Enabling causal systems understanding using a conceptual modelling workbench

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DynaLearn

Engaging and informed tools for learning conceptual system knowledge

BENEFICIARIES

University of Amsterdam
The Netherlands, (Coordinator), Human Computer Studies Laboratory

Universidad Politécnica de Madrid
Spain, Ontology Engineering Group

University of Augsburg
Germany, Multimedia Concepts and Applications

University of Brasília
Brazil, Institute of Biological Sciences

Tel Aviv University
Israel, Science and Technology Education Center

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Bulgarian Academy of Sciences
Bulgaria, Central Laboratory of General Ecology

University of Natural Resources and Applied Life Sciences
Austria, Institute of Hydrobiology and Aquatic Ecosystem Management

BOKU:

- MUHAR Susanne (IHG)
- ZITEK Andreas
- STELZHAMMER Michael
- POPPE Michaela

Duration:

- 01.02.2009-31.01.2012

Programme:

- FP7 - Cooperation - Information and Communication Technologies (ICT)
- EU-Project Instruments
- Spec. Target. o Inn. Project (STREP)

Target:

- Production of an interactive software for learning conceptual system knowledge on environmental issues, especially with regard to river catchments.

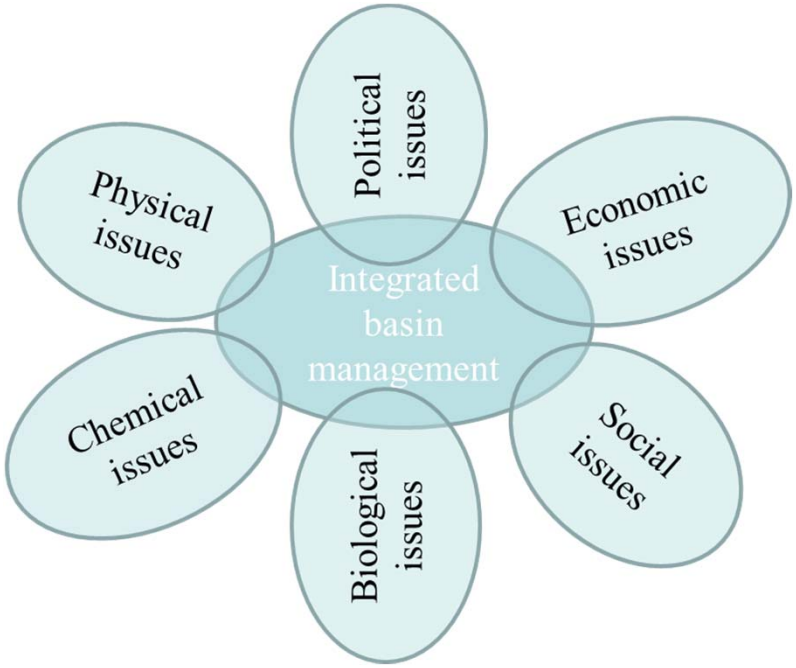
Aims of the DynaLearn (DL) project

- **Development of a software that supports students in learning about systems** allowing
  - to articulate one`s own ideas about systems
  - to simulate scenarios and viewpoints without the need of using numbers -> focus on conceptual & causal understanding
  - to confront one`s ideas with expert models
- **The DynaLearn Software**
  - is based on qualitative reasoning (area of AI)
  - semantic technology
  - has several interesting and engaging features (simulations, grounding to domain terminology, automated feedback via a model repository and animated characters)

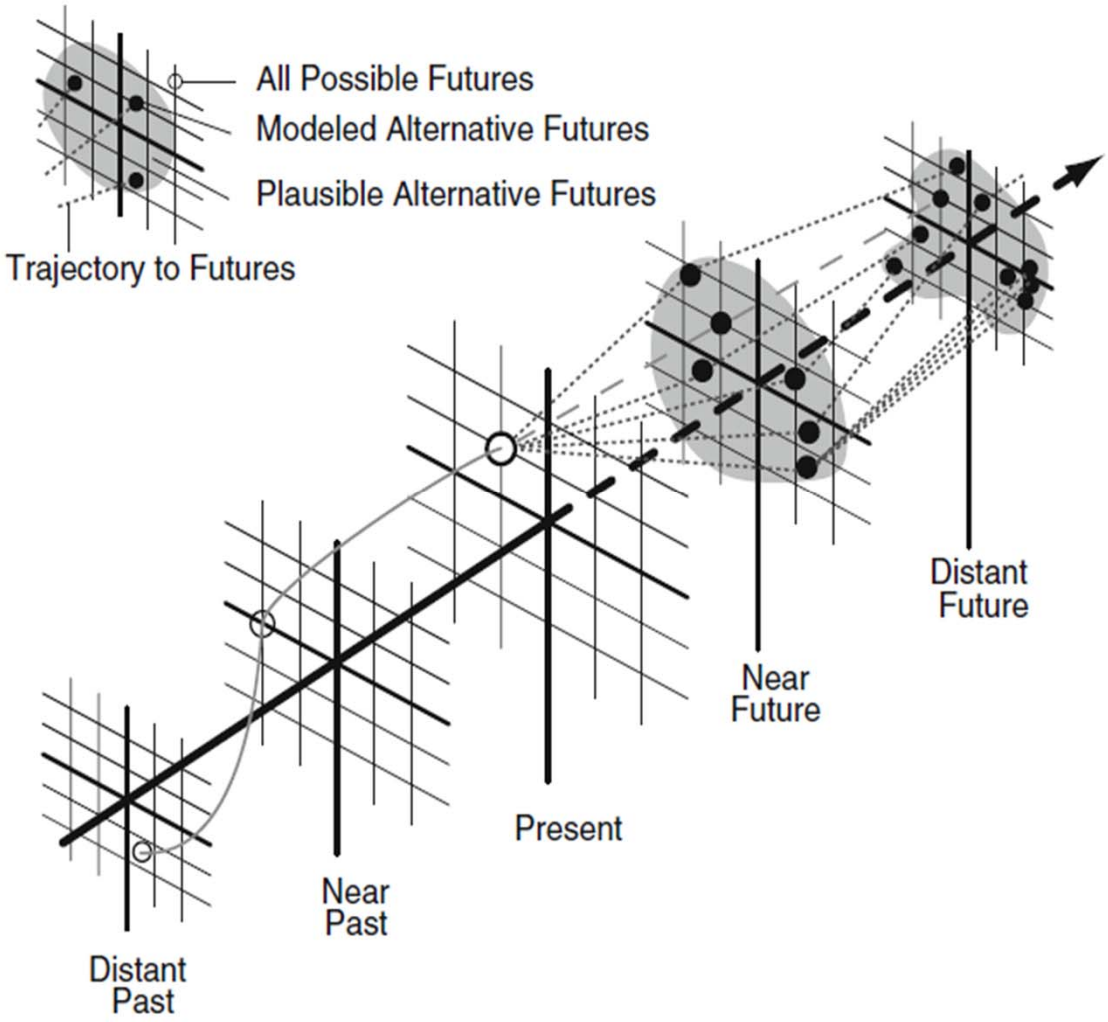
Challenge of river management

Integrated river basin management is one of the biggest challenges of the 21st century (UNESCO IHE)

- co-dependence of people and the biophysical dimensions of ecosystems have to be acknowledged
- Can only be achieved when physical, chemical, biological, social, economic and political issues are considered adequately.



Integrative frameworks needed…



Understanding of trajectories from past and present to future system states only possible using **integrative causal frameworks…**

Hulse et al., 2009

Modelling technology used in DL

- Model representations can be divided into

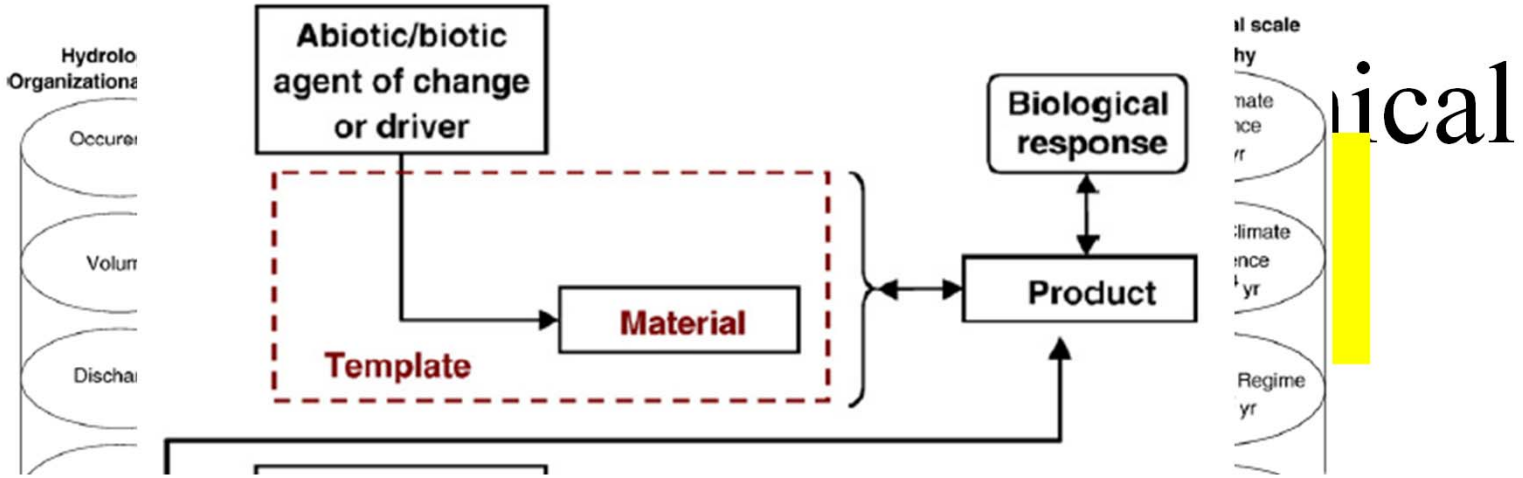
Qualitative

  - Mental
  - Pictural/physical representations
  - Verbal models (“prosa” models)
  - Concept maps
  - Causal loop diagrams (with only plus and minus)
  - Stock flow diagrams (separation in stocks and flows)
  - Statistical models
  - Equations

Quantitative

Qualitative Reasoning

Describing a system without numbers. Using rates (flows) and system states. System states are of ordinal scale and represent temporarily ordered landmarks of system behaviour.



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A framework for interdisciplinary understanding of rivers as ecosystems

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Backbones of the proposed approach

- **Concept maps**
- **Causal diagrams**
- **System & Pattern oriented modelling (POM)**
  - Archetypes
  - Powerful other system patterns – control circuits
- **Ecosystem theories**
  - Thermodynamics
  - Hierarchy theory
    - Scale, grain extent, possibilities of arrangements of entities and their possible ways influenceing each other
- **Consideration of different types of causality in different systems (technical ‘trivial systems‘ versus biological ‚non trivial systems‘)**
- **Features of the DynaLearn workbench built on QR**

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LS 1

Concept ma

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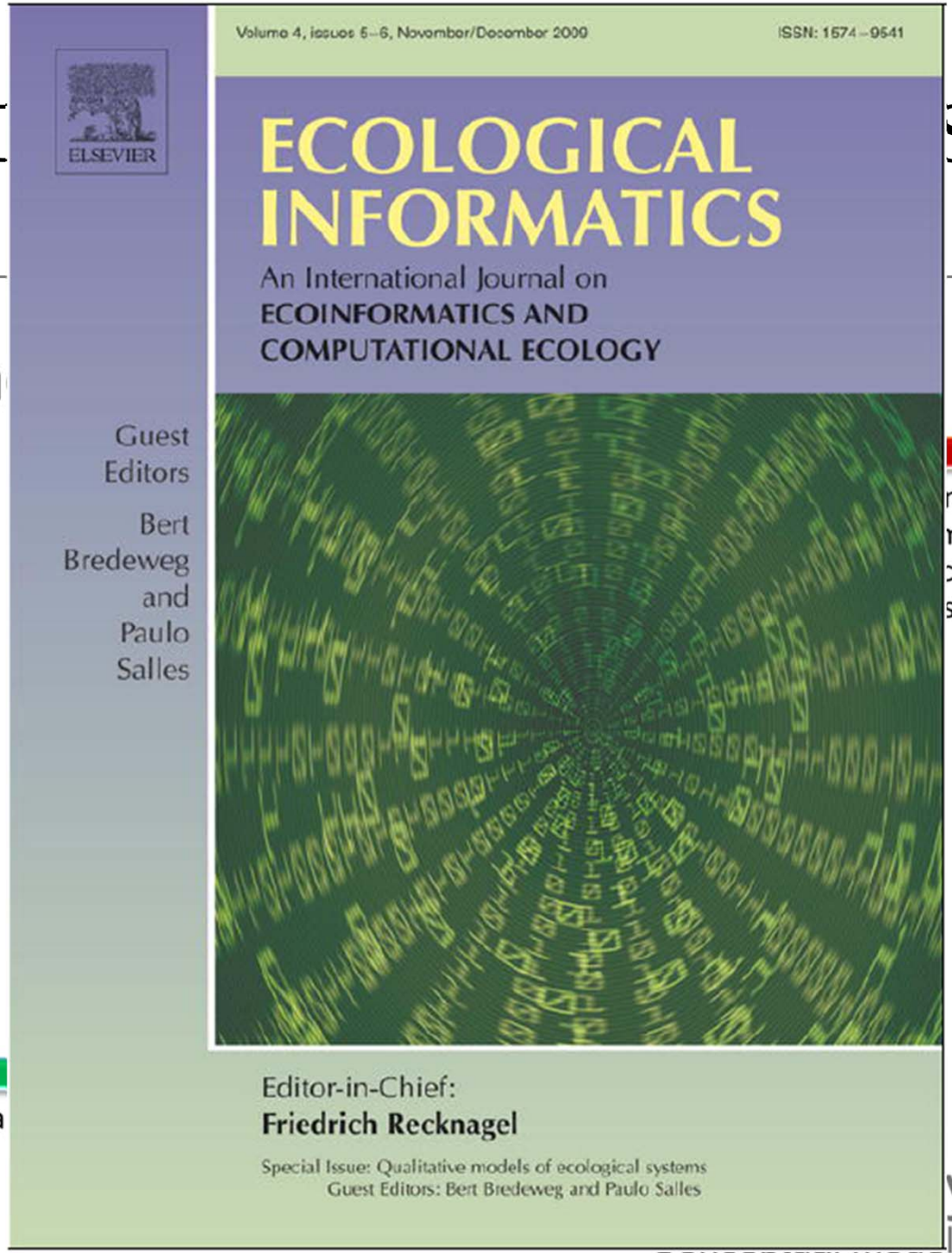
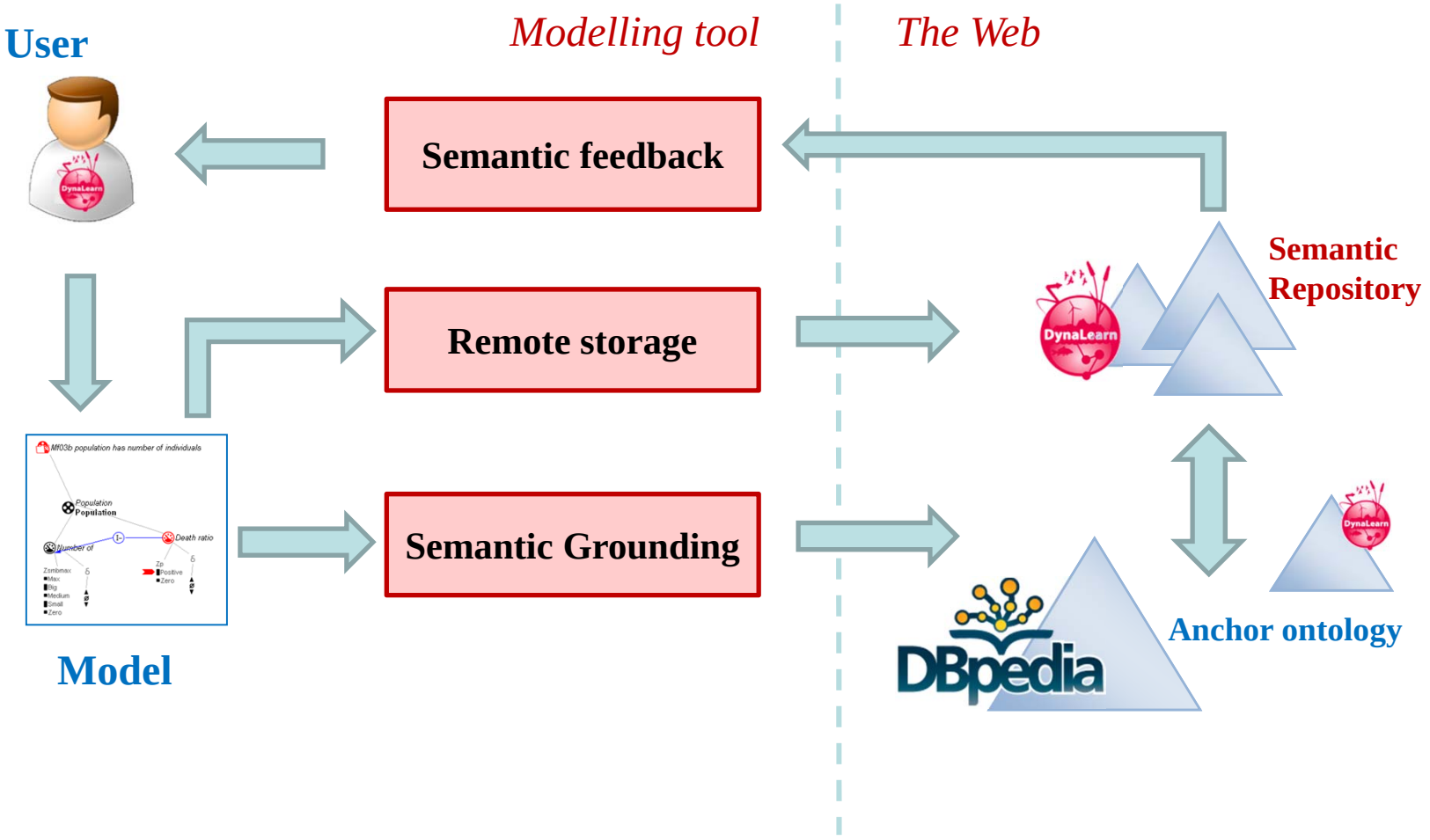
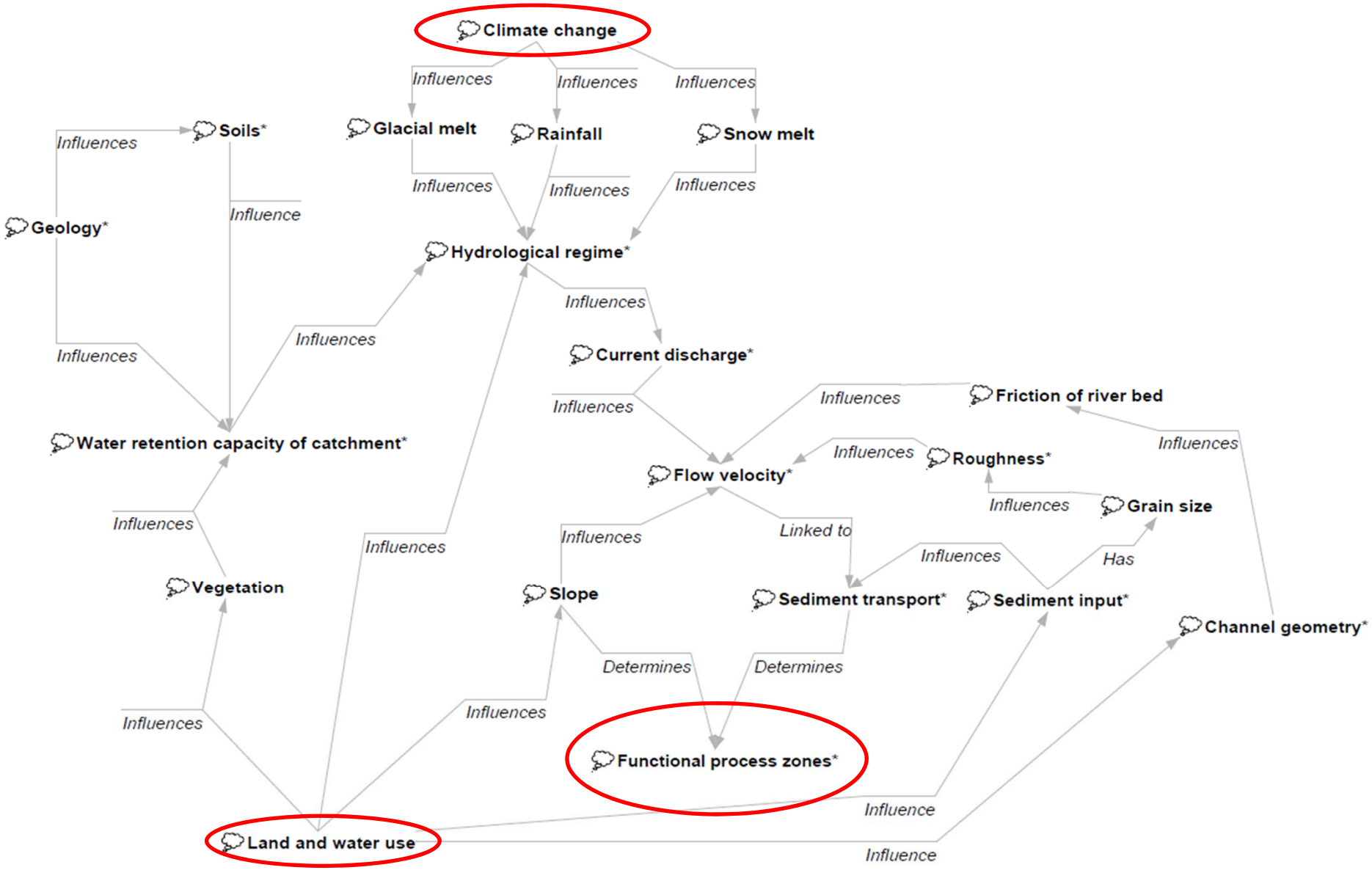


Grounding terms and getting semantic feedback

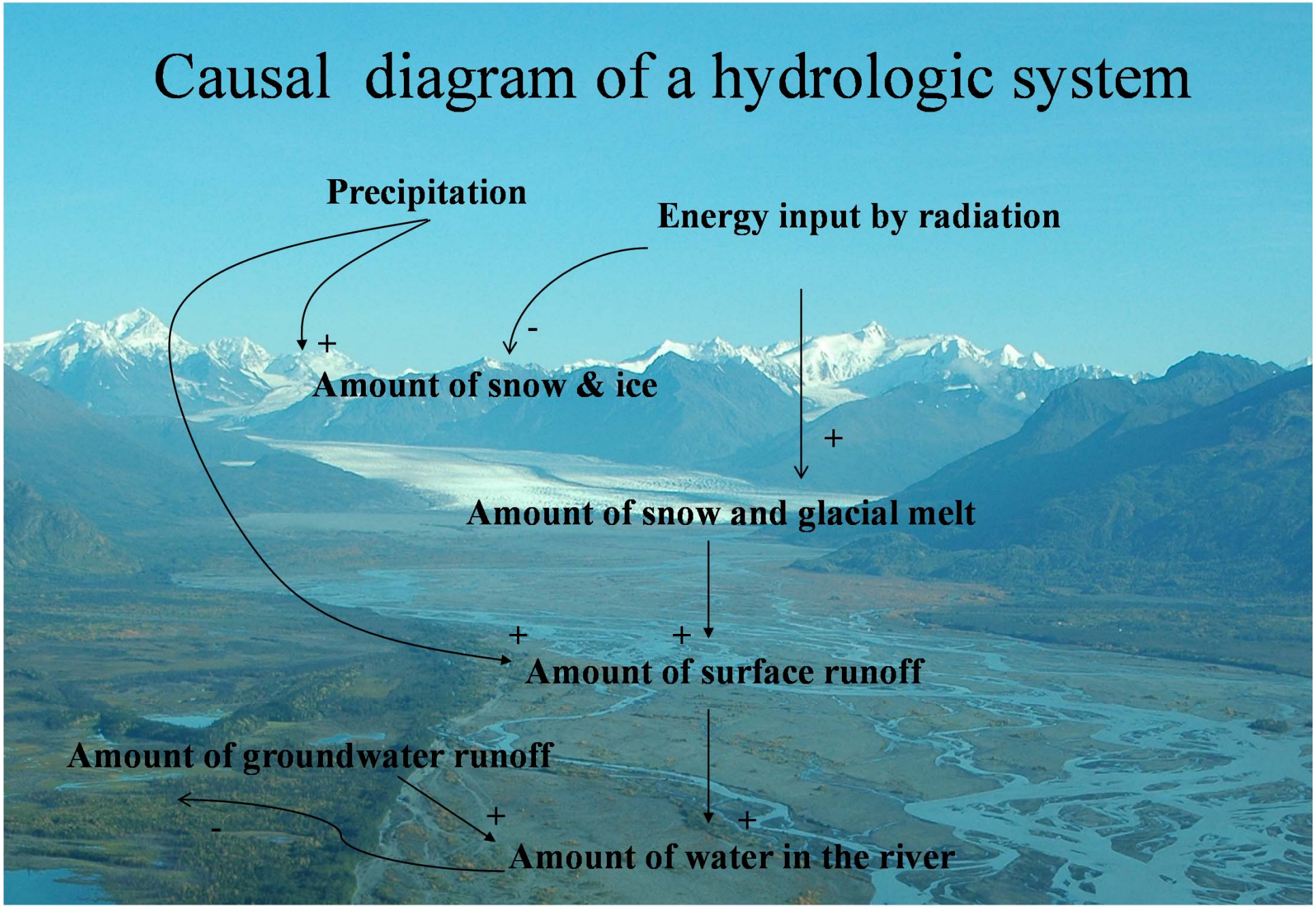


LS 1 - Concept map

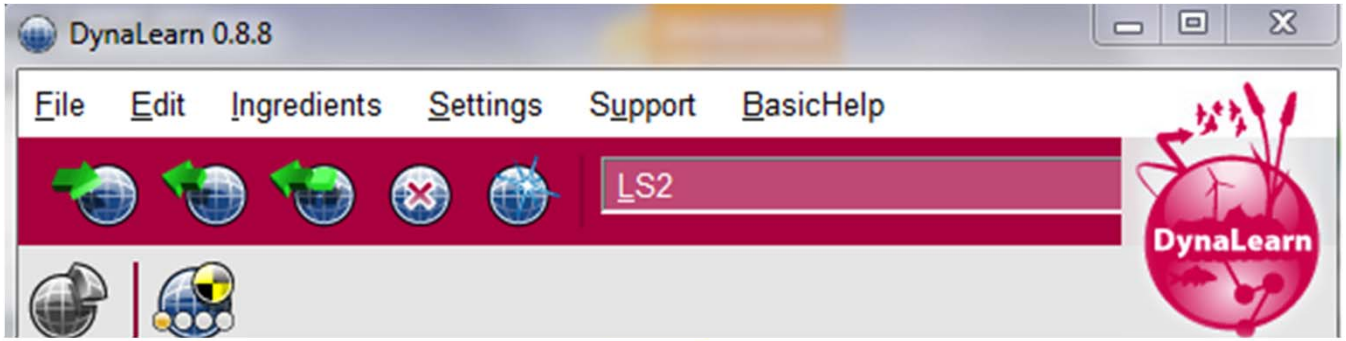


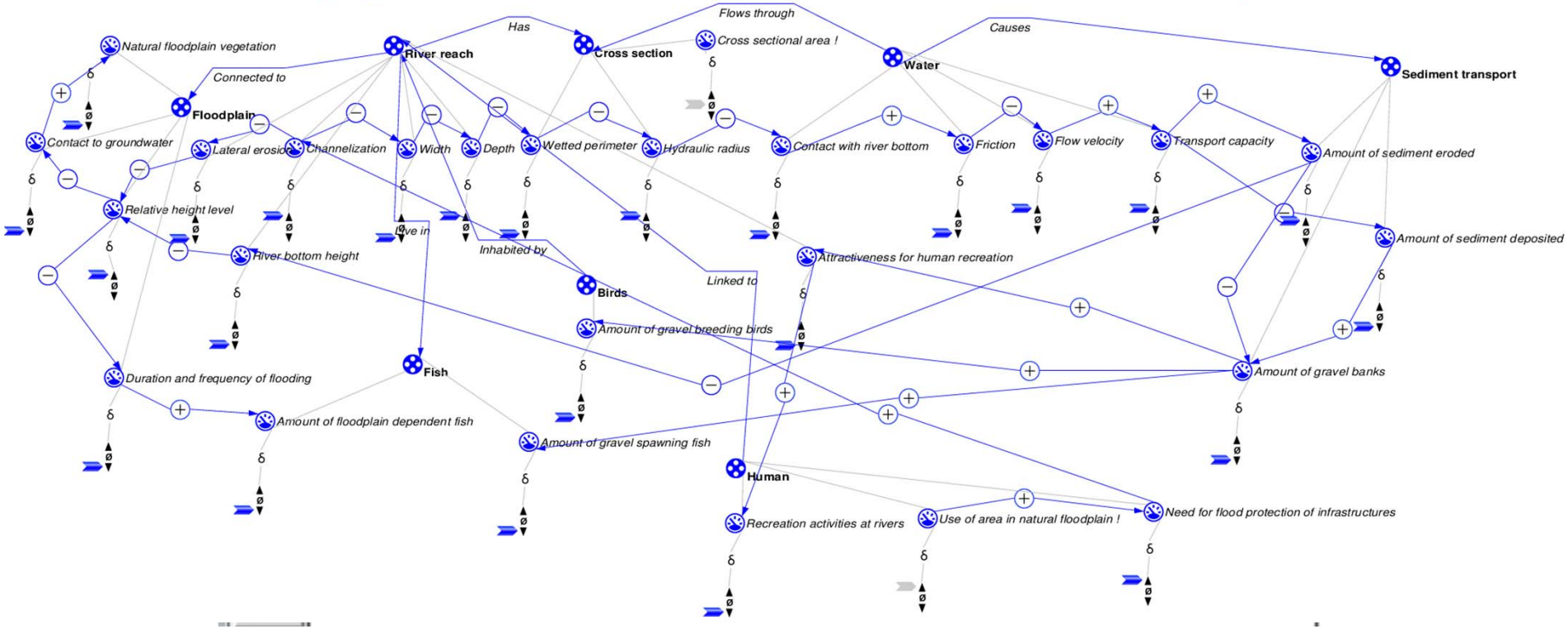
LS 1 - Concept map

Causal diagram of a hydrologic system

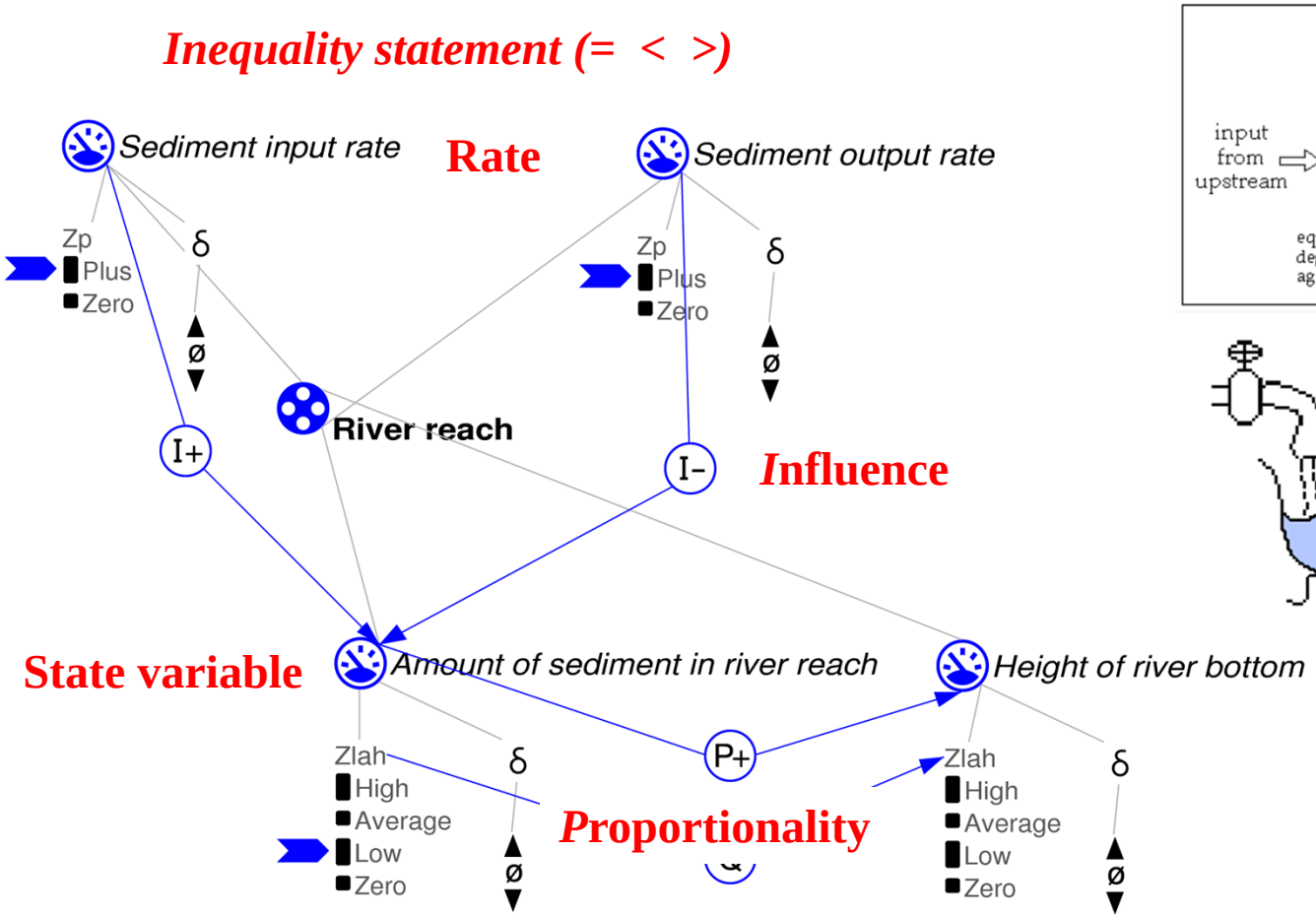


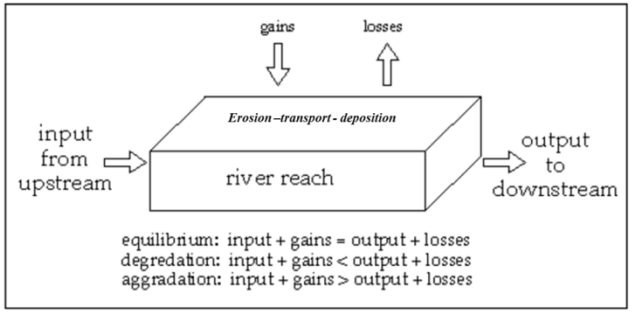
Causal modeling in DynaLearn LS 2

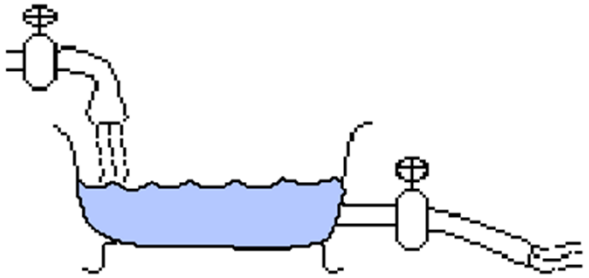


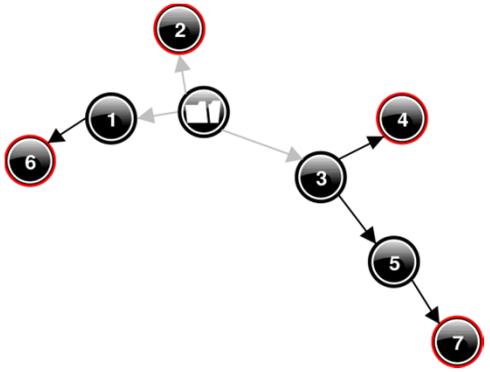


LS4 – Causal differentiation model (following the SD paradigm)

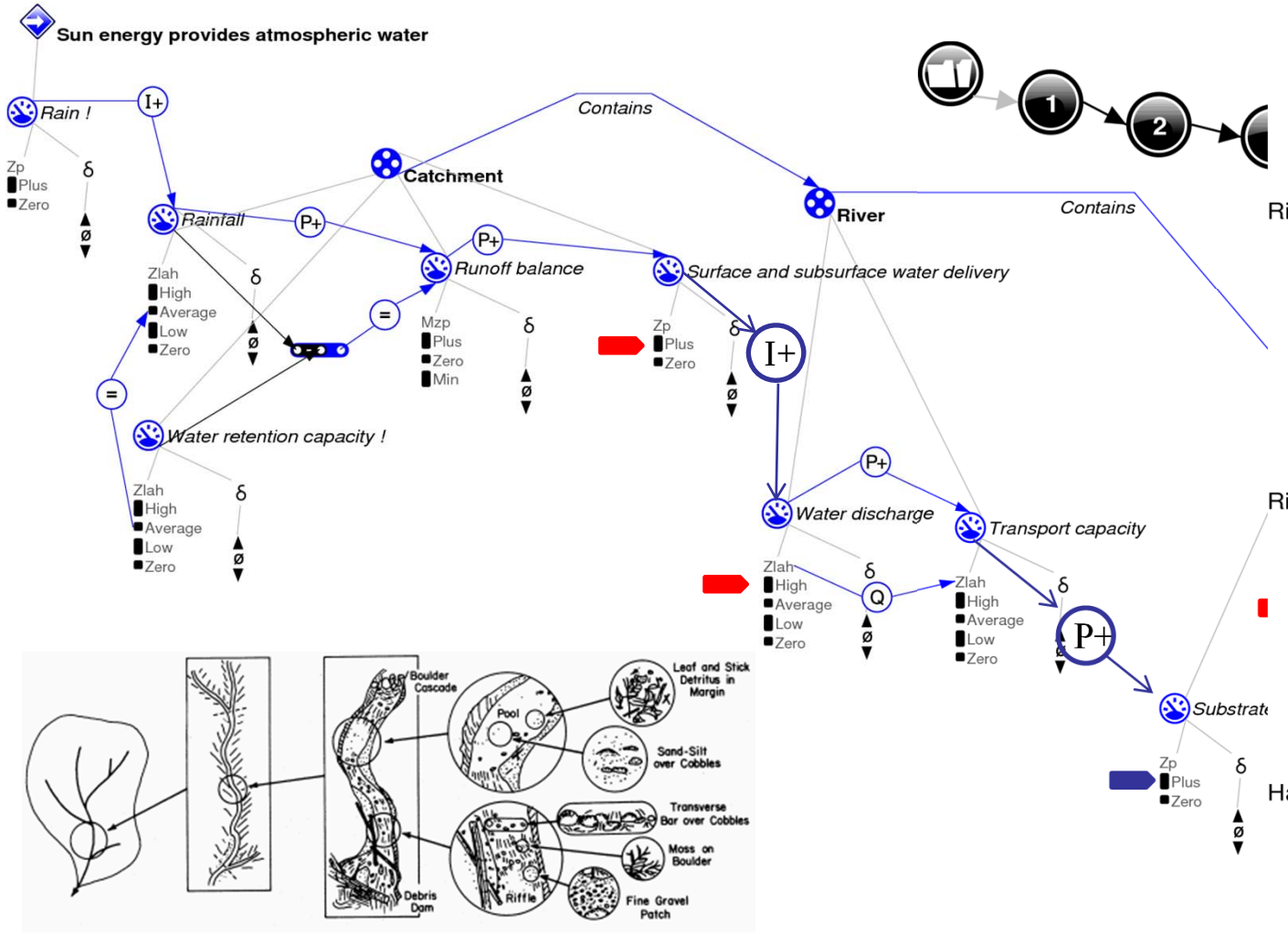


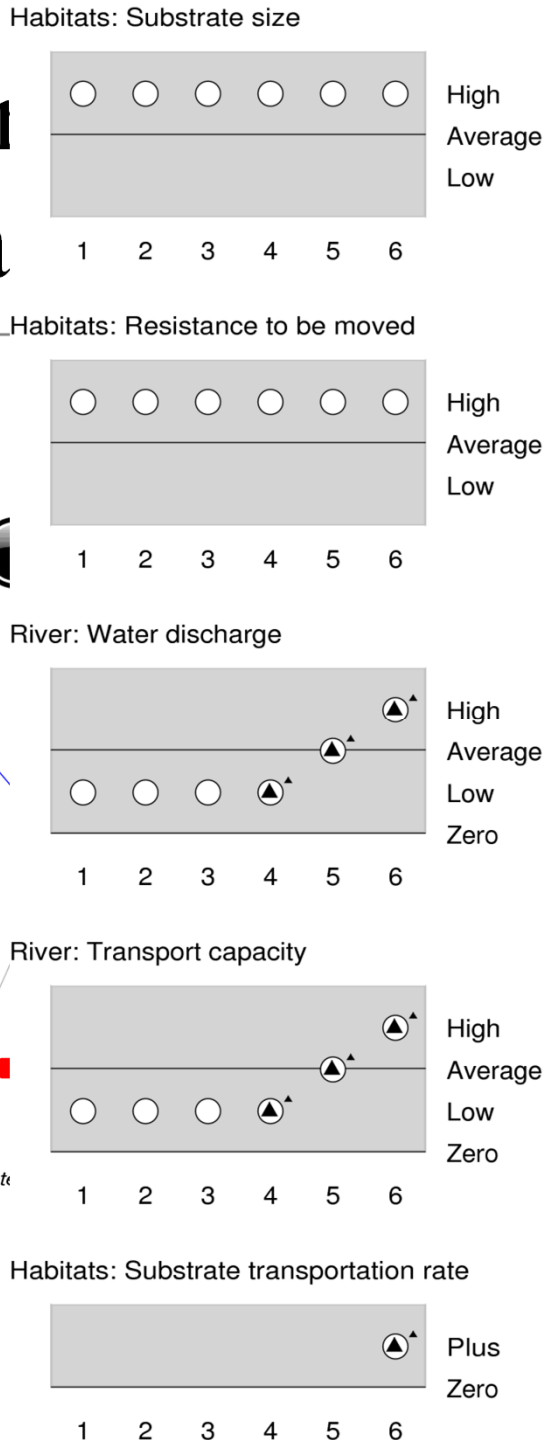






LS5 - Conditional hierar causal model of a river ca





Summary & outlook

- Complex systems can be captured in conceptual causal dynamic models following common ecosystem theories.
- Individual and social learning enriched by feedback from expert models can be supported.
- A model library of evidence based causal models and most (arche)typical management problems represents a valuable source of information.


DynaLearn
www.dynalearn.eu
BOKU
I·H·G
www.boku.ac.at/hfa
SEVENTH FRAMEWORK PROGRAMME
Thank you very much for your attention!
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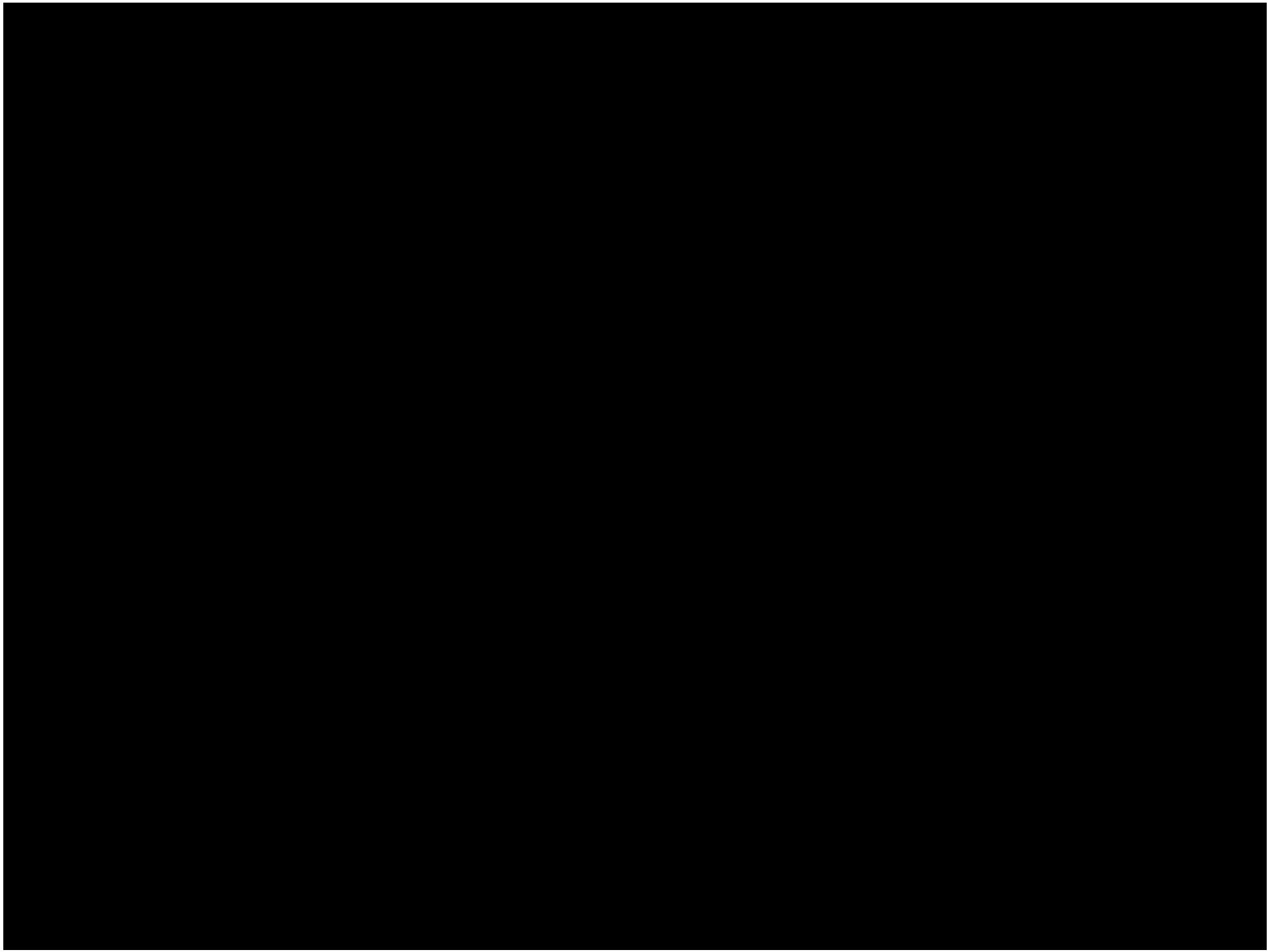

Challenge of causal data integration

- Increasing production of environmental data
- Advanced statistical data mining methods are able to provide partial evidence
- BUT: causal reasoning frameworks are lacking to integrate these fragmented relations of evidence
- Only a clear causal understanding of ecological phenomena represents a reasonable basis for developing experimental hypotheses and determining frameworks for environmental management.