

# A Spatial Decision Support System for Integrated Natural Resources Management

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**AFR**  **MAISON**



# The AfroMaison project



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- ❖ **Africa at meso-scale: adaptive and integrative tools and strategies for natural resources management**
- ❖ 15 partners of which 6 EU, 6 African and 3 international
- ❖ 5 case studies with different eco-regions
- ❖ FP7-AFRICA-2010
- ❖ Duration: 36M (1 March, 2011 – 28 Feb, 2014)
- ❖ Budget: 4.1 mio Euro (3.4 mio Euro EC contribution)



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ENV.2010.2.1.1-1 Integrated management of water and other natural resources in Africa

... the **outcome** of the project should be a **tool-box** for ... integrated natural resources management that could be used in a variety of environmental and socioeconomic conditions in Africa ...,

... the **expected impact** is a long-term **integrated management of natural resources**





**WP1 Project Management**

*Lead: ANTEA Belgium; Tom D'Haeyer*

**WP2 Multi-disciplinary rapid assessment & barriers for effective INRM**

*Lead: ICRAF; Delia Catacutan*

**WP3 Tools for restoration & adaptation**

*Lead: IWMI; Robyn Johnston*

**WP4 Economic tools & incentives**

*Lead: INR; Fonda Lewis*

**WP5 Tools for spatial planning**

*Lead: UNESCO-IHE; Masoom Hamdard*

**WP6 Global change, vulnerability & scenario design**

*Lead: PIK; Stefan Lierch*

**WP7 Operational Framework & Toolbox for adaptive INRM**

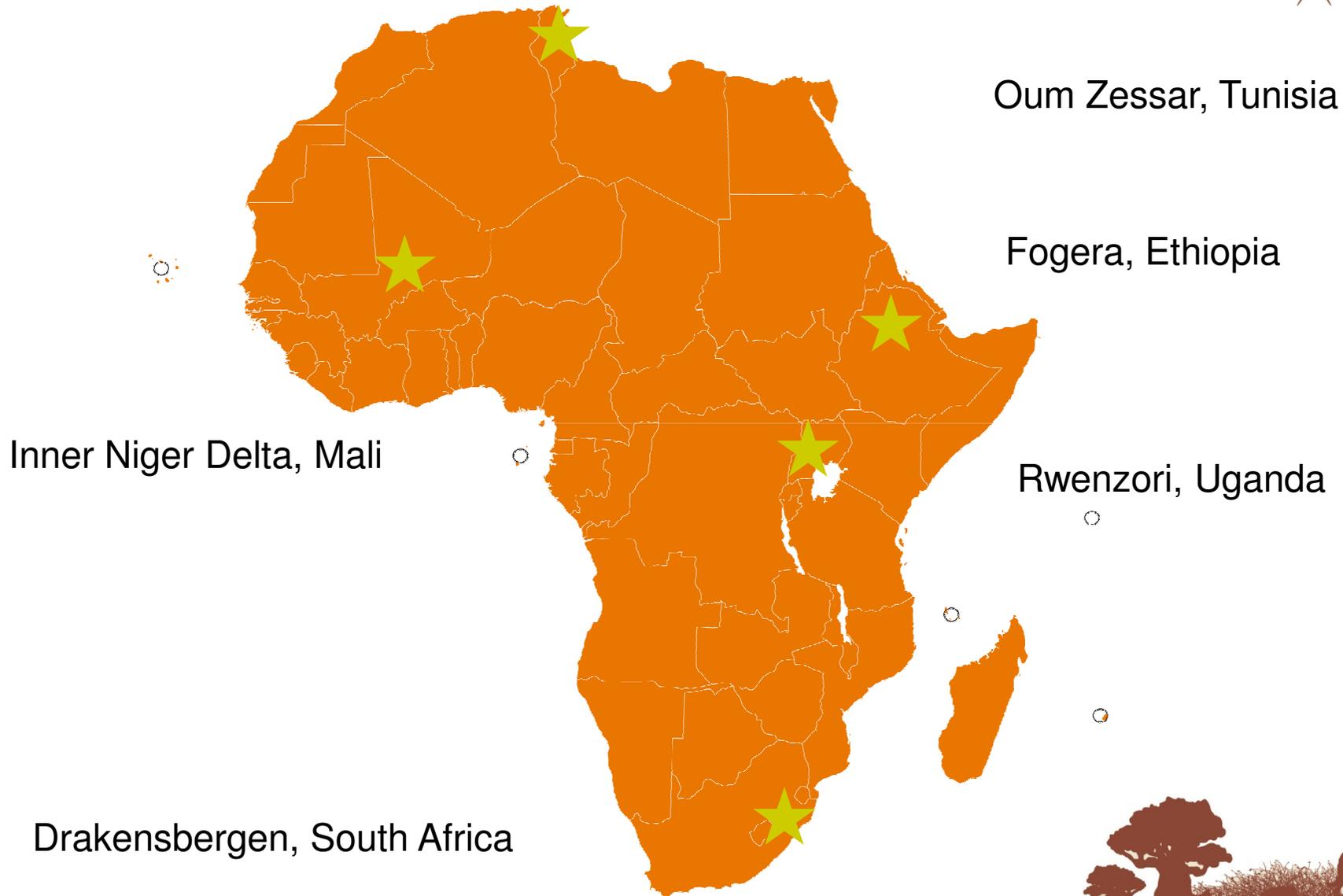
*Lead: CIRAD, Raphaëlle Ducrot*

**WP8 Dissemination, capacity building & end-user involvement**

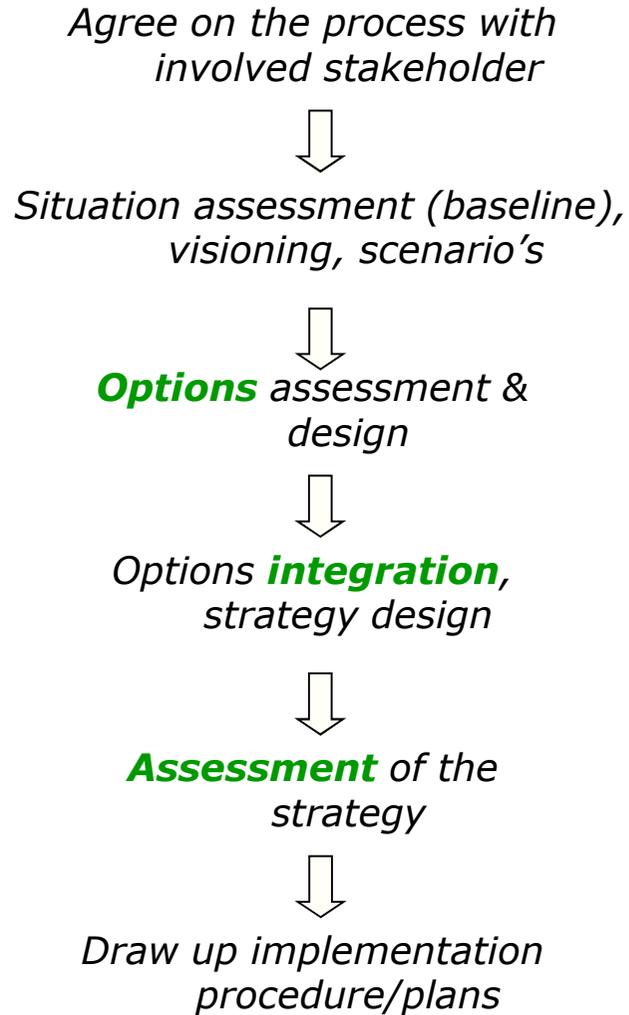
*Lead: UNIGE/GRID; Gregory Giuliani*



# Case studies



# INRM Guidelines for NRM @ Meso-scale



- 🌳 Overall pathway for the development and testing of INRM strategies.
- 🌳 At each phase a number of tools are used to implement it.
- 🌳 Each case study uses different tools and may shortcircuit some steps depending on local set-up, knowledge and tools available.





... to deliver:

-  Guidance document / INRM Manual
-  Toolbox
-  Training course (modules)
-  Policy briefs
-  Policy briefing / final AfroMaison event
-  Publications





- ❖ Manual for NRMers instructing how to implement the operational framework
- ❖ PART 1: Chapters on general topics *E.g. participatory planning, ecosystem services in development planning, climate change, vulnerability, spatial planning, economic tools*
- ❖ PART 2: Outlining the AfroMaison INRM pathway, documented with examples of AfroMaison case studies + suggested tools to use ⇒ *link to the toolbox..*



# Toolbox



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- ❖ Database with tools + standard
- ❖ Several keys to find tools in the database
- ❖ Wizard, queries, ..
- ❖ Interaction with online guidance in INRM / manual
- ❖ Possibility to add tools, cases, ..

The image displays two screenshots from the AFROMAISON website. The top screenshot shows a search interface with a map of Africa, a search bar, and various filters. The bottom screenshot shows a detailed project management diagram titled 'Proposed Approach' and 'Crosscutting processes and issues'. The diagram illustrates the relationship between various work packages (WPs) and crosscutting processes. Key elements include:

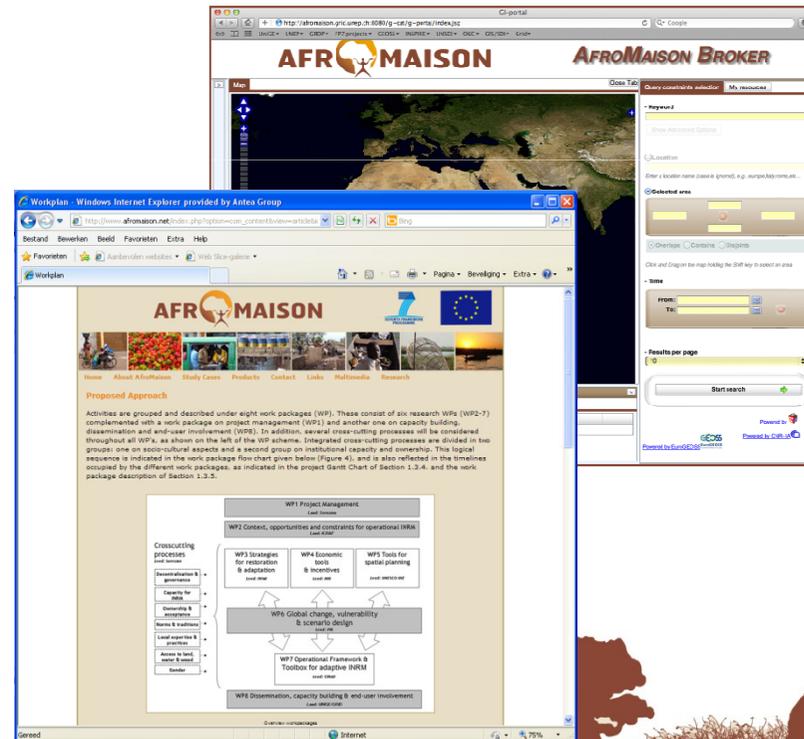
- WP1 Project Management** (Lead issue)
- WP2 Content, opportunities and constraints for operational INRM** (Lead actor)
- WP3 Strategies for resilience & adaptation** (Lead actor)
- WP4 Economic tools & incentives** (Lead actor)
- WP5 Tools for spatial planning** (Lead actor)
- WP6 Global change, vulnerability & scenario design** (Lead actor)
- WP7 Operational Framework & Toolbox for adaptive INRM** (Lead actor)
- WP8 Dissemination, capacity building & end-user involvement** (Lead actor)

The diagram also shows crosscutting processes and issues such as 'Dissemination & information', 'Capacity for INRM', 'Resilience & incentives', 'Access to land, water & forest', and 'Gender'.





- ❖ A portal with 3 main components:
  - ❖ *Guidelines for NRM managers @ meso-scale*
  - ❖ *Toolbox*
  - ❖ *Data repository (broker)*
- ❖ Additional materials
  - ❖ Case studies
  - ❖ Glossary
  - ❖ Additional reading
  - ❖ Training material, courses
  - ❖ ...



# Tools, guidelines & data for INRM @ Meso-scale



**Guidelines**

**Tools**

**Data**

Agree on the process with involved stakeholder



Situation assessment (baseline), visioning, scenario's



**Options** assessment & design



Options **integration**, strategy design



**Assessment** of the strategy



Draw up implementation procedure/plans

**Which tools can I use?**

- 🌳 Wizard
- 🌳 Search functions
- 🌳 Our suggestion...

You selected tool;

- 🌳 Purpose, expected outcome
- 🌳 Pros
- 🌳 Cons
- 🌳 Requirements; skills, **data...**

**Which data can I use?**

- 🌳 Check existence of data in the broker..





# Drakensbergen Case Study

## Coupling Land-Use and Hydrological Modelling for Management of Ecosystem Services

J. van der Kwast, S. Yalew, C. Dickens, J. Reinhardt, S. Liersch,  
M. Mul, M. Hamdard, W. Douven

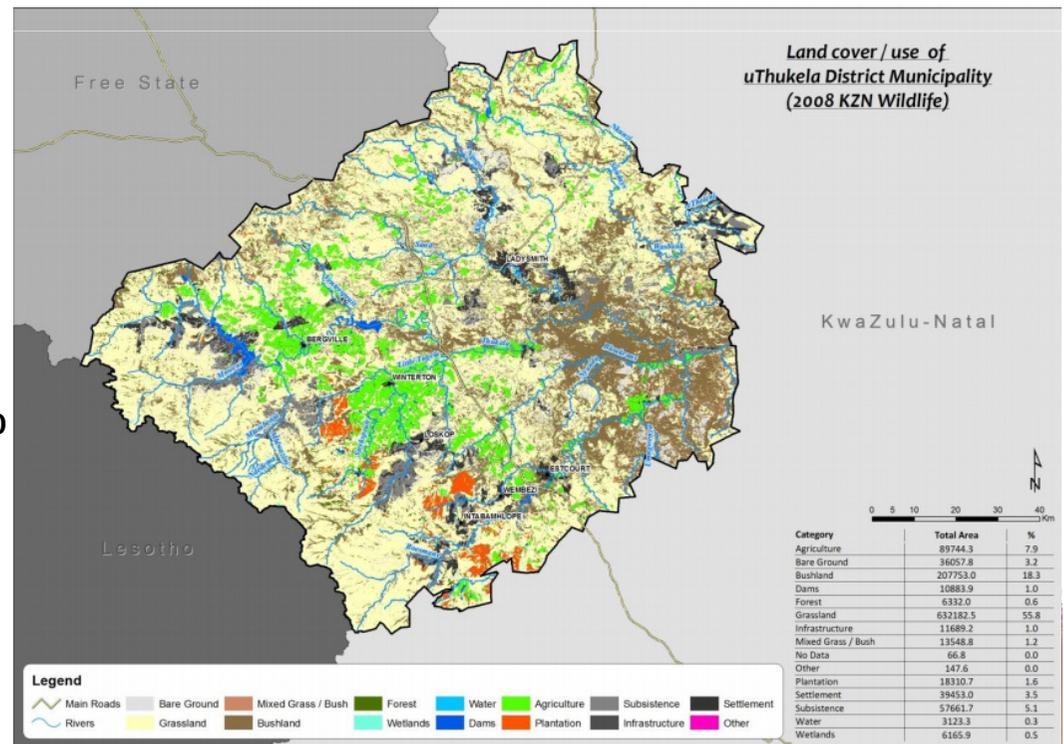




- Enkangala grassland, Drakensberg- bordering Lesotho
- Extremely important for watershed services- main source of water supply to Johannesburg
- Administration falls under uThukela District Municipality

## Land Use:

- Grassland (55.8%- 5.7% degraded)
- Bushland (18.3% - 2.5% degraded)
- Agriculture land in terms of cultivated land makes up 13% (commercial - 7.9% and subsistence - 5.1 %) of the land
- 58% of land is used for stock farming



# Problem and Drivers



- ❖ The main natural resource problem in the case study is **severely eroded land**
- ❖ The drivers includes but are not limited to
  - Poverty and low level of education, unemployment
  - Population growth (8.8% increase from 2001 to 2007)
  - Overgrazing, which results into severe soil erosion/vegetative cover related problems and decline in grass land
  - Culture, no. of cattle=status in the society
  - Lack of sense-of-ownership (communal land tenure system), as tribal authorities can evict people
  - Climatic conditions/climate change



# Environmental Management Framework Process



- South Africa has relatively strong institutional framework, but implementation is limited
- Recently, as a response to the natural resources issues, the **Environmental Management Framework (EMF)** is proposed to achieve sustainable and integrated natural resources management objectives

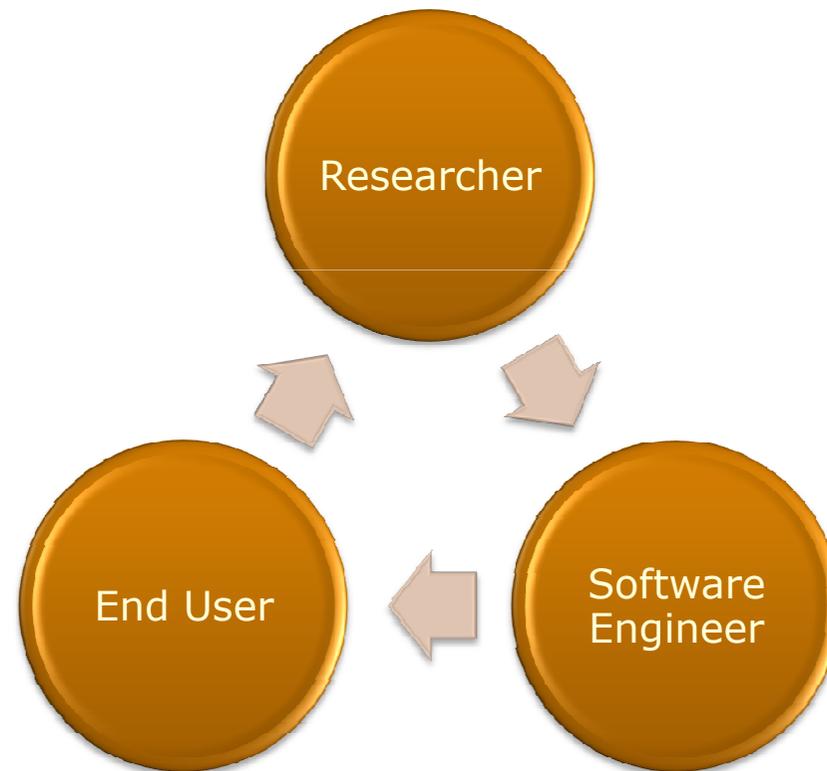
Phases	Description of activities and outputs
Inception	<ul style="list-style-type: none"><li>- Review of background data, information, scoping of stakeholders</li><li>- Output - inception report detailing nature and structure of the EMF and the proposed approach and methods for developing it.</li></ul>
Status quo	<ul style="list-style-type: none"><li>Maps and define the present state.</li><li>- Mapping of landuse and natural systems,</li><li>- Classify the type of natural systems, their current state, their conservation status, and importantly what drivers and pressures are responsible for the current state.</li><li>- Socio-economic evaluation. Overview of state of people and economy in the area.</li></ul>





Phases	Description of activities and outputs
Desired Future State (DFS)	<p>The aim is to develop a DFS (vision) based on analysis of the status quo. The analysis is undertaken via a Strategic Environmental Assessment which determines:</p> <ul style="list-style-type: none"><li>▪ Environmental assets – systems playing an important role in supporting socio-economic environment and systems with high conservation value.</li><li>▪ Environmental issues - where the state of natural systems is undermining the social wellbeing and/or where legal targets and environmental thresholds are not being met.</li><li>▪ Environmental opportunities and constraints - reflecting the understanding from points above.</li></ul>
Environmental Management Framework	<p>Spatial Outputs – Integrated maps showing zones of varying sensitivity</p> <p>Management Guidelines</p> <ul style="list-style-type: none"><li>▪ Documenting acceptable development types in the various zones</li><li>▪ The level of EIA process to be followed in the different zones, and</li><li>▪ Issues that require specific investigation in relation to the EIA process within the specific zones.</li><li>▪ While not explicitly a requirement – a Strategic Environmental Management Programme is often included. The SEMP details what programmes, plans and activities should be implemented to move from the ‘Present’ to the ‘Desired Future’ State. This is important at the District level in South Africa because these plans and actions can then be built into the integrated development plan and budgeted for. The SEMP also indicates who is responsible for implementing various aspects of the SEMP. This is important in further entrenching ‘integration’ within the process.</li></ul>

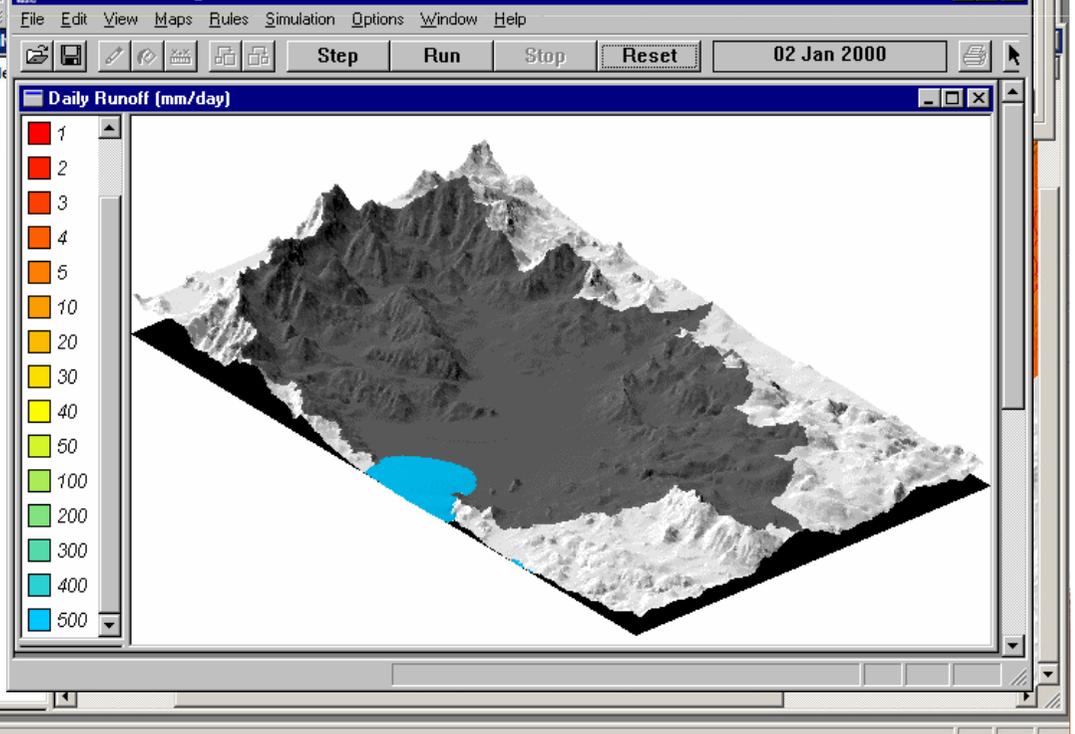
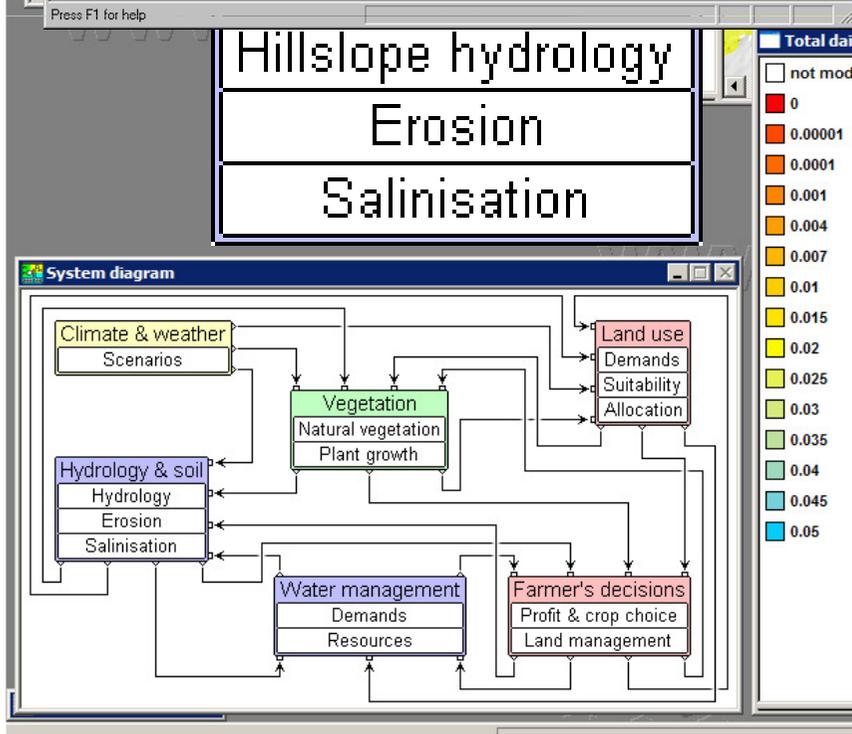
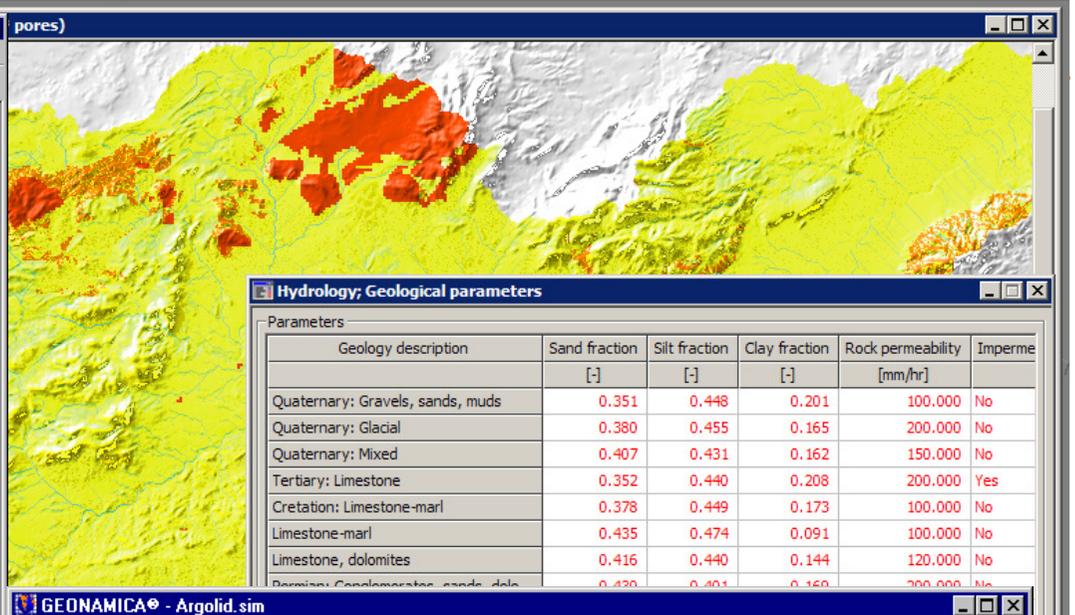
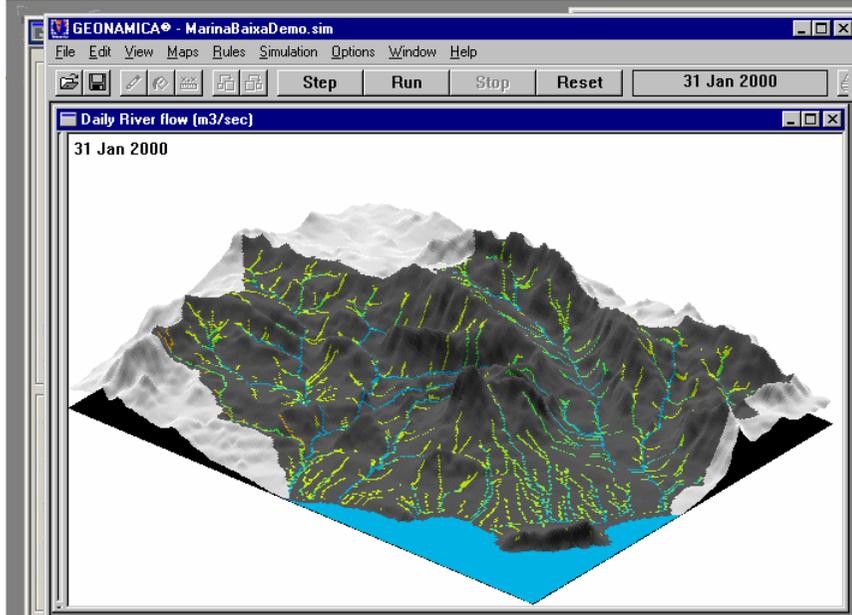
# Design of a Spatial Decision Support System





- 🌳 Should end-users (policy makers, planners) be able to run the model themselves?
  - ❖ If the answer is **yes**, then:
    - The model should have a graphical user interface
    - The model should be not too complex
    - Results of the model should be shown at runtime, therefore the runtime should not be too large
    - Visualisation of results (e.g. maps, uncertainty, etc.) should be intuitive for the end user







- 🌳 The risk is that models (or Decision Support Systems) become
  - ❖ Oversimplified
  - ❖ Black boxes
  - ❖ Loss of domain knowledge
  - ❖ IT driven instead of problem driven





- 🌳 Should end-users (policy makers, planners) be able to run the model themselves?
  - ❖ If the answer is **no**, then:
    - Couple models from different scientific domains
    - Scientists are responsible for proper model setup (**prototyping**), calibration and validation
    - Runtime of model less important
    - GUI less important for operation the model (experts)
    - Scientists are responsible for **communicating results** of modelling in a proper way to the end user
      - Traditional reports, maps, etc.
      - Desktop DSS
      - Web-based DSS (web 2.0)
    - Software engineers should implement the operational models and web interfaces





- 🌳 Preferably Open Source models and tools should be used for optimal interoperability between the coupled models and between the user interface
- 🌳 Open Standards (OCG, OpenMI, etc.)
- 🌳 Closed source frameworks tend to lock the modeller in, hard to make improvements
- 🌳 Open Source can be peer reviewed
  - ❖ More confidence in the model
  - ❖ Bugs are easier removed by the community

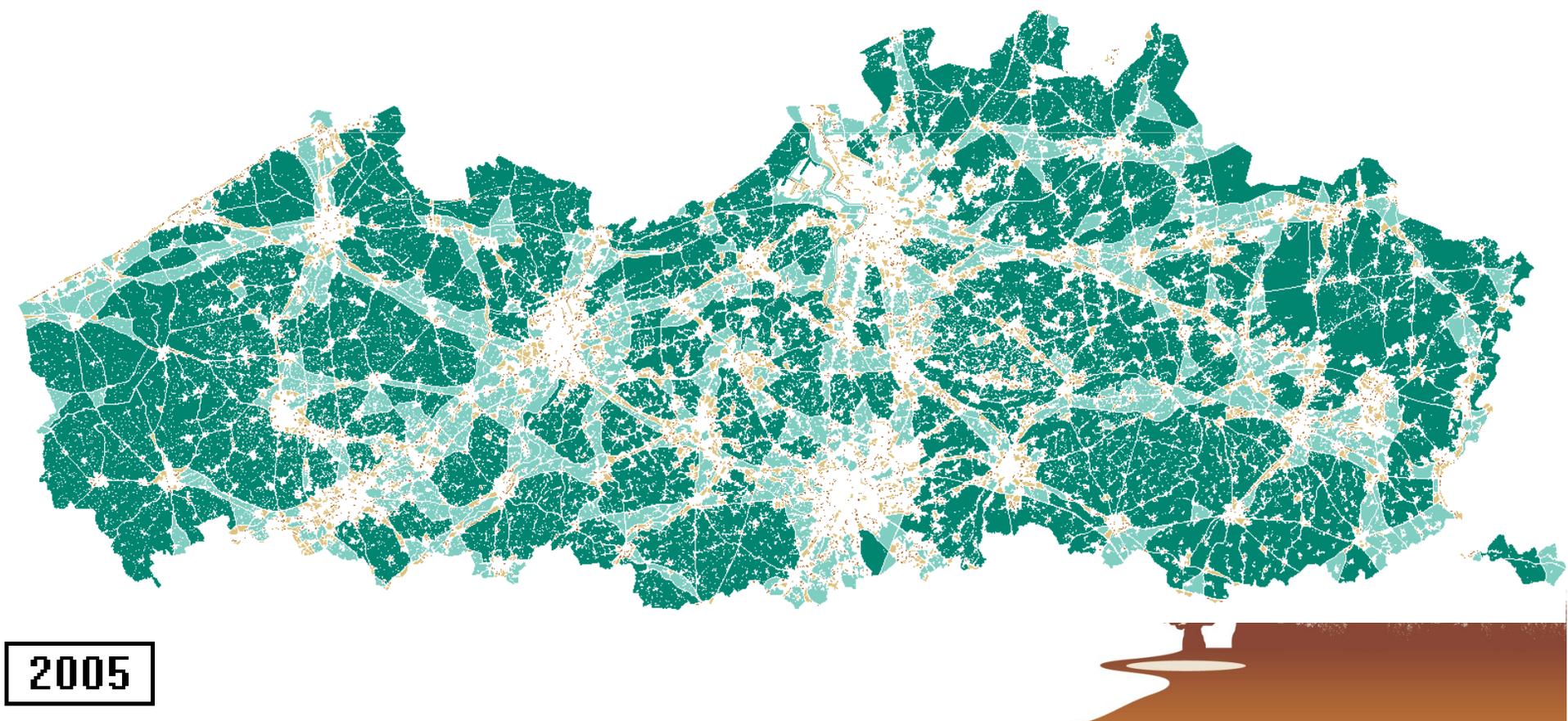




Example: web-based indicator atlas

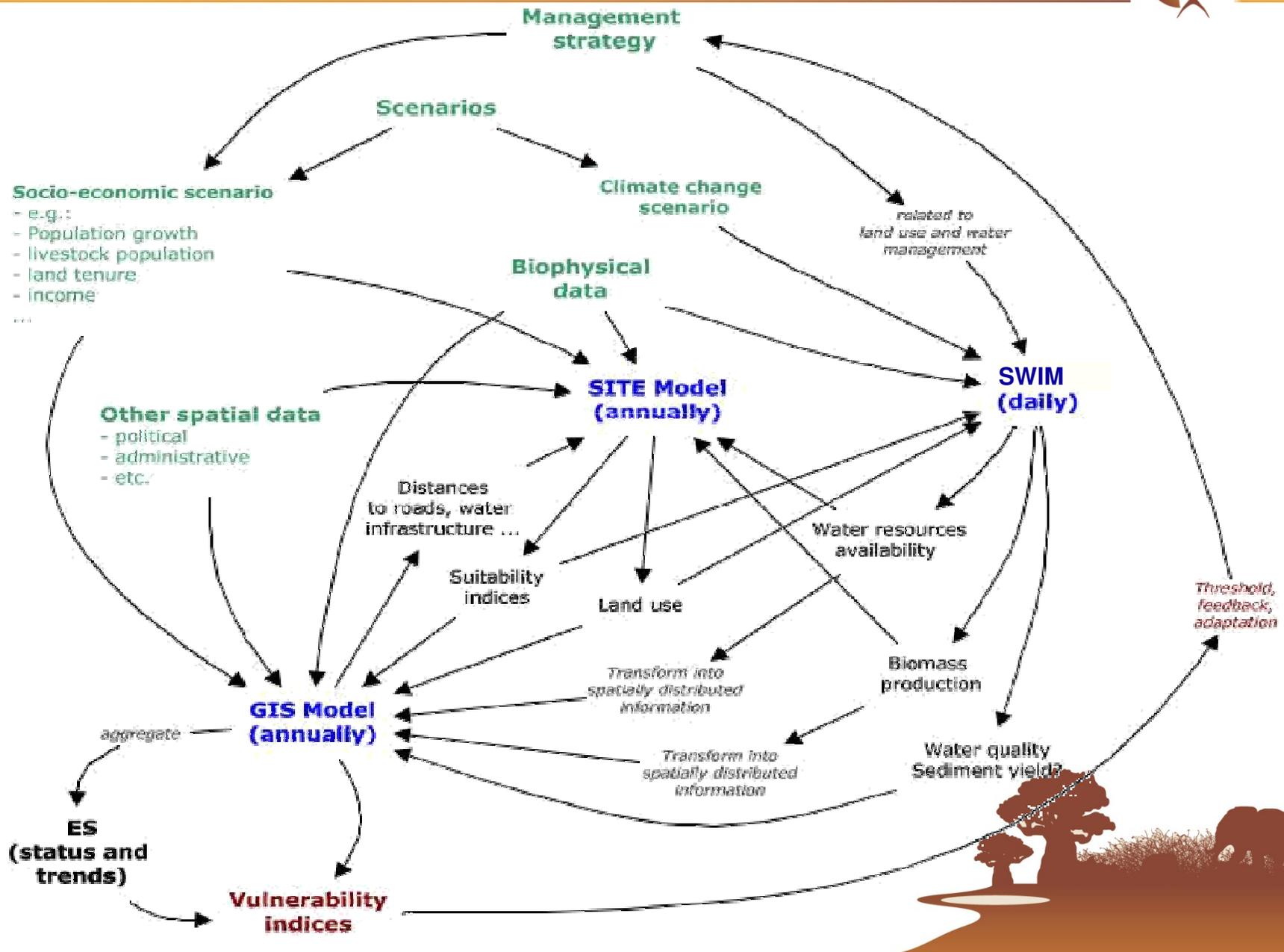
<http://rma.vgt.vito.be/verkenner/verkenning.jsf>

Contiguity and surface of open space



2005

# Conceptual model





- 🌳 It is well known that land-use changes influence the hydrological cycle and that those changes in the hydrological cycle influence land use.
- 🌳 The sophisticated spatial dynamic planning tools that have been developed in the last decades to support policy makers in the decision making process do not take into account the mutual feedbacks between land use and hydrology.





- 🌳 Mutual feedbacks between land use and hydrology have to be taken into account to preserve ecosystem services
  - ❖ More urbanisation: less infiltration, increase of runoff, pollution
  - ❖ Climate change: drought/flooding, areas less suitable for agriculture
  - ❖ Forest clearance impacts suitability of soils through erodibility
  - ❖ Transforming wetlands into agricultural areas has a large impact on ecosystem services



# Conclusions

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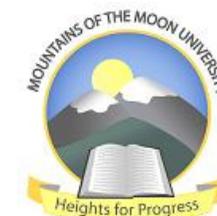
- 🌳 Coupling of models is important to assess the impacts of mutual feedbacks between models
- 🌳 Coupling is preferable over integration
- 🌳 Proper communication of model results to end users is important. IT can provide efficient tools for that (e.g. web 2.0)
- 🌳 Open source models are preferred because of their transparency
- 🌳 Local stakeholders should be involved for getting the right drivers and parameters for the models
- 🌳 Data should be retrieved and delivered using an SDI. GMES can play an important role.





# Thank you !

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Altenburg & Wymenga



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