TA/01

MULTIMODE - Results

A Multiscalar and Multiagent Modelling Framework for Assessing Sustainable Futures in a Globalised Environment

DURATION OF THE PROJECT
15/12/2006 - 30/06/2011

BUDGET
800.000 €

KEYWORDS
agent-based model, globalisation, policy support, spatio-temporal analysis, stakeholder dialogue, sustainability

CONTEXT

With increasingly globalised economies, sustainable development becomes an even greater challenge to both policy and science because new opportunities and unknown risks created by globalisation are unevenly distributed between regions and between people. Policy should be able to provide measures to help different regions and communities benefit from these opportunities and cope with these risks in a sustainable manner, and science should take the challenge to contribute to design such measures. This research project aims to contribute to this challenge by developing an integrated modelling framework. Such framework will be implemented through a ***multi***scalar & ***multi***agent ***mode***l (***MultiMode***) in which national impacts of global changes trickle down to the local communities through the adaptive decisions of institutions and agents at the regional, provincial and communal levels.

PROJECT DESCRIPTION

Objectives

The overall aim of *MultiMode* was to promote sustainable development in Belgium in a globalised context through the development of an integrated, multi-scale modelling framework of economic activities and their associated land uses. The modelling framework combined top-down and bottom-up models that address both urban and rural land use. Given the importance in spatial terms of agricultural land use, a specific focus was dedicated on the sustainability of farming practices. Specifically, Multimode aimed to generate multi-scale indicators of social, economic and ecological sustainability by integrating the empirical knowledge generated from different models.

Méthodology

MultiMode has four closely interconnected work packages (WP): a meta-model of policy options and global scenarios (WP1), a multi-scale constrained cellular-automata (CA) model (WP2), a landscape scale agent-based model (ABM) of decision rules (WP3), and stakeholder dialogue and feed-backs (WP4). The policy options and scenarios at the global and European scale from WP1 provide inputs to the CA of the WP2 and ABM of the WP3 as drivers of land use change and socio-economic decision-making processes. The meta-model of WP1 produces look-up tables and/or simple statistical functions of relevant global drivers (e.g., socio-economic, technological, demographic, climatic, etc.).

The constrained CA of WP2 generates spatio-temporal changes in the social, economic and natural environment, including land use, at different spatial scales. Results from the CA provide the boundary conditions for the ABM of WP3 by describing the spatial dynamics in the environment of the agents (e.g., farmers). The novelty of the ABM in assessing future sustainability rests in its ability to capture the behaviour of individual decision agents in adapting to the changes in their environment. Its results informed the CA about the impacts of their adaptive decisions on changes in the social, economic and natural environment. The feedback mechanism between the CA and ABM improves their practical use for assessing the indicators of sustainable development. In the ABM, adaptive decisions from agents are represented in social behavioural models (SBM). These SBM were developed from the knowledge elicited through stakeholder dialogue and feedbacks in WP4. Moreover, WP4 provides in-depth analyses of agri-environmental measures (AEMs) at the institutional and farmer levels.

MAIN RESULTS AND DELIVERABLES

Model analysis en simulation runs

- WP1 generated scenarios for socio-economic (e.g. population, employment) and farm-level indicators (e.g. yields, prices) for the period 2000-2060 based on time-series data from 1970s. Four scenarios were identified: Global and economic emphasis (GEE), Globalised and environmental/social emphasis (GES), Localised and economic emphasis (LEE), and Localised and emphasis on social/environment (LES). The values of the indicators were highest for GEE and lowest for the LES scenario.
- Using the WP1 socio-economic scenarios, the CA model from the WP2 generated land use change scenarios at different administrative levels. The strongest expansion of the built-up area is observed in LEE (+55%) and the least in LES (30%). The occupation of land by industrial and commercial activities is rather modest in LEE in comparison to the expansion of the built-up area in this scenario. There is a steep decline in the amount of agricultural land towards 2060 in all scenarios. This decline is most pronounced in LEE and GEE (both -17%) and least pronounced in LES (-11%).

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- The ABM model in WP3 identified four types of farmer typologies including imitative, innovative, conservative, and adaptive. When making land use decisions, the imitative and innovative farmers give more importance on the type of farm activities (45%) and social feedback (11%). Meanwhile, the conservative and adaptive farmers give more importance to the changes in farm income (21%). Based on the land use constraints from the WP2, the largest changes in land use pattern are expected to happen in LES scenario mainly as a response to changes in farm income.
- As an extension of the land use analysis in WP3, analysis of agri-environmental measures (AEMs) was carried out in WP4. In addition, two separate studies were conduced. First, Actor-Network analysis was performed to examine the mechanisms by which mobilisation for agri-environmental management proceeds, and by doing so, to develop mobilisation capacity as a concept to be used for evaluating policy implementation in this area. Second, a mixed-method approach was used to examine farmers' decision-making in relation to 'simple', 'medium' and 'complex' AEMs. Among others, this resulted in the identification of six styles of AEM participation.

Models and codes

- A series of documented model runs consisting of time-series sustainability indicators and maps at the European, national, regional, provincial, communal and farm levels.
- Validated models including multi-scalar cellular automata model at the national, regional, provincial and communal levels in Belgium as well as landscape scale agent-based models for the case study areas in the Flemish and Walloon regions.

Publications

- Working papers with full documentation of the work carried out, the main results, and recommendations for further analysis.
- Articles in internationally refereed journals: (1) A. Van Herzele, N. Dendoncker, and L. Acosta-Michlik, Mobilisation capacity for agri-environmental management, Journal of Environmental Management 92 (2011) 1023-1032; (2) R. White, I. Uljee, and G. Engelen, Integrated Modelling of Population, Employment, and Land Use Change with a Multiple Activity Based Variable Grid Cellular Automaton, International Journal of Geographical Information Science, accepted 2011; (3) A. Van Herzele et al., Effort for money? Farmers' response to agri-environment measures with different degrees of complexity, Land Use Policy, submitted 2011; (4) L. Acosta-Michlik et al., Complex social-ecological system modelling of sustainable land use decisions, special issue Regional Environmental Change, in preparation 2011.

CONTACT INFORMATION

Contact person

Dr. Lilibeth Acosta-Michlik
Département de Géologie et
de Géographie (GEOG)
Université catholique de Louvain
Place Louis Pasteur, 3
B-1348 Louvain-la-Neuve, Belgium
Tel: +32-10-47-9182
Fax: +32-10-47-2877
acosta@geog.ucl.ac.be

Partners

Bruno Henry de Frahan
Université catholique de Louvain (UCL)
Unité d'économie rurale (ECRU),
Faculté d'ingénierie biologique,
agronomique et environnementale,
Place de l'Université
1, B-1348 Louvain-la-Neuve, Belgium
Tel: +32 (0)10 473673,
Fax: +32 (0)10 473675,
henrydefrahan@ecru.ucl.ac.be

Ann Van Herzele
Vrije Universiteit Brussel (VUB)
Vakgroep Menselijke Ecologie,
Laarbeeklaan 103, B-1090 Brussel,
Belgium
Tel: +32 (0)2 4774924,
Fax: +32 (0)2 4774964,
avherzel@vub.ac.be

Guy Engelen
Vlaamse Instelling voor Technologisch
Onderzoek (VITO),
Expertisecentrum Integrale Milieustudies,
Boeretang 2002400 Mol, Belgium
Tel: +32 (0)14 335907,
Fax: +32 (0)14 331185,
guy.engelen@vito.be

Mark Rounsevell
Centre for the study of Environmental
Change and Sustainability (CECS),
School of Geosciences,
University of Edinburgh,
Crew Building, King's Buildings,
Edinburgh EH9 3JN, UK,
Tel. +44 (0)131 651 7165,
Fax: +44 (0)131 662 0478
mark.rounsevell@ed.ac.uk

Roger White
Memorial University of Newfoundland,
Department of Geography, St John's, Nfl
d A1B 3X9,
Canada
Tel: +1 (709) 737.8193,
Fax: +1 (709) 737.4000,
roger@morgan.ucs.mun.ca

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belspo

BELGIAN SCIENCE POLICY
Louizalaan 231 Avenue Louise • B-1050 Brussel
Tél. +32 (0)2 238 34 11 • Fax +32 (0)2 230 59 12 • www.belspo.be/ssd
Contact. Marc Van Heuckelom

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