Understanding tropical land use change

A programme for interdisciplinary methodology development

The livelihoods of two billion rural people directly depend on the quality of their land, especially on the soils and the natural resources, such as forests and fisheries. Twenty percent of the soils worldwide, however, is suffering from degradation, and deforestation proceeds at an ever increasing rate. This process is called land use change. It affects not only rural areas but also urban populations. Flash flooding of rivers, for instance, is largely caused by soil and forest degradation. And there are effects on a global scale as well: tropical deforestation, for instance, has a negative impact on global biodiversity and the climate system.

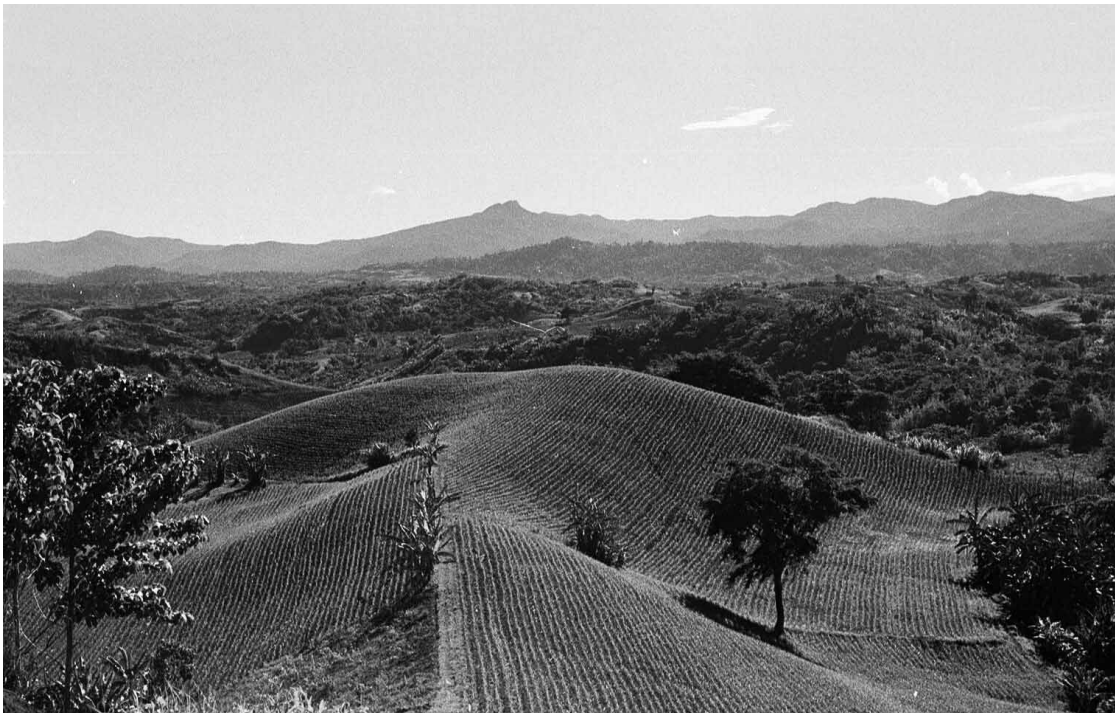
In developing countries, land use change is the key process that affects and determines the fate of soils, forests and other natural resources. The WOTRO-funded programme 'Integrating macro-modelling and actor-oriented research in studying the dynamics of land use change in North-East Luzon, Philippines' addresses the question of how the integration of the natural and social sciences can best be achieved in order to get insight into the actors and factors that drive land use change. The issue of interdisciplinarity is especially pressing for land use change, because land use in itself is a physical 'thing' that is influenced by physical factors, such as the climate, but also by social factors in the economy, culture and institutions of a region. One way to stimulate the integration of the social and natural sciences is to develop models that comprise both the physical factors and the social factors that drive land use change.

Two approaches

The WOTRO programme 'Integrating macro-modelling' has taken up this interdisciplinary challenge. The programme has a primary methodological objective, says programme leader Prof. Wouter de Groot (Leiden University). Therefore, it does not focus on a large, complex or special research area but rather on a relatively small and not too complicated nor too specific place on the globe. "We chose one municipality in North Philippines with a small township, some rivers, a hilly landscape and farmers with rice, corn and bananas as basic crops, intermingling with exploitation of the nearby rainforest." Focusing on this single area, the project tests and compares two different methodological approaches for the integration of the natural and social sciences.

The first approach is inductive. This means that real-world data come first and that the researcher then tries to find relationships within these data. In the project, many of the real-world data are compiled in a Geographic Information System (GIS), such as maps of land use, slopes, population and roads. The researcher then tries to identify associations between land use and possible physical, social and economic causes ('driving forces') of this land use and its changes, using statistical techniques such as regression. Prof. De Groot: "It may then turn out, for instance, that rapid deforestation correlates with high population densities in one place, but not in another. In terms of natural 'versus' social science, this approach means that analysis of mostly natural science data comes first and social science interpretations are added, for instance in the form of accessibility of arable fields that determine much of the labor and transportation costs of agricultural activities. We may find, for instance, that heavy, low-value crops have a tendency to be concentrated close to roads and towns, and we may then check if indeed transportation costs are an important factor in the profits that farmers can make."

Construction of a new rice paddy



Cultivation of yellow corn as a cash crop is an important land use in the area

The other approach is more deductive, essentially working the other way around. First comes what the researcher himself, on the basis of theories and field work, assumes to know about why farmers make their location and land use choices. All these assumptions are then brought together into a computer model that can generate demographic and land use change maps. In the WOTRO programme, a multi-agent model (MAM) has been designed for this work. The model is then analysed to understand its internal logic and subsequently parameters of the model are calibrated so as to form a best fit with reality. In terms of natural 'versus' social science, this approach means that social science comes first and that natural science is added, e.g. in the form of soil quality, slopes and distances. Prof. De Groot: "If we assume, for instance, that farmers work for profit and then calculate the costs and benefits for various crops including the transport costs, the closeness of heavy low-value crops to roads and towns is predicted by the model, which we then may check against reality."

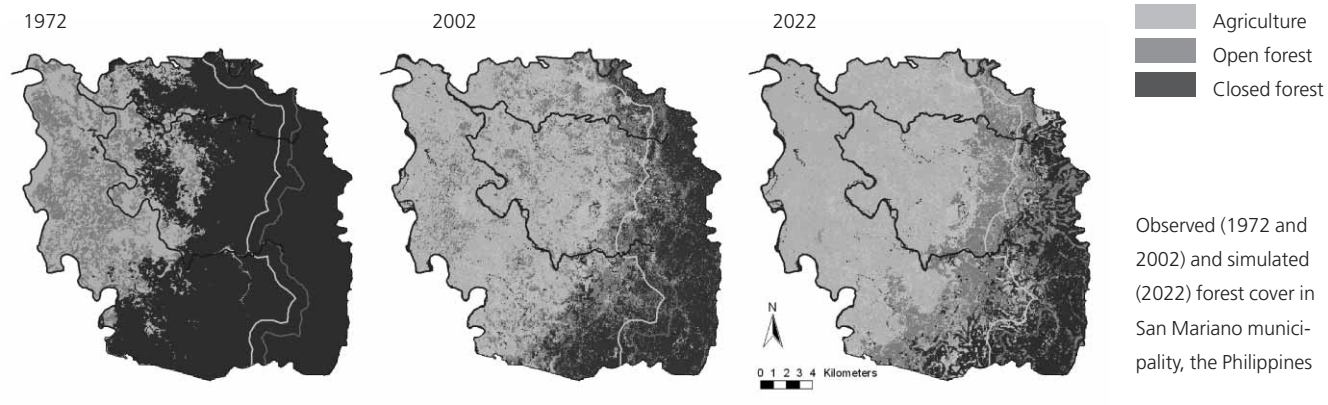
International research

Within the international programme called Land Use and Cover Change (LUCC, www.lucc.nl), researchers are collaborating to achieve a better connection between the natural sciences and the social sciences studying land use change. The LUCC is a joint undertaking of the International Geosphere-Biosphere Program (IGBP, www.igbp.kva.se) and the International Human Dimensions Program on Global Environmental Change (IHDP).

Sharing a single room

During the research, both approaches showed to have their weak and strong sides. The inductive approach, for instance, gives little insight into the causality of processes but has a strong link with real-world data. The deductive approach, on the other hand, gives much more causal insight but is only more indirectly connected to empirical data. Prof. De Groot: "This shows, for instance, when we pose the question of what would happen if a new crop would be introduced in the area. The inductive model cannot easily handle this question, simply because this new crop is not in the real-world data the model is based on. The deductive model can easily take up the new crop if a few characteristics of this crop, such as investment cost and labor requirements, are known, and make predictions of how the crop could spread through the research region. But then, the model being so full of assumptions, would these predictions be really true?"

The further strengthening of the two approaches separately is already a great good in itself, according to Prof. De Groot. The particular design of the programme, with the two methods working side by side in the same area, also allows for more combined analyses and reporting. "This is more difficult, and more unique, than one might think at first sight. Bridging gaps between schools of thought



Observed (1972 and 2002) and simulated (2022) forest cover in San Mariano municipality, the Philippines

(paradigms), be they substantive or methodological, is very difficult because paradigms are worlds apart, with strong internal logics built on different epistemological foundations. Coherent comparison and joint learning of paradigms is very rare."

"This WOTRO programme has offered one such rare opportunity for inter-paradigmatic comparison and joint learning. The research team has designed the project so as to make the most of this opportunity. Not only did it share the research region but also a single room. It is especially in this unique inter-paradigmatic area that the research team hopes to do more work and feed the discussion between research groups from different disciplines, for instance on the comparison of the approaches in full and the construction of combined and intermediary methods." Part of this work could continue on the existing basis in the Philippines, but new empirical learning could start in parallel, for instance by applying the joint approach on land use change to a dryland (Sahel) region in Africa. This would move the effort to new types of data and with that to new learning, and also to a region of great poverty and a strong demand for land use research.

At present, the researchers in the project are in the reporting phase. Feedback to the stakeholders in the fieldwork region will be given in April 2005 during a conference organised by the joint Dutch-Philippine field station CVPED, while the scientific community was informed during a conference in October 2004 in Amsterdam. The final results will be presented at the IHDP (International Human Dimensions Program on Global Environmental Change Open Meeting) in Bonn in October 2005.

Research programme and research team

The programme 'Integrating macro modelling and actor-oriented research in studying the dynamics of land use change in North-East Luzon, Philippines' was carried out between 2001 and 2005 by the Leiden University and Wageningen University in The Netherlands and Isabela State University in the Philippines, supported in the field by the joint Leiden/Isabela field station CVPED (www.cvped.org). It consisted of the following projects:

- Spatially explicit multi-agent modelling of land use change in the Sierra Madre, Philippines (Ph.D. project)
- Linking processes and patterns of land use change at the watershed level in the Sierra Madre region, Philippines (Ph.D. project)
- Linking global processes to local conditions: a spatially explicit analysis of land use change in the Northern Philippines (postdoc-project)

The programme was carried out by:

- Prof. Wouter T. de Groot (Leiden University, Institute of Environmental Sciences)
- Prof. Tom Veldkamp (Wageningen University and Research Centre)
- Dr Peter H. Verburg (Wageningen University and Research Centre)
- Marco G.A. Huigen (Leiden University / Radboud University)
- Koen P. Overmars (Leiden University)
- Cecille Mangabat (Isabela State University, Philippines)

The publication list of this research programme, which shows the inter-paradigmatic results of the programme, will be published on www.nwo.nl/wotro (then click 'News' and choose 2005 May).