

Spatial Analysis and Decision Support



IVM Institute for
Environmental Studies

Faculty of Earth and Life Sciences

130 years **VU**  UNIVERSITY
AMSTERDAM

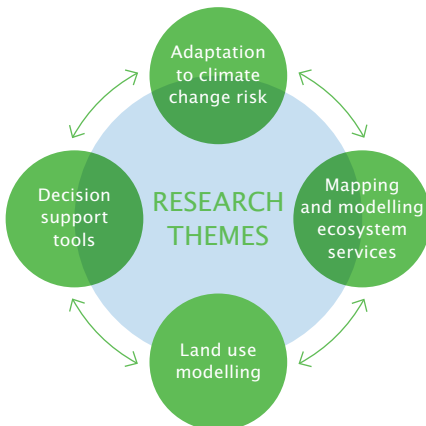
INTRODUCTION

The department Spatial Analysis and Decision Support of the Institute for Environmental Studies investigates the role of spatial variation in environmental systems to increase our understanding of environmental change and support environmental management. We study how socio-economic and biophysical processes lead to the emergence of spatial patterns.

Methods include monitoring environmental change by remote sensing and multi-scale analysis of spatial patterns and processes. Adaptation to climate change is addressed by mapping risks and associated costs. Alternative adaptation strategies are evaluated in the context of both developed and developing countries. Temporal dynamics and future scenarios are explored with spatial modelling of changes in land use and ecosystem



services, including rural, urban, marine and coastal systems. Advanced methods for stakeholder participation and ex-ante evaluation are developed and tested to support environmental management and land use planning. Prof. dr. ir. Peter Verburg is head of the department which consists of approx. 30 researchers and PhD candidates.



OBJECTIVES

- To develop, demonstrate and test methods for environmental spatial analysis in the context of problems of scientific and social significance;
- To apply spatial analysis and modelling to environmental problems;
- To train a new generation of spatially enabled scientists, resource managers and policy analysts.

• Adaptation to climate risk

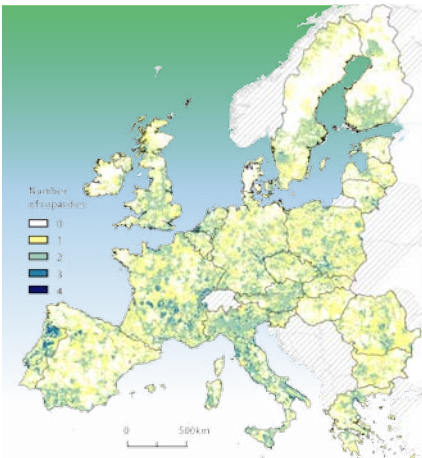
Methods for risk analysis and evaluation of associated costs of damage due to flooding and drought are developed. Dynamic links between hydrological models, land use models and economic damage assessments have been established to allow an integrated analysis of exposure, damage and possible adaptation options. These studies involve projections of people, assets and their location, in combination with estimates of future hazard probabilities based on climate scenarios. Adaptation measures, are evaluated in different contexts ranging from local measures such as small sand dams to store water in areas suffering droughts; urban planning and risk management in coastal cities such as Rotterdam, Jakarta, Ho Chi Minh City, and New York, to global assessments of adaptation costs in the water supply sector.

• Mapping and modelling ecosystem services

Ecosystem services have received increasing attention by both scientists and policy makers as a means to address the multiple benefits received from our environment. It is a common challenge to incorporate the concept of ecosystem services into environmental management strategies and operational policy. To meet this challenge, new methods to monitor, quantify and value ecosystem services are needed. In addition, assessments of ecosystem services are incorporated in scenario studies to explore the future dynamics under changing policy conditions. The department aims at preparing a tool box for the mapping and quantification of ecosystem service provision making use of

a thorough understanding of ecological processes, both in terrestrial and marine environments. The department contributes to several projects in which, together with environmental economists, new approaches to valuation of ecosystem services are explored.

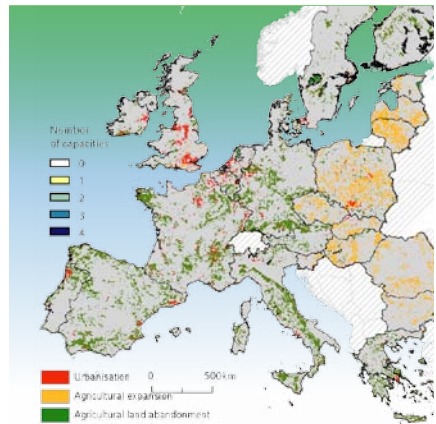
Insights are used to inform policy design, schemes for PES (payments for environmental services), multi-functional land use and rural development.



Assessment of supply of ecosystem services in Europe: the map indicates the number of services for which a high

• Land use modelling

Land use change is the result of many interacting processes across multiple scales involving different economic sectors and a wide variation of actors. Different land uses may lead to competing claims given that land is a limited resource. Policy and land use planning aim at enhancing the synergies between different land uses and addressing the trade-offs between different choices. The department aims at improving the overall understanding of land use change using a spatial, multi-sectoral perspective across multiple spatial and temporal scales. Spatial models for simulating scenarios of land use change are developed and applied. Models range from agent-based models at local to integrated models of land use system change at continental to global scales. Models are used to test hypotheses of land use transitions, evaluate integrative scenarios and make ex-ante assessment of specific policies, including agricultural policy reform or biofuel policies. Researchers of the department have developed the CLUE model that is one of the best-known operational land use models and widely used throughout the world. Besides land cover change the model is capable of addressing dynamics in livestock distribution, agricultural intensity, forest dynamics, urbanisations and land functions.



Simulated changes in land use between 2000 and 2030

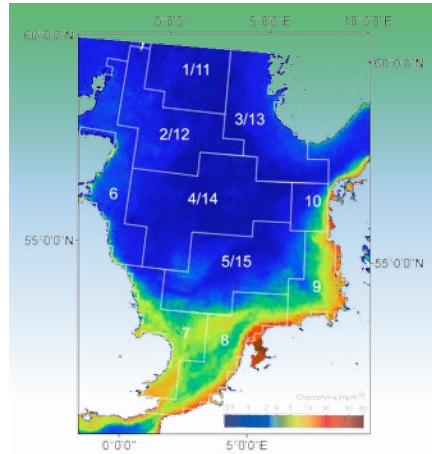
• Decision support tools

The ultimate objective of spatial decision support is to make sure that the best possible plan is produced in a way that best suits all stakeholders involved. In practical terms this is the plan that makes the most of the information available, and has the largest possible support of the stakeholders. Because the information load is high, spatial decision support should complement design by the landscape architects. Important issues are: fragmentation, landscape patterns, spatial design algorithms, and evaluation under uncertainty.

The communication of scientific findings to policy makers and the discussion of alternative management strategies and land use planning require techniques that allow the involvement of stakeholders. Within the department, different techniques and tools are evaluated that support such stakeholder dialogue. These include the use of spatial multicriteria analysis on a interactive 'touch table' to support spatial planning; the use of photorealistic landscape scenarios for participatory workshops on rural development options and a contribution to an European discussion support system for rural areas (EURURALIS, www.eururalis.eu).

BRIDGING DISCIPLINES

The interdisciplinary expertise of the department has been used in a wide range of integrated projects. The researchers have a strong expertise and experience in bridging different disciplinary perspectives of environmental change and integrated assessment modeling. The complexity of the environmental problems we address requires understanding and fusion of spatial and other data from many sources and multiple disciplinary perspectives. For this reason, we are capable of resolving problems of integration that are both technological and human in nature.



Satellite derived estimates of phytoplankton for coastal and open water modelling of nutrient budgets

TEACHING

Within IVM the Spatial Analysis and Decision Support department makes a strong contribution to the MSc programme Environment and Resource Management, the BSc and MSc Earth Science and Economy, the distance learning initiative UNIGIS and many other courses within VU University Amsterdam and the Amsterdam University College. Besides organising and contributing to these programmes the department contributes to IVM's PhD programme and hosts several PhD students.

Resources:

- MSc Environment and Resource Management - www.environmentmaster.nl
- BSc Earth Science and Economy - www.falw.vu.nl/nl/opleidingen/bacheloropleidingen/aarden-economie
- MSc Earth Science and Economy - www.falw.vu.nl/nl/opleidingen/masteropleidingen/earth-sciences/specializations/earth-and-economics.asp
- UNIGIS - www.unigis.nl
- IVM PhD programme - www.ivm.vu.nl/en/teaching/PhD-programme

ACTIVITIES

Addressing the spatial dimensions of environmental systems

Spatial heterogeneity of the environment and human activity causes the impacts of global environmental change to depend on location and context. The identification of vulnerable people and places under conditions of environmental change is of prime importance in designing effective environmental management strategies and planning.

The department contributes to this challenge by high-level education and research. We develop innovative methods for monitoring environmental change by remote sensing and use state-of-the-art methods for analysing spatial patterns to better understand processes across different scales. Explicit attention is given to feedback mechanisms and the emergence of spatial patterns as a result of interacting human-environment processes. Climate change is a central topic and is addressed by mapping exposure, risks and associated costs. Adaptation strategies are evaluated in the context of both developed and developing countries. To support discussion on future environmental problems, and to evaluate proposed policies temporal dynamics and future scenarios of land use and ecosystem services are explored with spatial modelling. Besides addressing rural and urban systems the department has a strong expertise in marine and coastal systems. Advanced methods for stakeholder participation and ex-ante evaluation of policy are developed and tested to support environmental management and land use planning. The department is also a key player in the communication and dissemination of the Dutch national research programmes on climate change.



LISTED

Key publications Adaptation to climate change risk

- World Bank (2010) The Costs to Developing Countries of Adapting To Climate Change. New Methods and Estimates. The Global Report On the Economics of Adaptation to Climate Change Study. The World Bank, Washington D.C., 84 pp.
- Ward, PJ, Beets, W, Bouwer, LM, Aerts, JCJH, Renssen, H (2010). Sensitivity of river discharge to ENSO. Geophysical Research Letters, 37, L12402 - DOI: 10.1029/2010GL043215.
- Aerts, JCJH, Major, DC, Bowman, MJ, Dircke, P, Marfai, MA (2009). Connecting Delta Cities. Coastal Adaptation, Flood Risk Management and Adaptation to Climate Change. VU University Press, Amsterdam, The Netherlands, 91 pp.
- Bouwer, LM, Bubeck, P & Aerts, JCJH (2010). Changes in future flood risk due to climate and development in a Dutch polder area. Global Environmental Change 20(3), 463-471 - DOI: 10.1016/j.gloenvcha.2010.04.002.
- Maaskant, B, Jonkman, SN, Bouwer, LM (2009). Future risk of flooding: an analysis of changes in potential loss of life in South Holland (The Netherlands). Environmental Science and Policy, 12(2), 157-169 - DOI: 10.1016/j.envsci.2008.11.004.
- Bouwer, LM, Vermaat, JE & Aerts, JCJH (2008). Regional sensitivities of mean and peak river discharge to climate variability in Europe. Journal of Geophysical Research, 113, D19103 - DOI: 10.1029/2008JD010301.

Key publications Mapping and modelling ecosystem services

- Verburg PH, van de Steeg J, Veldkamp A, Willemen L (2009). From land cover change to land function dynamics: A major challenge to improve land characterization.

Journal of Environmental Management 90, 1327-1335 - DOI: 10.1016/j.jenvman.2008.08.005.

- Brander, L, Bräuer, I, Gerdes, H, Kuik, O, Navrud, S, Schaafsma, M, Wagtendonk, A (2009). Scaling-up ecosystem services' values: towards guidelines for a policy-relevant approach. IVM report commissioned by European Environment Agency, Framework contractnr. EEA/AIR/04/004.
- Gilbert, AJ (2009). Connectance indicates the robustness of food webs when subjected to species loss. Ecological Indicators, 9, 72 – 80 - DOI: 10.1016/j.ecolind.2008.01.010.
- Vermaat, J, Goosen, H, Omtzigt, N (2008). Do biodiversity patterns in Dutch wetland complexes relate to variation in urbanisation, intensity of agricultural land use or fragmentation? Biodiversity Conservation 16: 3585-3595 - DOI: 10.1007/s10531-006-9128-4.
- Hommersom, A, Peters, S, Wernand, MR, de Boer, J (2009). Spatial and temporal variability in bio-optical properties of the Wadden Sea. Estuarine, Coastal and Shelf Science 83, 360-370 - DOI: 10.1016/j.ecss.2009.03.042.
- Bouma, J, Van der Woerd, HJ, Kuik, O, (2009). The value of information for water quality management in the North Sea. Environmental Management, Volume 90, 1280-1288 - DOI: 10.1016/j.jenvman.2008.07.016.
- Vermaat, J, Hellmann, F (2010). Covariance in water- and nutrient budgets of Dutch peat polders: what governs nutrient retention? Biogeochemistry 99, 109-126 - DOI: 10.1007/s10533-009-9395-8.

Key publications Land use modelling theme

- Verburg, PH, van Berkel, D, van Doorn, A, van Eupen, M, van Heiligenberg, HARM (2010). Trajectories of land use change in

- Hellmann, F and Verburg, PH (2010). Impact assessment of the European biofuel directive on land use and biodiversity. *Journal of Environmental Management*, in press - DOI: 10.1016/j.jenvman.2010.02.022.
- Neumann, K, Verburg PH, Stehfest, E, Mueller, C. (2010). The yield gap of global grain production: A spatial analysis. *Agricultural Systems* 103: 316-326 - DOI: 10.1016/j.agsy.2010.02.004.
- Britz W, Verburg PH, Leip A (2010). Modelling of land cover and agricultural change in Europe: Combining the CLUE and CAPRI-Spat approaches. *Agriculture, Ecosystems & Environment* - DOI: 10.1016/j.agee.2010.03.008.

Key publications Decision support tools theme

- Stewart, TJ, Joubert, A, Janssen, R (2010). MCDM Framework for fishing rights allocation in South Africa, *Group Decision and Negotiation*. Volume 19(3) 247-265 - DOI: 10.1007/s10726-009-9159-9.
- Janssen, R, van Herwijnen, M, Stewart, TJ, Aerts, JCH (2007). Multiobjective decision

support for land use planning. *Environment and Planning B: planning and design*. Volume 34 - DOI: 10.1068/b33071.

- Janssen, R, Verhoeven, JTA, Arciniegas, G, van Riet, B (in press), Spatial evaluation of ecological qualities to support interactive design of land use plans, *Environment and Planning B: planning and design*.
- Verburg, PH, Eickhout, B, van Meijl, H (2008). A multi-scale, multi-model approach for analyzing the future dynamics of European land use. *Annals of Regional Science*, 42(1): 57-77 - DOI: 10.1007/s00168-007-0136-4.
- Lovett, A, Carvalho Ribeiro, S, van Berkel, D, Verburg, PH, Firmino A. Representing and communicating rural futures through 3D landscape visualizations: experiences from the RUFUS project. In: Buhmann/Pietsch/Kretzler (eds) (2010) *Peer Reviewed Proceedings of Digital Landscape Architecture 2010*, Anhalt University of Applied Sciences. Wichmann Verlag, Heidelberg, May 2010.

Links: [Publications](#)
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Spatial Analysis and Decision Support

www.ivm.vu.nl/space

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