Midterm Review Report

NWO Sustainable Earth – Knowledge for Climate project

Connecting micro and macro: bringing case-studies and model-based approaches together in analysing patterns of vulnerability to global environmental change

Knowledge
for Climate

NWO
Netherlands Organisation for Scientific Research

Mid-term review KfC-NWO project 09-204

Titel: Connecting micro and macro: bringing case-studies and model-based approaches together in analysing patterns of vulnerability to global environmental change

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Institutions involved: Rural Development Sociology Group, Department of Social Sciences, Wageningen University (RDS-WUR); PBL Netherlands Environmental Assessment Agency , Bilthoven

Core Research Team: Dr Jenny Ordoñez (postdoc), Dr Diana Sietz (postdoc); Dr Kathleen Neumann (postdoc); Drs Marcel Kok (PBL), Dr Henk Hilderink (PBL); Prof Dr Han van Dijk (RDS-WUR)

1. Main objectives and expected results

Objective:

The objective of this project is to build bridges between quantitative system dynamic simulation models that are developed at PBL (IMAGE/GISMO) and qualitative case-studies by attempting to upscale lessons learned from local case-studies through Qualitative Comparative Analysis (QCA) and by down-scaling Integrated Assessment Models (IAMS) through cluster analysis of model outcomes. In this way a contribution can be made to the refinement of the IAMs and the better targeting of adaptation policies to global change.

Research questions:

The project tries to answer the following questions:

1) Which causal mechanisms underlie patterns of vulnerability in drylands and coastal zones following a systematic analysis of local level case-studies of human-environment interactions?
2) Which patterns of vulnerability emerge out of a cluster analysis of model outcomes such as GISMO/IMAGE?
3) How can the outcomes of these analyses be synthesised and translated in possible coping and adaptation strategies and policies at intermediate level?

Methodology

This project aims at connecting the information and studies at various geographical scales, from local to global. In order to do so, it has to integrate different approaches, each applied to its associated level. In the figure below, the approach that will be followed in this project, including various methods is presented. The project consists of four components:

A. (Further) development of methodology for analysing patterns of vulnerability
B. Improving GISMO model and indicator-based cluster-analysis, using model outcomes from PBL modelling framework GISMO/IMAGE
C. Meta-analysis case-studies vulnerability in drylands and coastal areas, using Qualitative Comparative Analysis (QCA).
D. Integrated assessment of vulnerability and possible coping and adaptation strategies drylands and coastal areas

2. Summary of conducted research

Personnel

The project took off in July 2010 with one postdoc researcher (0,8 fte), Dr. Jenny Ordoñez, starting with the first two components (A & B), development of methodology and improving model and indicator-base cluster analysis. She left the project 12 months later when she accepted a research position at ICRAF in Costa Rica. She was succeeded by Dr. Kathleen Neumann in February 2012, who is working jointly on this project (0,6 fte) and a related project at the Netherlands Environmental Assessment agency (0,2 fte). The second postdoc position (0,8 fte) was taken up by Dr. Diana Sietz. Due to health problems, she was only able to start in August 2011. She is responsible for research component C and D of the project. Drs Marcel Kok, Dr Henk Hilderink and Prof Dr Han van Dijk are resource persons and form the supervisory team.

Research activities

a. Overall structure of the project

Due to the changes in personnel and health issues, the execution of the project has experienced considerable delay and is behind schedule. During the first period, a database was compiled for the cluster analysis of factors relating to food security and vulnerability in drylands. For Africa, the dataset was enlarged to encompass the forest zones and coastal areas as well. Given the mobility of the population in Africa and particularly in West Africa, factors underlying patterns of vulnerability are obviously related. In response to stress in the drylands and better opportunities in the coastal and forest zones, millions of people have moved over the past decades to the coastal and forest zones of West Africa. These population movements have not been integrated into Integrated Assessment Models, but have important consequences on vulnerability patterns in both coastal areas and drylands. The second major response to increasing vulnerability to climate change was to increase investments in soils and water conservation technologies, in order to maintain and increase the productivity of natural resources. It was decided to develop a conceptual model of migration on the basis of case studies of migration in West Africa and to develop a conceptual model of climate-induced migration and to explore possibilities to link up the results of the cluster analysis with migration profiles of the region (see c). In order to assess the mechanisms behind investments in soil and water conservation technologies a set of case-studies was assembled to gain more insight in the mechanisms behind the adoption (or non-

adoption) of soil and water conservation technologies as the second major option for inhabitants of drylands to respond to stress factors and vulnerability.

b. Cluster Analysis

Different sets of factors were taken into account for the cluster analysis of vulnerability of drylands focusing either on climate and biophysical factors (soil (combined soil constraints as proxy for edaphic suitability) gan (annual mean precipitation), gvui (soil water erosion sensitivity) ,hws (human water stress), arid (aridity) ,agrikm2 (agricultural area (crops plus pasture) ,yield (crop yields), rue (rain use efficiency as indicator for land degradation) or a combination of the biophysical and socio-economic (GDP, malnutrition rates, child mortality, governance). For the forest zones, different indicators were selected (see figure 1 and 2). Vulnerability is a very complex concept and current databases do not provide for a comprehensive set of indicators. A pattern of vulnerability is defined as: 'a specific representative pattern of the interactions between environmental change and human well-being'. The method not only looks at environmental changes but also includes the wider socio-economic context in which these changes take place, addressing the integrated human-environment system from a global or regional perspective. As the benchmark for vulnerability food security was taken exemplified in child malnutrition rates and/or child mortality.

Figure 1:. Schematic representation of the interactions of the determinants of food security in dry-lands and selected indicators. Filled boxes represent the factors for which indicators have been selected. Solid arrows indicate hypothesized relationship between the determinants of food security and broken arrows connect specific determinants with their indicators. Specific combinations of these determinants result in particular vulnerability profiles.
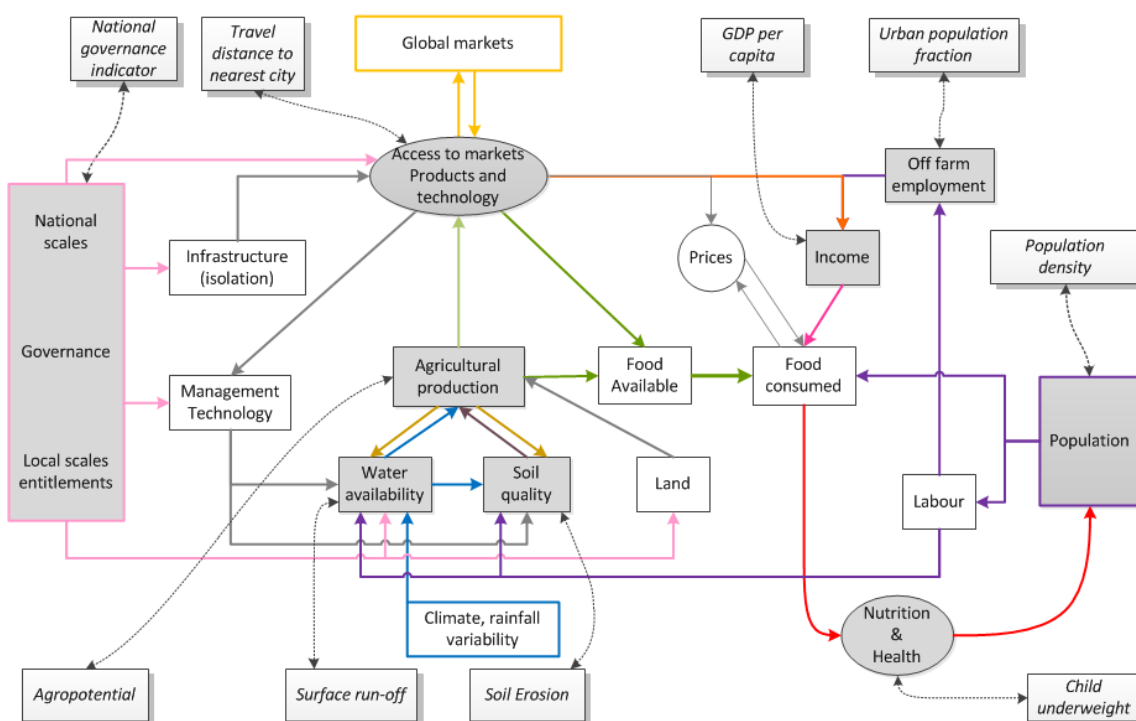
Figure 2: Schematic representation of the interactions of the determinants of food security in forests and selected indicators. Filled boxes represent the determinants for which indicators have been selected. Solid arrows indicate the hypothesized relationship between the determinants of food security and broken arrows connect specific determinants with their indicators
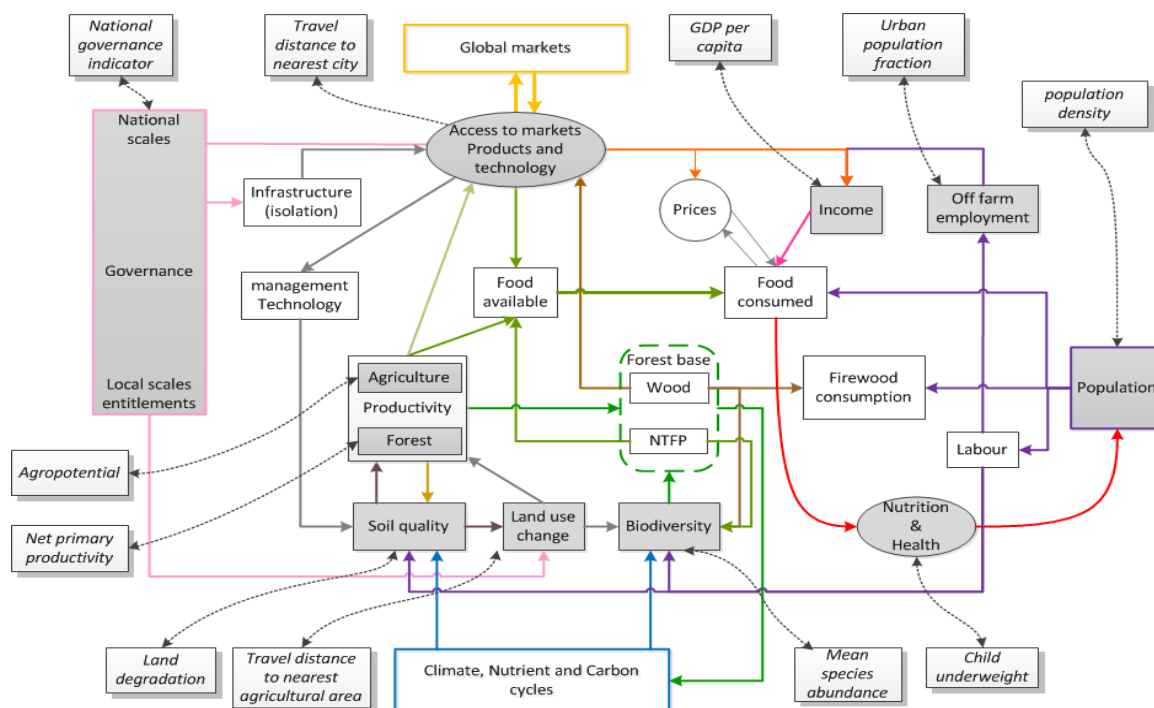
Different runs were made with global and African data sets, both normalized on a global and an African level. The results are currently coming out. A first result is reported in Annex 3.

An important drawback of the cluster analysis is that a number of variables are not sufficiently differentiated, because they are only available at the level of a country, such that within country differences are underrepresented in the clusters.

c.   Migration and population movements

In addition, it was decided to devote attention to migration as an outcome of vulnerability and to try to link migration to the results of the cluster analysis. A first glance at the case-studies on vulnerability and climate adaptation revealed that mobility (temporary, permanent migration) is a very common and in fact one of the most important adaptation strategies to climate change and climate variability. These population movements have potentially enormous consequences for land use, economic development and political stability both in sending and receiving areas. Within Integrated Assessment Models, the process of migration is represented in a simplified manner and is subjected to further improvement. In the next step the results of the cluster analysis will be linked to migration profiles, with the help of the

migration data in de CIESIN (Center for International Earth Science Network) Database. Research is now focusing on the development of a qualitative model of the factors involved in population movements, in order to have a better view on the relation between climate change and variability and climate-induced migration

Figure 3. Summary of migration pathways illustrating return and permanent migration for the different groups. Broken lines indicate paths that are not well described in literature, with the exception of colonization (for rich households) for which after colonization movements with broken lines might represent not return migration, but seasonal migration (directionality is inversed in this case).
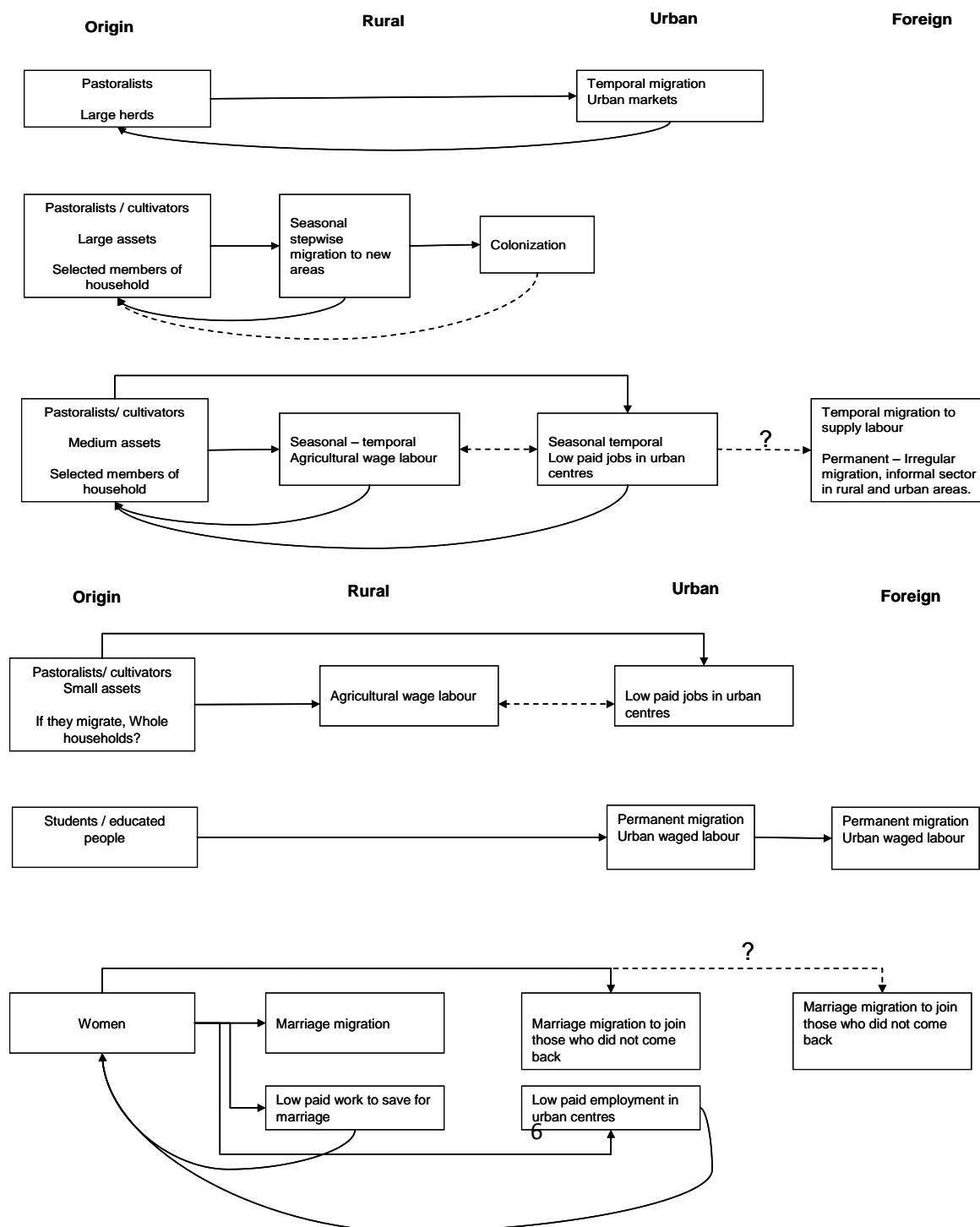
At this stage, a conceptual model of drivers of migration is ready. This model takes into account that migration is a very complex phenomenon and that the role of climate in migration cannot be easily determined. Climate is part of a wider range of factors including food production, market access and also the situation in the receiving areas. Taking all this into account a whole range of migration pathways in the region can be distinguished (see figure 3). Based on case- studies of migration more specific models will be developed with respect to the drivers of migration

    d.   Case study analysis and QCA

The objective of the case-study analysis through QCA was to develop a means to scale up case-studies in a semi-quantitative way in order to relate these to the quantitatively identified patterns of vulnerability and to identify mechanism leading to and strategies leading away from vulnerability. This proved a bit more of a challenge. Despite the fact that there is a great number of case studies in drylands of land use, and coping strategies to deal with food insecurity because of climate variability, the ways in which the studies are done, the variety in methodologies and theoretical frameworks, the data categories involved, make it difficult to select a coherent set of case studies. Moreover, the quality of the methodological design of these studies is extremely varied and in some cases does not allow extrapolation. For the analysis of the case-studies on adoption of soil and water conservation a framework was developed involving the contents and quality of the studies including:

- Rate and cause of adoption of SWC, study details, strength and weaknesses, conclusions)
- Contextual details
- Content and quality of SWC measures

In this way, research efforts have been refocused on the analysis of mechanism of land degradation and factors promoting the adoption or non-adoption of soil and water conservation measures in relation to food security. This will be done in a number of selected areas, located within specific types of clusters coming out of the cluster analysis. With the help of additional contextual information on biophysical, nutritional and migration data, links will be established with the cluster analysis and the modeling of migration on population mobility.

    e.   Outcomes

On the basis of the work so far, a number of publications have been planned by the research team sometimes in collaboration with partners:

- Paper on the relation between food security and patterns of vulnerability (draft as annex)
- Paper on a model to analyse environmental drivers of human migration in global drylands - a spatial picture: Outline is ready
- Review paper on the methodological challenges of combining top-down and bottom-up approaches

- Synthesis paper combining an analysis of climate-induced migration with a systematic analysis of success and failure in soil and water conservation (Why do people migrate and not invest in in SWC?).
- Paper on the influence of climate and climate change on migration
- A paper on the impact of climate change on crop yield and yield variability in drylands in collaboration with other teams at PBL working on this issue on a global scale
- A paper based on the QCA of soil and water conservation successes and failure
- Methodological paper on the merits and problems of QCA of sets of case studies on soil and water conservation

3. Scientific value of the research

The value of the research is in the first place located in new orderings and combinations of existing databases and model outcomes through the cluster analysis, the combination with the new CIESIN database on migration and the analysis of sets of case studies of dryland adaptation strategies and the adoption of soil and water conservation technologies. As a result, we will be able to differentiate climate versus non-climate drivers for migration from drylands to other areas. The linkages between cluster analysis, migration data and case-studies will help us to understand better the dynamics of drylands and the interactions with other climate zones such as coastal areas and forest zones.

In addition conceptual models will be developed to better assess climate-induced migration and the mechanisms behind the (non-)adoption of soil and water conservation technologies as a possible policy option for adaptation to climate changes in drylands. Sets of case studies will be analyzed to identify mechanism underlying migration patterns and the adoption of soil and water conservation technologies.

4. Contributions to broader debates and issues

The research clearly contributes to broader debates on climate-induced migration in relation with other types of migration and will also try to come to grips with population movements within West Africa over the past decades and its implications for land use, demographics and political stability. The methodological papers will address broader issues of bridging the gap between micro- and macro-approaches to vulnerability and adaptation to climate change and how to upscale case-studies and make generalizations out of these sets of case studies. All these contributions do not only have relevance for current scientific debates, but also contribute to policy debates about drylands, food security and adaptation to climate change.

Annexes

Annex 1: PowerPoint mid-term progress slides JO

Annex 2: food-security patterns of vulnerability draft 3

Annex 3: Food security results [2]

More results will be presented on October 4, as they are not ready yet in draft papers