunisia) compared to rural-urban areas (Indonesia) in which non-land based activities and infrastructure are perceived of higher importance to economic development.

Differences in LUFs also appeared in the two social LUFs of "quality of life (SOC 2)" and "food security (SOC 3)" which were perceived to be of high importance particularly in India compared to the other country regions in which these two were given lower priorities. This reflects well the situation of stakeholders in India, who are particularly concerned about food security, due to the gaps between actual farm income and rising prices in the off-farm sector. Such factors increase agrarian crisis in India.

The most similar weights among all nine LUFs were attached to the economic LUF of "land-based production (ECO1)", an indication that primary production (mainly agriculture) plays an important role in all regions under consideration. Since all policy scenarios were intended to affect land use, results also showed that they were perceived as being particularly important for local people.

Table 12: Perceived importance of regional Land Use Functions (Scale: 0=low importance, 10=high importance)

LUFs	China	India	Indonesia	Kenya	Tunisia
ECO 1	8,5	8,3	7,6	8,0	8,0
ECO 2	6,0	6,3	8,5	5,8	5,1
ECO 3	6,1	7,1	8,1	6,0	4,4
SOC 1	6,1	7,1	7,9	6,8	7,9
SOC 2	7,0	9,5	7,8	7,6	7,4
SOC 3	7,1	9,3	8,8	8,0	6,0
ENV 1	7,6	7,1	7,7	8,0	6,3
ENV 2	6,5	8,4	8,0	6,9	7,7
ENV 3	7,5	8,8	8,1	7,3	6,3

ECO = Economic, SOC = Social, ENV = Environmental

3.3.2 Assessing the impact of the business as usual scenario

The impacts of the business as usual (BAU) scenarios on regional LUFs are illustrated in Figure 11. This shows that, in general, most economic and social LUFs were assessed to improve towards future development until the corresponding regional target year (ranging between 2015 and 2030). Most environmental LUFs were assessed to degrade at the same time. This development trend reflects the situation of economic development and increasing pressure on regional land resources.
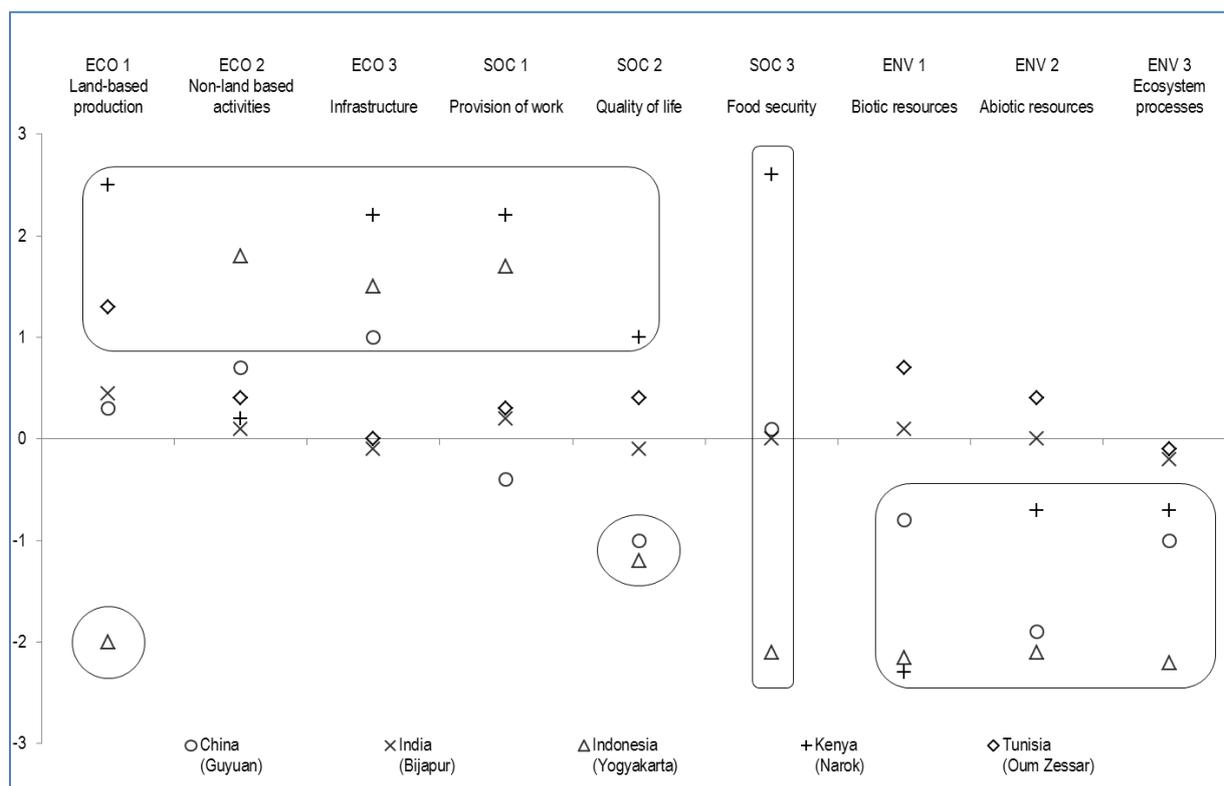
Figure 11: Assessed impact of the BAU scenarios (continuation existing land use trends without introduction of new land use polices) on the regional Land Use Functions. Similarities and main differences were highlighted for: mainly positive impacts (upper left box), most different impacts (vertical box), most negative impacts (right box), and exceptions (small circles). Scale: -3 highest negative impact, 0 = no impact changes, +3 highest positive impact.

The LUF "land-based production (ECO 1)" was considered to improve in all cases, mainly as a result of technical innovation in the agrarian sector, with the exception of Yogyakarta in Indonesia. In the case of Yogyakarta, rural-urban land conversion was judged to negatively affect land-based production, reducing the area of land available for agriculture and forestry while increasing the share of built-up areas.

The LUF "provision of work (SOC1)" was assessed negatively in the case of Guyuan in China mainly as a result of low rural development and corresponding high unemployment rates in this region.

The LUF "quality of life (SOC 2)" was assessed to decrease in two out of five regions: Guyuan (China) and Yogyakarta (Indonesia). This reflects the prediction that people in Guyuan would continue to live at subsistence level with low income available to improve their livelihood. Whereas in the case of Yogyakarta, uncontrolled rural-urban expansion was anticipated to harm human health due to increasing rates of waste disposal, water and air pollution and uncontrolled building activities along rivers and streams which are particularly prone to natural hazards.

In Narok (Kenya), "food security (SOC 3)" was expected to improve as a result of increasing agricultural activities and improved technologies (technical changes, new seed varieties, use of GMOs, fertilizer and pesticides), whereas in Oum Zessar watershed (Tunisia) this LUF was already perceived to be secure and was therefore not considered to be of relevance. In Yogyakarta, food security was assessed to be threatened as a result of decreasing agricultural land and increasing demands by the growing urban population at the same time.

3.3.3 Assessing the impact of land use policies on sustainable development

Table 4 shows how the LUFs are affected by the chosen land use policy options compared to the BAU scenarios in the five regions.

Table 13: Weighted scenario impacts aggregated along sustainability dimensions.

Country (region)	Scenario Land management	SD dimension Economic	Social	Environmental
China (Guyuan)	BAU (no policy)	1,39	-0,89	-2,57
	SLCP-P1	2,44	1,92	3,50
	SLCP-P2	3,23	2,38	5,75
India (Bijapur)	BAU (mixed)	0,44	-0,16	-1,93
	organic	3,08	4,97	5,78
	non-organic	-2,21	-5,61	-1,32
Indonesia (Yogyakarta)	BAU (no policy)	1,30	-1,39	-5,13
	forest protection	0,58	1,66	4,75
	paddy conservation	1,79	4,28	-0,50
Kenya (Narok)	BAU (cropping)	3,35	4,36	-2,83
	livestock	3,16	4,43	-1,43
	ecotourism	2,34	1,93	3,39
Tunisia (Oum Zessar)	BAU (SWC 70%)	1,24	0,53	0,73
	SWC 85%	1,81	1,70	1,06
	SWC 100%	2,37	2,17	0,71

Guyuan (China)

Soil erosion and land degradation were considered to be the main problem in Guyuan. The large scale afforestation actions were assessed to achieve the desired policy target of reduced soil erosion which, on average, was also a primary priority of regional environmental LUFs (ENV 1, ENV 3). Higher scenario impacts were assessed for the scenario SLCP-p2 (additional policy phase 2). The BAU scenario, instead, was predicted by stakeholders to cause a continued negative development of the environmental and social dimensions of SD. The main reasons behind the positive impact of the SLCP policy on the environmental dimension refer to the introduction of permanent land cover (forest) which is considered to significantly reduce soil erosion. Although policy induced structural changes actively promoted a shift from subsistence agricultural towards more off-farm activities, higher returns were expected for rural livelihood with the afforestation program (income available to buy food).

Bijapur (India)

The region of Bijapur is characterized by small-scale agriculture and frequently suffers from droughts. Land use productivity is low in most areas, and there are few prospects for productivity growth due to limited credit access which hindering investments and due to a high exposure to extreme weather events. This situation has become increasingly serious over the past decade. Increasing market competition and stagnating productivity in the agrarian sector have caused dramatic problems at farm household level; in some cases leading to farmers committing suicide. The promotion of organic production seemed to be a promising farming practice to break the dependence of farmers on multi-national seed and pesticide companies, while reducing the financial risk associated with possible crop

failure. Compared to the reference and non-organic scenarios, the organic scenario was assessed to improve the economic, social and environmental situation in the region of Bijapur. This is mainly due to low-input farming practices (little investments), market independency (low risk) and the high LUF weights attached to the social dimension (SOC 2, SOC 3). Growing awareness about these problems, and initiatives by local NGOs seemed to successfully promote organic-farming practices while supporting the market infrastructure and extension of required knowledge.

Yogyakarta (Indonesia)

Uncontrolled rural-urban land conversion and the frequent occurrence of natural hazards were considered to be the main problems in Yogyakarta region. Spatial zoning policies aimed at the protection of remaining forest land and the maintenance of regional food security through conservation incentives for paddy fields. Regional stakeholders assessed the forest protection scenario to improve all environmental LUFs, and consequently, to reduce the impact of natural hazards on the LUF "quality of life" (SOC 3); the LUF that was given the highest priority in the region. The paddy field conservation scenario was assessed to improve the social situation in the region significantly, particularly with regard to regional food security, whilst harming human health due to high applications of chemicals in rice production. However, high migration pressure and uncontrolled land conversion appeared to be the main constraint to spatially target and successfully implement these policies.

Narok (Kenya)

Land use conflicts between intensive and conventional crop-farms, livestock farmers and wildlife have caused severe land degradation problems due to increased land use pressure. The policy of group ranch sub-division has resulted in the privatization of traditional Maasai land and the regulation of land use conflicts among different interest groups. The BAU scenario of crop production (currently the dominating land use activity) and the livestock scenario were assessed to positively contribute to both economic and social development, while decreasing the environmental condition of land due to the over-exploitation of natural resources. Compared to these two scenarios, the ecotourism scenario was assessed to have positive impacts on all sustainability dimensions. Equally high priorities in regional LUFs were attached to "land-based production (ECO 1)", "food security (SOC 3)" and the "provision of biotic resources (habitat for wildlife) (ENV 1)", indicating the dilemma of conflicting interests. According to regional stakeholders, although the ecotourism scenario appeared to be 'most sustainable', there currently exists no effective policy to regulate the market-driven expansion of farmland. Therefore, it might be more realistic and suitable to balance among all scenarios by taking into account spatial zoning measures.

Oum Zessar watershed (Tunisia)

Arid climate and water scarcity were considered the main limiting land use factors in Oum Zessar watershed, Tunisia, where land-based production LUF (ECO 1) was given the highest priority. This region differs from the other case studies in which the BAU scenario is not considered to affect SD negatively but was reported to contribute only little to social and environmental development. A full implementation of the SWC policy was assessed to mainly improve economic and social development, whilst having less positive effects on environmental aspects due to artificial dam constructions and the disturbance of natural land. For this reason, an expansion of soil and water conservation measures at 85% appeared to be most promising.

3.4 Discussion

3.4.1 Similarities and differences across regions

The five regions in this study had in common that agriculture, the main land use type in all regions, was recognized to contribute to rural livelihood (Tiwari 2000), providing food and income to rural people. In the case of China and India, most agricultural activities were still at subsistence level due to limited water resources, low profits from farming or in some cases droughts or calamities. In the case of Kenya crop production contributed to national food security (wheat supply) whereas in the case of Tunisia cash crops including olive, fig, almond, date – were produced for export. In the case of Indonesia, a rural-urban region currently under transition, the agricultural sector continuously declines while infrastructure and non-land based activities, two growing economic activities were considered to increasingly play an important role for providing access to as well as new and better paid jobs in the service and industry sectors for rural farmers (Gibson and Olivia 2010).

Most land use problems evolved as a result of the overexploitation of land resources resulting into land intensification or land use changes. Most land use policies follow one specific objective, for example, a reduction in soil erosion, while targets of SD may be of multiple goals of economic, social and environmental aspects (De Smedt 2010). Human (e.g., policy or market) or nature induced (e.g., climate change) land use changes, both, bear the burden of structural changes to which local people have to adapt substantially. These changes might be seen as positive technical progress while also bearing the risk of negative side effects on other land use functions. In fact, all policies aimed at tackling region specific and environmental problem issues whereas the aim from the view of the decision maker or planner is to minimize trade-offs and unintended side effects on the social and economic side.

For example, in the case of Indonesia, development of infrastructure appeared to be an important function to improve economic and social LUFs, e.g., provision of work and income generation while putting regional food production and the environment at risk. Nevertheless, this finding also depends on the regional context and might appear opposite in another region. In the case of Guyuan in China, for example, impacts of large-scale land use changes from crop land into forestry on regional food supply did not affect food security in a negative direction due to an overall reduction in soil erosion and governmental compensation subsidies provided to farmers who participated in the policy program (Zhen et al. 2009).

3.4.2 Merits and shortcomings of the FoPIA method

One objective of this study was to test the transferability of the FoPIA method, originally developed for the European context, for application in developing countries.

By using the concept of LUFs in the FOPIA method differences in regional sustainability could clearly be distinguished among regions. During the impact assessments processes itself, we found that through stakeholder participation, both, decision makers and local actors could both receive and provide important information, options and insights. For example, during the scenario development, it appeared that in some cases the original policy plans (e.g., at national level) and actual implementation at regional level differed from each other (Williamson 2001). This knowledge gap can be made explicit through regional stakeholder involvement in a way that would not be possible through a data intensive and quantitative modeling approaches. Consequently, stakeholder participation could contribute to a detailed and holistic picture of the current situation in a given region (Dougill et al. 2006, Reed et al. 2011), the starting point for the impact assessment.

The FoPIA method builds upon qualitative and subjective judgments of stakeholders. The outcome of the impact assessment therefore very much depends on the knowledge and understanding of the participating stakeholders. In this regard, the stakeholder selection and group setting appeared to be a crucial aspect (Reed et al. 2009). In the case of Indonesia, for example, regional experts from land

administration or ministries (with higher education) were very ambitious to directly enter the impact discussion, while, in contrast, local farmers, from a less academic background kept rather silent. This might have been a result of hidden hierarchy within the group and methodological complexity. A separation of these groups was necessary in order to continue the assessment workshop.

Another challenge was the ambition to integrate interdisciplinary knowledge into one holistic sustainability impact assessment procedure. Most integrated impact assessments have focused on either, a single or only two sustainability dimensions and have lacked a balanced integration that considers the economic, social and environmental dimensions at the same time (Paracchini et al. 2011). It could therefore be argued that trade-offs towards SD could only be assessed if all dimensions mentioned are considered (United Nations, 2004). The concept of Land Use Functions was one attempt to cope with this challenge while translating key sustainability issues of regional land use into a communicable platform of trans-disciplinary research.

In order to cope with the challenge of complex causal relationships, we found it very important to have a clear assessment structure (Figure 1) that enables the integration of economic, social and environmental issues while also considering the regional context through stakeholder participation. Whilst causal linkages between land management and environmental functions were well understood in most cases, impacts on social issues (e.g., quality of life, health) appeared to be more difficult to be attributed to a certain policy (Baur et al. 2003, Thomas and Sporton 1997).

3.4.3   Implications of results and practical application

Our results revealed that stakeholder participation in impact assessments of land use policies, if well structured, could lead to a high degree of transparent and widely accepted results. This method could hence support decision making processes, for example, in land use planning and land management. In addition, and maybe more important, this method could also serve as a communication platform between different stakeholder groups. If key stakeholders are included into the assessment, results should provide a solid basis for sound decision support.

3.5 Conclusion

Regional policy implementation and land management practices underlie a complex pattern of causalities that cannot easily be generalized and require flexible and stakeholder based assessment tools. In this study we have used a stakeholder based assessment method (FoPIA) to study the impact of alternative land use policies on rural sustainability in five case study regions.

In most case studies, stakeholders assessed the environmental LUFs to be degraded under future development trends in regional land use. Policy impacts were mainly assessed to successfully tackle the problem of environmental degradation while trade-offs among social and economic criteria could be highlighted. However, it turned out that regional policy implementation plays a critical role, and that in fact, the most 'sustainable' scenario could remain a vision if the necessary institutional settings and governance structures are lacking, as mentioned by some concerned stakeholders. This aspect was not directly analysed in this study even though it was part of the workshop discussions. This aspect could be considered in future applications of FoPIA.

The challenge of bridging the gap between policy targets and stakeholder needs requires flexible and transparent tools. The FoPIA method demonstrated to be a useful tool supporting communication and knowledge exchange in interdisciplinary stakeholder groups. It thereby helped to make implicit knowledge of the experts explicit and to exchange different views of anticipated scenario impacts while providing important insights in causal relations between human actions and consequences on SD. However, the method needs to be understood as a qualitative assessment tool that could also be used jointly with quantitative assessment studies.

Having in mind that the task was to test the applicable of such tool in different regions with different problem issues in developing countries, the FoPIA proved to be a flexible and transferable methodology for stakeholder based impact assessment.

4 Part IV: General conclusions

Ex-ante policy impact assessments help policy-makers to understand the intended and unintended impacts of the assessed policies on diverse stakeholders and institutions - including those not directly targeted by the policy. Policies may be focused on achieving one specific environmental, economic or social objective. A policy aimed at promoting biodiversity, for example, may not have any specific goal of increasing income for those dependent upon the natural resources that are targeted by the policy. Similarly, a policy aimed at reducing poverty will probably not include specific measures to protect the natural resources upon which potential economic growth is based. But some policies target a mix of objectives, even though they may be to some extent difficult to reconcile. In fact, several of the case studies in this project refer to such integrated policies, that include goals set for both the protection of natural resources as well as the economic development of those depending on them; while others are primarily aimed at one dimension of sustainable development although not ignoring the other two. It is very rare that a policy is able to promote all three dimensions of sustainable development at the same time; which is precisely why an integrated assessment is needed.

This report has presented an overview of diverse efforts to improve the understanding of land use policies in the context of sustainable development. The case studies that are reviewed originate from Latin America, Africa and Asia. They also include a range of economic development pathways, with societies facing extreme poverty in Mali and Kenya and emerging economies with high growth rates in China and India. In addition, different pressures on the environment are observed, with biodiversity loss in Brazil and Indonesia, land degradation processes in Tunisia, Kenya, Mali and India, as well as problems related to the availability and quality of water resources in Tunisia, Mali, Kenya, China and India. Finally, social constraints are observed in many cases, and the required institutional setting often is not in place to properly implement the policies.

Although the case studies are very varied, some general conclusions emerge regarding the development and use of tools to assess the impacts of land use policies for sustainable development in developing countries.

On the significance of land use policies

Land-use related activities are influenced by several sectors; while agriculture and forestry are dominant users of the limited land resources in most cases, tourism and the designation of nature conservation zones are important as well. Policies such as those identified in the case studies to cope with land degradation are often also targeted at the alleviation of poverty in developing countries. Land use policies are also increasingly suited for the regional level and appropriate to cope with even more localised issues.

On the need for ex-ante assessments

Methods for ex-ante assessments of land use policies at regional (i.e. sub-national) level are hardly available for use by scientists in developing countries. The approaches that are available often focus on assessment of environmental themes (e.g. land degradation policies to cope with soil erosion or eutrophication). Impact assessment approaches are needed that link policy measures with decisions regarding agriculture, forestry, tourism and nature management, and that explore their linkages with sustainable development at large.

On the consultation of stakeholders

To ensure local knowledge and anchoring, stakeholders should be consulted. Such consultation includes regular interaction between policy makers and the researchers involved. Such interaction increases both the quality and the policy relevance of the research. It is essential to design and

implement policies that are forward looking, taking into account the challenges that are often felt at regional level between economic development, with its claims on the physical and natural environment, and the broader social context. In many poor countries existing research currently underestimates the importance of the ecological and social dimensions that shape, and are shaped by, economic development. To overcome such constraints, research capacity to perform impact assessments is urgently needed.

On participatory approaches

Participatory approaches provide a source of new ideas for policy options. Such participatory approaches require a careful selection of participants. If this is not done in a proper manner, the impact assessments would at best result in biased outcomes, and could even provide incorrect claims about the links between land use policies with sustainable development. Focus groups, for example, are suitable to analyse the policies for implementation by the actors. As part of such focus groups, factors critical to the successful implementation of policies could be identified as well as strategies to cope with them in real-world situations.

On the need for a multidisciplinary approach

A prerequisite for an integrated impact assessment is a multidisciplinary approach. It is necessary to draw on a range of disciplines, from both natural and social sciences. It is important that researchers work together over an extended period of time, in order to clarify and resolve differences in perspective, and even terminology, as a basis for undertaking a coherent and integrated study which is accessible to policy-makers.

On data constraints

Major data constraints are often faced when preparing an integrated assessment. Serious limitations in data availability should not prevent researchers from understanding the issues at stake and exploring the room for policy intervention; expert knowledge can often be used in place of statistics. Regular interaction between researchers and policy makers is indispensible to explore promising intervention strategies.

On the role of the researcher

The role of the researcher in an impact assessment study needs to be clearly understood. With regard to analysing factual trade-offs between sustainable development objectives he/she is an expert; but with regard to the value trade-offs the researcher's role is that of facilitator, to elicit the views and priorities of stakeholders.

On the iterative nature of impact assessments

An impact assessment study is necessarily iterative; initial data, findings, and even terminology, need to be seen as preliminary – subject to revision as the study proceeds, even till the last stage.

On the importance of different scales

The impacts of policies are felt at different scales. While the impact of measures are felt mainly by individual actors, in the case of economic and social domains, pressures on the environment (and the impact of measures to reduce them) are often observed at regional level. Policy measures need to be taken that cope with such pressures across the different spatial levels.

On the chances of implementation

In selecting policy options, and in assessing their impact, it is important to be realistic about the willingness and ability of government to implement them, and to build this into the assessment methodology.

For sustainable development an integrated and forward-looking approach to policy-making is needed, which seeks to combine two primary goals: to protect the environment and to alleviate poverty in developing countries. The seven different case studies, from three continents, demonstrate not only the

theoretical but also the practical challenge of designing suitable methods for assessing the impact of alternative policies. There will always be some degree of conflict between different goals, and also between different interest groups; but integrated assessment approaches contribute to the adoption of policies that are fair, feasible and forward-looking.

References

Aguilar-Støen, M., Angelsen, A., Moe, S. R., 2011. Back to the forest, exploring forest transitions in Candelaria Loxicha, Mexico. Lat. Am. Res. Rev. 46(1), 194-216.

Alcamo, J., 2001. Scenarios as tools for international assessments. Expert's corner report Prospects and Scenarios. 5, Copenhagen, Denmark, European Environment Agency (EEA). p. 31. http://www.millenniumassessment.org/documents/document.330.aspx.pdf.

Amman, H. M., Duraiappah, A. K., 2004. Land tenure and conflict resolution: a game theoretic approach in the Narok district in Kenya. Environ. Dev. Econ. 9, 383-407.

Asai, M., Reidsma, P., Feng, S., 2011. Impacts of agricultural land/use changes on biodiversity in Taihu Lake Basin, China: a multi-scale cause effect approach considering multiple land-use functions. Int. J. biodiv. sci, ecosyst. serv. manage., 1-12.

Bacic, I. L. Z., Bregt, A. K., Rossiter, D. G., 2006. A participatory approach for integrating risk assessment into rural decision-making: A case study in Santa Catarina, Brazil. Agr. Syst. 87, 229-244.

Baur, H., Poulter, G., Puccioni, M., Castro, P., Lutzeyer, H. J., Krall, S., 2003. Impact assessment and evaluation in agricultural research for development. Agr. Syst. 78, 329-336.

Birdsall, N., Rodrik, D., Subramanian, A., 2005. How to help poor countries. Foreign Aff. 84(4), 136-152.

Bonin, M., Coudel, E., Cissé, Y., Feng, S., Gicheru, P., Novira, N., Ounalli, N., Purushothaman, S., Rodrigues Filho, S., Sghaier, M., Shi, X., Tonneau, J. P., 2011. Critical analysis of land use policies. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

Brandão, A. S. P., 2005. Crescimento agrícola no Brasil no período de 1999/2004, explosão da soja e da pecuária bovina e seu impacto sobre o meio ambiente. IPEA, Rio de Janeiro, pp. 26.

Brondeau, F., 2000. Macina forestry resources and wood supply for the Office of Niger (Mali). Cah. Agric. 9(6), 485-503.

Carr, D., 2009. Population and deforestation: why rural migration matters. Prog. Hum. Geog. 33(3), 355-378.

Cerri, C. C., Maia, S. M. F., Galdos, M. V., Cerri, C. E. P., Feigl, B. J., Bernoux, M., 2009. Brazilian greenhouse gas emissions: The importance of agriculture and livestock (Piracicaba, Brazil). Sci. Agric. 66(6), 831-843.

Chen, L., P. Gicheru, H. J. Koenig, and S. Makokha, (2011). D8.2 Assessment of the impact of selected land use related policy(ies) on sustainable development and critical factors of its implementation in the case study of Kenya. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

Cissé, Y., F. Bousquet, and J. P. Tonneau, (2011). D11.2 Assessment of the impact of selected land use related policy(ies) on sustainable development and critical factors of its implementation in the case study of Mali. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

De Groot, R., 2006. Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. Landscape Urban Plan. 75, 175-186.

De Ridder, W., Turnpenny, J., Nilsson, M., Von Raggamby, A., 2007. A framework for tool selection and use in integrated assessment for sustainable development. Journal of Environmental Assessment Policy and Management 9, 423-441.

De Smedt, P., 2010. The Use of Impact Assessment Tools to Support Sustainable Policy Objectives in Europe. Ecol. Soc. 15, Art. 30.

Dinda, S., 2004. Environmental Kuznets curve hypothesis. A survey. Ecol. Econ. 49, 431-455.

Dougill, A. J., Fraser, E. D. G., Holden, J., Hubacek, K., Prell, C., Reed, M. S., Stagl, S., Stringer, L. C., 2006. Learning from doing participatory rural research: Lessons from the Peak District National Park. J. Agr. Econ. 57, 259-275.

Duinker, P. N., Greig, L. A., 2007. Scenario analysis in environmental impact assessment: Improving explorations of the future. Environ. Impact Asses. 27, 206-219.

Fan, S., Gulati, A., Thorat, S., 2008. Investment, subsidies, and pro-poor growth in rural India. Agric Econ 39, 163-170.

Faturohman, Wicaksono, D., Setiyadi, M., Syahbudin, L., 2004. Dimanika Kependudukan dan Kebijakan. Centre for Population and Policy Studies, Yogyakarta.

Feng, S., P. Reidsma, X. Luo, and F. Qu, (2011). D10.2 Assessment of the impact of selected land use related policy(ies) on sustainable development and critical factors of its implementation in the case study of China. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

Feng, S., Xiaoping, S., Reidsma, P., Xianlei, M., Qu, F., 2011. Agricultural non-point source pollution in Taihu Lake, China. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

Figueiredo, C., 2007. From paper parks to real conservation: Case studies of national park management effectiveness in Brazil. Columbus, The Ohio State University.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., Snyder, P. K., 2005. Global consequences of land use. Science 309, 570-574.

Fraser, E. D. G., Dougill, A. J., Mabee, W. E., Reed, M., McAlpine, P., 2006. Bottom up and top down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. J. Environ. Manage. 78, 114-127.

Freeman, E. R., 1984. Strategic Management: A Stakeholder Approach. Pitman, Boston.

Fu, B. J., Hu, C. X., Chen, L. D., Honnay, O., Gulinck, H., 2006. Evaluating change in agricultural landscape pattern between 1980 and 2000 in the Loess hilly region of Ansai County, China. Agric. Ecosyst. Environ. 114, 387-396.

Fürst, C., König, H. J., Pietzsch, K., Ende, H. P., Makeschin, F., 2010. Pimp Your Landscape - a Generic Approach for Integrating Regional Stakeholder Needs into Land Use Planning. Ecol. Soc. 15, Art. 34.

Galeottia, M., Lanza, A., Pauli, F., 2006. Reassessing the environmental Kuznets curve for CO2 emissions: A robustness exercise. Ecol. Econ. 57, 152-163.

Geist, H. J., Lambin, E. F., 2002. Proximate causes and underlying driving forces of tropical deforestation. Bioscience 52(2), 143-150.

George, C., Kirkpatrick, C., 2006. Assessing national sustainable development strategies: Strengthening the links to operational policy. Natural Resources Forum 30, 146-156.

Gibson, J., Olivia, S., 2010. The effect of infrastructure access and quality on non-farm enterprises in rural Indonesia. World Dev. 38, 717-726.

Gicheru, P., S. Makokha, L. Chen, L. Gachimbi, J. Wamuongo., 2011. Land subdivision and degradation in Narok, Kenya. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

Giller, K. E., Leeuwis, C., Andersson, J. A., Andriesse, W., Brouwer, A., Frost, P., Hebinck, P., Heitkönig, I., Van Ittersum, M. K., Koning, N., Ruben, R., Slingerland, M., Udo, H., Veldkamp, T., Van de Vijver, C., Van Wijk, M. T., Windmeijer, P., 2008. Competing claims on natural resources: What role for science? Ecol. Soc. 13(2), 34.

Government of Karnataka, 2003. State of the Environment Report. Department of Ecology and Environment, Bangalore.

Grossmann, G. M., Krueger, A. B., 1991. Environmental impacts of a North American free trade agreement. NBER Working papers National Bureau of Economic Research, Cambridge.

Hacking, T., Guthrie, P., 2002. A framework for clarifying the meaning of Triple Bottom-Line, Integrated, and Sustainability Assessment. Environ. Impact Asses. 28, 73-89.

Hauge, W., Ellingsen, T., 1998. Beyond environmental scarcity: Causal pathways to conflict. J. Peace Res. 35(3), 299-317.

Helming, K., De la Flor, I., Diehl, K., 2011. Integrated Approaches for ex-ante Impact Assessment Tools – the Example of Land Use. In: A. von Raggamby, F. Rubik (Eds.), Sustainable development, evaluation and policy-making. Edward Elgar, Cheltenham.

Helming, K., Diehl, K., Bach, H., Dilly, O., König, B., Kuhlman, T., Perez-Soba, M., Sieber, S., Tabbush, P., Tscherning, K., Wascher, D., Wiggering, H., 2011a. Ex Ante Impact Assessment of Policies Affecting Land Use, Part A: Analytical Framework. Ecol. Soc. 16, Art. 27.

Helming, K., Diehl, K., Kuhlman, T., Jansson, T., Verburg, P. H., Bakker, M., Perez-Soba, M., Jones, L., Verkerk, P. J., Tabbush, P., Morris, J. B., Drillet, Z., Farrington, J., LeMouel, P., Zagame, P., Stuczynski, T., Siebielec, G., Sieber, S., Wiggering, H., 2011b. Ex Ante Impact Assessment of Policies Affecting Land Use, Part B: Application of the Analytical Framework. Ecol. Soc. 16, Art. 29.

Helming, K., Pérez-Soba, M., 2011. Landscape scenarios and multifunctionality: Making land use impact assessment operational. Ecol. Soc. 16(1).

Helming, K., Pérez-Soba, M., Tabbush, P. (Eds.), 2008. Sustainability Impact Assessment of Land Use Changes. Springer, Berlin, pp. 508.

Homewood, K., Coast, E., Thompson, M., 2004. In-migrants and exclusion in east African rangelands: Access, tenure and conflict. Africa 74(4), 567-610.

IPCC, 2007. IPCC Fourth Assessment Report: Climate Change 2007. http://www.ipcc.ch/publications_and_data/ar4/wg2/en/spmsspm-b.html.

Jeromi, P. D., 2007. Farmers' indebtedness and suicides: impact of agricultural trade liberalisation in Kerala. Econ. Polit. Weekly. 42(31), 3241-3247.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B., Dickson, N. M., Faucheux, S., Gallopin, G. C., Grubler, A., Huntley, B., Jager, J., Jodha, N. S., Kasperson, R. E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., O'Riordan, T., Svedin, U., 2001. Environment and development - Sustainability science. Science 292, 641-642.

Kohsaka, R., 2010. Developing biodiversity indicators for cities: applying the DPSIR model to Nagoya and integrating social and ecological aspects. Ecol. Res. 25(5), 925-936.

König, H. J., Purushothaman, S., Suarma, U., Makokha, S., Sghaier, M., Zhen, L., Schuler, J., Chen, L., Helming, K., Uthes, S., Morris, J., Brouwer, F., H.Wiggering, 2011. Participatory impact assessment of land use policies: a cross-country study from five developing countries using the FoPIA approach. Land use Policy, submitted.

König, H. J., Schuler, J., Suarma, U., McNeill, D., Imbernon, J., Damayanti, F., Dalimunthe, S. A., Uthes, S., Sartohadi, J., Helming, K., Morris, J., 2010. Assessing the Impact of Land Use Policy on Urban-Rural Sustainability Using the FoPIA Approach in Yogyakarta, Indonesia. Sustainability 2(7), 1991-2009.

König, H., S. Purushothaman, U. Suarma, S. Makokha, M. Sghaier, L. Zheng, J. Schuler, L. Chen, K. Helming, S. Uthes, J. Morris, F. Brouwer, and H. Wiggering, (in review). Participatory impact assessment of land use policies: a cross-country comparison of five cases using the FoPIA approach, Land Use Policy.

Lambin, E. F., Geist, H. J., Lepers, E., 2003. Dynamics of land-use and land-cover change in tropical regions. Annu. Rev. Env. Resour. 28, 205-241.

Lambin, E. F., Meyfroidt, P., 2011. Global land use change, economic globalization, and the looming land scarcity. P. Natl. Acad. Sci. USA 108(9), 3465-3472.

Lamprey, R. H., Reid, R. S., 2004. Expansion of human settlement in Kenya's Maasai Mara: what future for pastoralism and wildlife? J. Biogeogr. 31(6), 997-1032.

Le Tourneau, F. M., Bursztyn, M., 2010. Projetos de colonização e reforma agrária na Amazônia Brasileira. Centro de Desenvolvimento Sustentável, Universidade de Brasília, Brasília.

Lebel, L., Anderies, J. M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T. P., Wilson, J., 2006. Governance and the capacity to manage resilience in regional social-ecological systems. Ecol. Soc. 11, 19.

Leichenko, R. M., O'Brien, K. L., Solecki, W. D., 2010. Climate Change and the Global Financial Crisis: A Case of Double Exposure. Ann. Ass. Am. Geo. 100(4), 963-972.

Liu, J. G., Raven, P. H., 2010. China's Environmental Challenges and Implications for the World. Crit. Rev. Env. Sci. Tec. 40(9-10), 823-851.

Mahmood, I. P., Singh, J., 2003. Technological dynamism in Asia. Resour. Policy 32(6), 1031-1054.

MAPA, M. d. A., Pecuária e Agricultura (2009). Retrieved December 17 2009, from www.mapa.gov.br.

Marwasta, D., 2010. Yogyakarta urban growth versus smart growth : Towards Yogyakarta slow city proposal. Urban Research Plaza Yogyakarta Sub-Center, Yogyakarta.

McNeill, D., Nesheim, I., Brouwer, F. (Eds.), 2011. Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

McNeill, D., Verburg, R., Bursztyn, M., 2011. Institutional context for sustainable development. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

MEA, 2005. Ecosystems and Human Well-being: Desertification Synthesis. Millennium Ecosystem Assessment, Press, I., Washington D.C., Pp. 36. http://www.millenniumassessment.org/documents/document.

MEA, 2005. Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Synthesis, Island Press, Washington, D.C. http://www.maweb.org/en/index.aspx.

Meaux, S., 2004. Aménagement hydraulique et conflits agropastoraux. Analyse spatio-temporelle en zone Office du Niger (Mali). Cah. Agric. 13, 495-503.

Metzger, M. J., Rounsevell, M. D. A., costa-Michlik, L., Leemans, R., Schrotere, D., 2006. The vulnerability of ecosystem services to land use change. Agric. Ecosyst. Environ. 114, 69-85.

Ministère de l'Environnement et de l'Aménagement du Territoire MEAT, 1998. Plan d'action national de lute contre la désertification, Tunis.

Morris, J. B., V. Tassone, R. de Groot, M. Camilleri, S. Moncada, 2011. A framework for participatory impact assessment: Involving stakeholders in European policy making, A case study of land use change in Malta. Ecol. Soc. 16(1).

Morris, J., Tassone, V., De Groot, R., Camilleri, M., Moncada, S., 2011. A Framework for Participatory Impact Assessment' (FoPIA): involving stakeholders in European policy-making, a case study of land use change in Malta. Ecol. Soc. 16, Art. 12.

Narayanamoorthy, A., 2007. Does groundwater irrigation reduce rural poverty? Evidence from Indian states. Irrig. Drain. 56(2), 349-362.

Narok County Council, 2005. Narok strategic plan 2005-2010, Narok.

Nepstad, D., Carvalho, G., Barros, A. C., Alencar, A., Capobianco, J. P., Bishop, J., Moutinho, P., Lefebvre, P., Silva, U. L., Prins, E., 2001. Road paving, fire regime feedbacks, and the future of Amazon forests. Forest Ecol. Manag. 154(3), 395-407.

Nesheim, I., P. Reidsma, I. Bezlepkina, R. Verburg, M. A. Abdeladhim, M. Bursztyn, L. Chen, Y. Cissé, S. Feng, P. Gicheru, H. König, N. Novira, S. Purushothaman, S. Rodrigues-Filho, and M. Sghaier, (in review). Analyzing causal chains and policy trade offs for sustainable development: experience from seven countries in the south, Land Use Policy.

Novira, N., Dalimunthe, S. A., Dewi, N. I. S., Rahayu, T. S., Wicaksono, A. P., H. König, Schuler, J., 2011. Pressure on land in the Yogyakarta Region, Indonesia. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

Novira, N., H. König, S. A. Dalimunthe, F. Damayanti, N. I. S. Dewi, T. S. Rahayu, and J. Sartohadi, (2011). D12.2 Assessment of the impact of selected land use related policies on sustainable development and critical factors of its implementation in the case study of Indonesia. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

OECD, 1993. Core Set of Indicators for Environmental Performance Reviews. Environmental Monographs 83, OECD, Paris.

Ogolla, B. D., Mugabe, J., 1996. Land tenure systems. In: Juma, C., Ojwang, J. B., Otwang, J. B. (Eds.), In land we trust. Initiative Publishers, Nairobi.

Paracchini, M. L., Pacini, C., Jones, M. L. M., Perez-Soba, M., 2011. An aggregation framework to link indicators associated with multifunctional land use to the stakeholder evaluation of policy options. Ecol. Indic. 11, 71-80.

Paracchini, M. L., Pacini, C., Jones, M. L. M., Pérez-Soba, M., 2011. An aggregation framework to link indicators associated with multifunctional land use to the stakeholder evaluation of policy options. Ecol. Indic. 11(1), 71-80.

Parra-Lopez, C., Groot, J. C. J., Carmona-Torres, C., Rossing, W. A. H., 2009. An integrated approach for ex-ante evaluation of public policies for sustainable agriculture at landscape level. Land Use Policy 26(4), 1020-1030.

Pérez-Soba, M., Petit, S., Jones, L., Bertrand, N., Briquel, V., Omodei-Zorini, L., Contini, C., Helming, K., Farrington, J. H., Mossello, M. T., Wascher, D., Kienast, F., Groot, R., 2008. Land use functions − a multifunctionality approach to assess the impact of land use changes on land use sustainability. In: Helming, K., Pérez-Soba, M., Tabbush, P. (Eds.), Sustainability Impact Assessment of Land Use Changes. Springer, Berlin, Germany, pp. 375-404.

Perman, R., Stern, D. I., 2003. Evidence from panel unit root and cointegration tests that the Environmental Kuznets curve does not exist. Aust. J. Agr. Resour. Ec. 47, 325-347.

Pingali, S., 1989. Adaptative window flow control in ISDN frame relay networks. M.S. Thesis. South Carolina, Clemson University. M.S. Thesis.

Purushothaman, S., Patil, S., Kashyap, S., 2011. Agrarian crisis and policy links: a framework for Karnataka, India. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Institutional context for sustainable development. Edward Elgar, Cheltenham, in press.

Purushothaman, S., S. Patil, and I. Francis, (2011). D9.2 Implementation of assessment of the impact of selected land use related policy(ies) on sustainable development and critical factors of its implementation in the case study of India. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

Raudsepp-Hearne, C., Peterson, G. D., Tengo, M., Bennett, E. M., Holland, T., Benessaiah, K., MacDonald, G. K., Pfeifer, L., 2010. Untangling the environmentalist's paradox: Why is human well-being increasing as ecosystem services degrade? Bioscience 60(8), 576-589.

Reed, M. S., 2008. Stakeholder participation for environmental management: A literature review. Biol. Conserv. 141, 2417-2431.

Reed, M. S., Buenemann, M., Atlhopheng, J., Akhtar-Schuster, M., Bachmann, F., Bastin, G., Bigas, H., Chanda, R., Dougill, A. J., Essahli, W., Evely, A. C., Fleskens, L., Geeson, N., Glass, J. H., Hessel, R., Holden, J., Ioris, A. A. R., Kruger, B., Liniger, H. P., Mphinyane, W., Nainggolan, D., Perkins, J., Raymond, C. M., Ritsema, C. J., Schwilch, G., Sebego, R., Seely, M., Stringer, L. C., Thomas, R., Twomlow, S., Verzandvoort, S., 2011. Cross-Scale Monitoring and Assessment of Land Degradation and Sustainable Land Management: A Methodological Framework for Knowledge Management. Land Degrad. Dev. 22, 261-271.

Reed, M., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C., Stringer, L., 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. J. Environ. Manage. 90, 1933-1949.

Reidsma, P., König, H., Feng, S., Bezlepkina, I., Nesheim, I., Bonin, M., Sghaier, M., Purushothaman, S., Sieber, S., van Ittersum, M. K., Brouwer, F., 2011. Methods and tools for integrated assessment of land use policies on sustainable development in developing countries. Land Use Policy 28(3), 604-617.

Reidsma, P., König, H., Feng, S., Bezlepkina, I., Nesheim, I., Bonin, M., Sghaier, M., Purushothaman, S., Sieber, S., van Ittersum, M. K., Brouwer, F., 2011. Methods and tools for integrated assessment of land use policies on sustainable development in developing countries. Land Use Policy 28, 604-617.

Rekolainen, S., Kämäri, J., Hiltunen, M., 2003. A conceptual framework for identifying the need and role of models in the implementation of the water framework directive. Int. J. River Bas. Manag. 1(4), 347-352.

Rigg, J. D., 2006. Forests, marketization, livelihoods and the poor in the Lao PDR. Land Degrad. Dev. 17(2), 123-133.

Rodrigues Filho, S., Bursztyn, M., Lindoso, D., Debortoli, N., Nesheim, I., Verburg, R., 2011. Road development and deforestation in Amazonia, Brazil. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, UK (forthcoming).

Rodrigues Filho, S., R. Verburg, M. Bursztyn, D. Lindoso, N. Debortoli, G. Litre, I. Nesheim, and D. McNeil, (2011). D13.2 Assessment of the impact of selected land use related policy(ies) on sustainable development and critical factors of its implementation in the case study of Brazil. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

Rodrigues, A. S. L., Ewers, R. M., Parry, L., Souza, C., Veríssimo, J. A., Balmfoord, A., 2009. Boom-and-bust development patterns across the Amazon deforestation frontier. Science 324, 1435-1437.

Rotmans, J., 1998. Methods for IA: The challenges and opportunities ahead. Environ. Model. Assess. 3, 155-179.

Rounsevell, M. D. A., Dawson, T. P., Harrison, P. A., 2010. A conceptual framework to assess the effects of environmental change on ecosystem services. Biodivers. Conserv. 19(10), 2823-2842.

Sandker, M., Campbell, B. M., Ruiz-Perez, M., Sayer, J. A., Cowling, R., Kassa, H., Knight, A. T., 2010. The Role of Participatory Modeling in Landscape Approaches to Reconcile Conservation and Development. Ecol. Soc. 15, Art. 13.

Schmit, C., Rousevell, M. D. A., La Jeunesse, I., 2006. The limitations of spatial land use data in environmental analysis. Environ. Sci. Policy 9, 174-188.

Schößer, B., Helming, K., Wiggering, H., 2010. Assessing land use change impacts - a comparison of the SENSOR land use function approach with other frameworks. J. Land Use Sci. 5, 159-178.

Schwilch, G., Bachmann, F., Liniger, H. P., 2009. Appraising and Selecting Conservation Measures to Mitigate Desertification and Land Degradation Based on Stakeholder Participation and Global Best Practices. Land Degrad. Dev. 20, 308-326.

Scrieciu, S. S., 2007. The inherent dangers of using computable general equilibrium models as a single integrated modelling framework for sustainability impact assessment. A critical note on Bohringer and Löschel (2006). Ecol. Econ. 60, 678-684.

Serneels, S., Lambin, E. F., 2001. Proximate causes of land-use change in Narok district, Kenya: A spatial statistical model. Agr. Ecosyst. Environ. 85(1-3), 65-81.

Sghaier, M., A. M. Abdeladhim, J. P. Tonneau, J. Imbernon, N. Ounalli, J. Houcine, R. Bechir, F. Chouikhi, L. Chant, H. Koenig, J. Schuler, and V. Bonnal, (2011). D7.2 Assessment of the impact of selected land use related policies on sustainable development, and critical factors of its implementation, in the case study of Tunisia. LUPIS project, EU 6th Framework Programme, contract no. 36955, www.lupis.eu PU.

Sghaier, M., Abdeladhim, M., Tonneau, J.-P., Ounalli, N., Djeder, H., Bonin, M., 2011. Land degradation in the arid Jeffara Region, Tunisia. In: McNeill, D., Nesheim, I., Brouwer, F. (Eds.), Land Use Policies for Sustainable Development: Exploring Integrated Assessment Methods. Edward Elgar, Cheltenham, in press.

Shroff, S., 2008. Agrarian distress and farmers' suicide in India: Focus on Maharashtra. India Econ. Rev. 5, 204-209.

Stern, D. I., Common, M. S., Barbier, E. B., 1996. Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development. World Dev. 24(7), 1151-1160.

Stringer, L. C., Dougill, A. J., Fraser, E., Hubacek, K., Prell, C., Reed, M. S., 2006. Unpacking "participation" in the adaptive management of social ecological systems: A critical review. Ecol. Soc. 11, Art. 39.

Svarstad, H., Petersen, L. K., Rothman, D., Siepel, H., Watzold, F., 2008. Discursive biases of the environmental research framework DPSIR. Land Use Policy 25(1), 116-125.

Thomas, D., Sporton, D., 1997. Understanding the dynamics of social and environmental variability: the impacts of structural land use change on the environment and peoples of the Kalahari, Botswana. Appl. Geogr. 17, 11-27.

Thompson, D. M., S. Serneels, D.O. Kaelo, P.C. Trench, 2009. Maasai Mara – Land Privatization and Wildlife Decline: Can Conservation Pay Its Way? In: Homewood, K., Kristjanson, P., Trench, P. (Eds.), Staying Maasai? Livelihoods, Conservation and Development in East African Rangelands. Springer, New York.

Tiwari, P. C., 2000. Land-use changes in Himalaya and their impact on the plains ecosystem: need for sustainable land use. Land Use Policy 17, 101-111.

Tress, B., Tress, G., 2003. Scenario visualisation for participatory landscape planning - a study from Denmark. Landscape Urban Plan. 64, 161-178.

Tscherning, K., K. Helming, B. Krippner, S. Sieber, and S. G. y. Paloma. Does research applying the DPSIR framework support decision making?, *Land Use Policy* In Press, Corrected Proof. doi:10.1016/j.landusepol.2011.05.009.

Tscherning, K., König, H., Schößer, B., Helming, K., Sieber, S., 2008. Ex-ante Impact Assessments (IA) in the European Commission - an overview. In: Helming, K., Pérez-Soba, M., Tabbush, P. (Eds.), Sustainability Impact Assessment of Land Use Changes. Springer, Berlin, Germany, pp. 17-33.

Turner, B. L., Lambin, E. F., Reenberg, A., 2007. The emergence of land change science for global environmental change and sustainability. Proc. Natl. Acad. Sci. USA. 104, 20666-20671.

UN REDD programme (2010). REDD+ Partnership Meeting in Brazil. Newsletter, from http://www.un-redd.org/Newsletter10/REDD_Brazil_Meeting/tabid/4859/language/en-US/Default.aspx.

UNEP, 2010. Dead Planet, Living Planet – Biodiversity and Ecosystem Restoration for Sustainable Development. A Rapid Response Assessment. UNEP, pp. 112.

United Nations., 2004. Institutional framework for sustainable development. Division For Sustainable Development.   United Nations. 6-6-2011. http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIchapter11.htm.

US Embassy (2010). U.S.- Mali Cooperation: 100 billion FCFA to Develop Office du Niger Embassy of the United States in Bamako, Mali (from http://mali.usembassy.gov/mali_us_cooperation.html).

Uthes, S., Fricke, K., König, H., Zander, P., van Ittersum, M., Sieber, S., Helming, K., Piorr, A., Müller, K., 2010. Policy relevance of three integrated assessment tools - A comparison with specific reference to agricultural policies. Ecol. Model. 221, 2136-2152.

Van Paassen, A., Roetter, R. P., Van Keulen, H., Hoanh, C. T., 2007. Can computer models stimulate learning about sustainable land use? Experience with LUPAS in the humid (sub-) tropics of Asia. Agr. Syst. 94(3): 874-887.

Verburg, R., Rodrigues Filho, S., Debortoli, N., Lindoso, D., Nesheim, I., Bursztyn, M., 2011. Evaluating sustainability options in an agricultural frontier of the Amazon using Multi-criteria analysis. Land Use Policy, under review.

Walter, C., Stützel, H., 2009. A new method for assessing the sustainability of land-use systems (I): Identifying the relevant issues. Ecol. Econ. 68, 1275-1287.

Webler, T., Tuler, S., Krueger, R., 2001. What is a good public participation process? Five perspectives from the public. Environ. Manage. 27, 435-450.

Williamson, I. P., 2001. Land administration "best practice" providing the infrastructure for land policy implementation. Land Use Policy 18, 297-307.

Yang, G., Wang, D. (Eds.), 2003. Economic development, water environment and water disaster in Taihu Lake Basins. Science Press, Beijing.

Zhang, W., Wang, S., Ji, H., Kolbe, H., 2004. Estimation of agricultural non-point source pollution in China and the alleviating strategies I. Estimation of agricultural non-point source pollution in China in early 21 century. Sci. Agric. Sinica 37(7), 1008-1017.

Zhen, L., Cao, S., Cheng, S., Xie, G., Wei, Y., Liu, X., Li, F., 2009. Arable land requirements based on food consumption patterns: Case study in rural Guyuan District, Western China. Ecol. Econ. 69, 1443-1453.