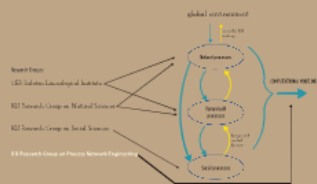




A new, multi-traced approach  
to provide supervision of  
natural, human-built and social processes

1.837-74.521A-BW-2017-001-0022 project  
financed by the Federal Government, Ministry of  
Education, Science and Research, as well as the states, in equal  
partnership, in the framework of the German Research  
Foundation (DFG) and the Federal Government  
Research Alliance (FGF) - research 2025  
DFG logo FGF logo

LandUseLab  
Karlsruhe University (KIT)  
H2S Center for Ecological Research (H2S)

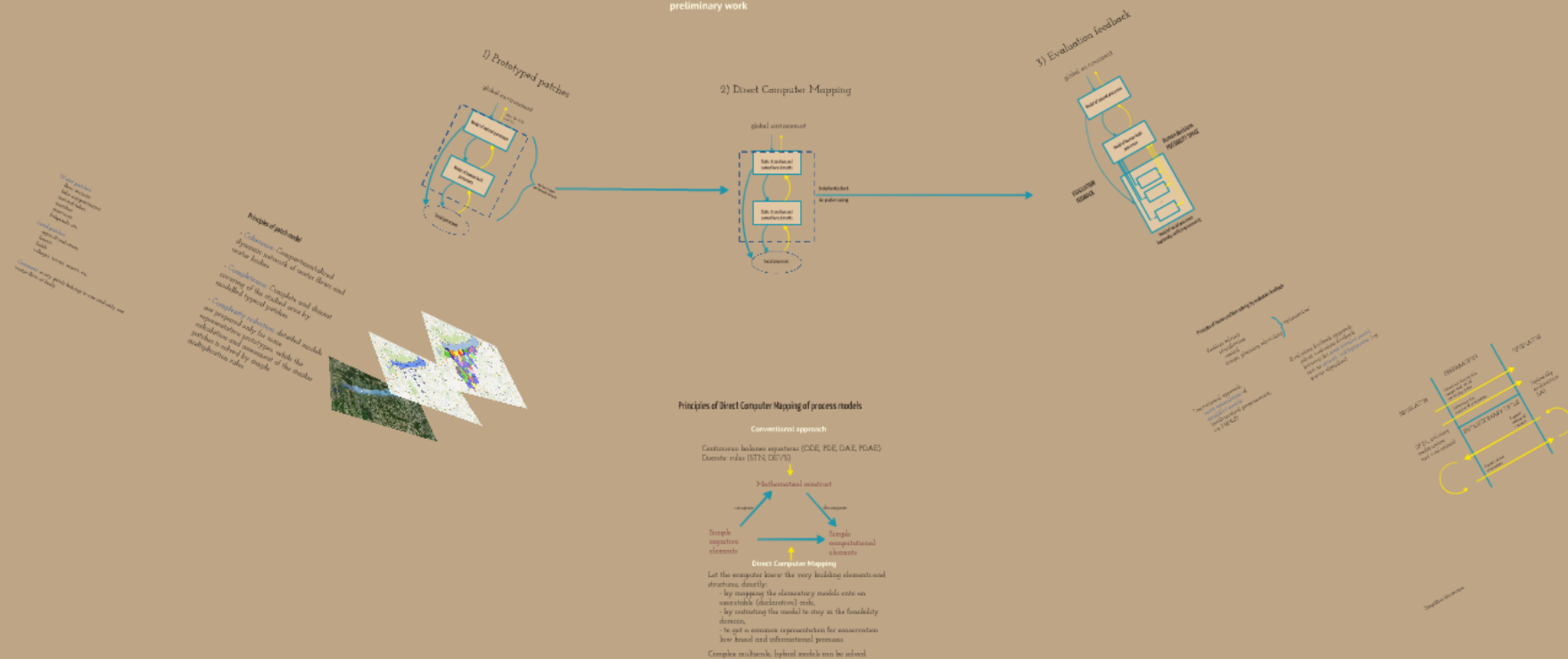


Future perspectives  
- Prototyped patches linked to the water  
network can help the multi-objective  
modeling approach  
- Direct Computer Mapping proved to be  
able to build 'model' similar  
models from various knowledge sources  
- Multi-objective evaluation methods  
could support the evaluation or  
comparative validation of patch models  
in the development of the model  
structure  
- Ideal goal to elaborate a methodology  
for Conceptualization of Technical Models

## Methodological elements of the ongoing work

- 1) Prototyped patch types linked to the components of the water network
- 2) Direct Computer Mapping of process models onto an accessible computer code
- 3) Optionally multiobjective evaluation feedback between the human decisions and the detailed process model

Today: oversimplified illustration of preliminary work



Simplified illustration

# A new, model based approach to promote cooperation of natural, human-built and social processes

Monika Varga, Bela Csukas  
Research Group on Process Network Engineering  
Kaposvar University





# TÁMOP-4.2.2.A-11/1/KONV-2012-0038 project

Study on the complex environmental impacts of human activities and on the solution of social conflicts in a sensitive geographical area, near a shallow lake (Lake Balaton and its South catchment basin)

Duration: October 2012 - January 2015

Nemzeti Fejlesztési Ügynökség  
[www.ujszachenyierv.gov.hu](http://www.ujszachenyierv.gov.hu)  
06 40 630 638



A projekt az Európai Unió támogatásával, az Európai Szociális Alap társfinanszírozásával valósul meg.



## Consortial partners:

Kaposvar University (KU)

HAS Centre for Ecological Research (CER)

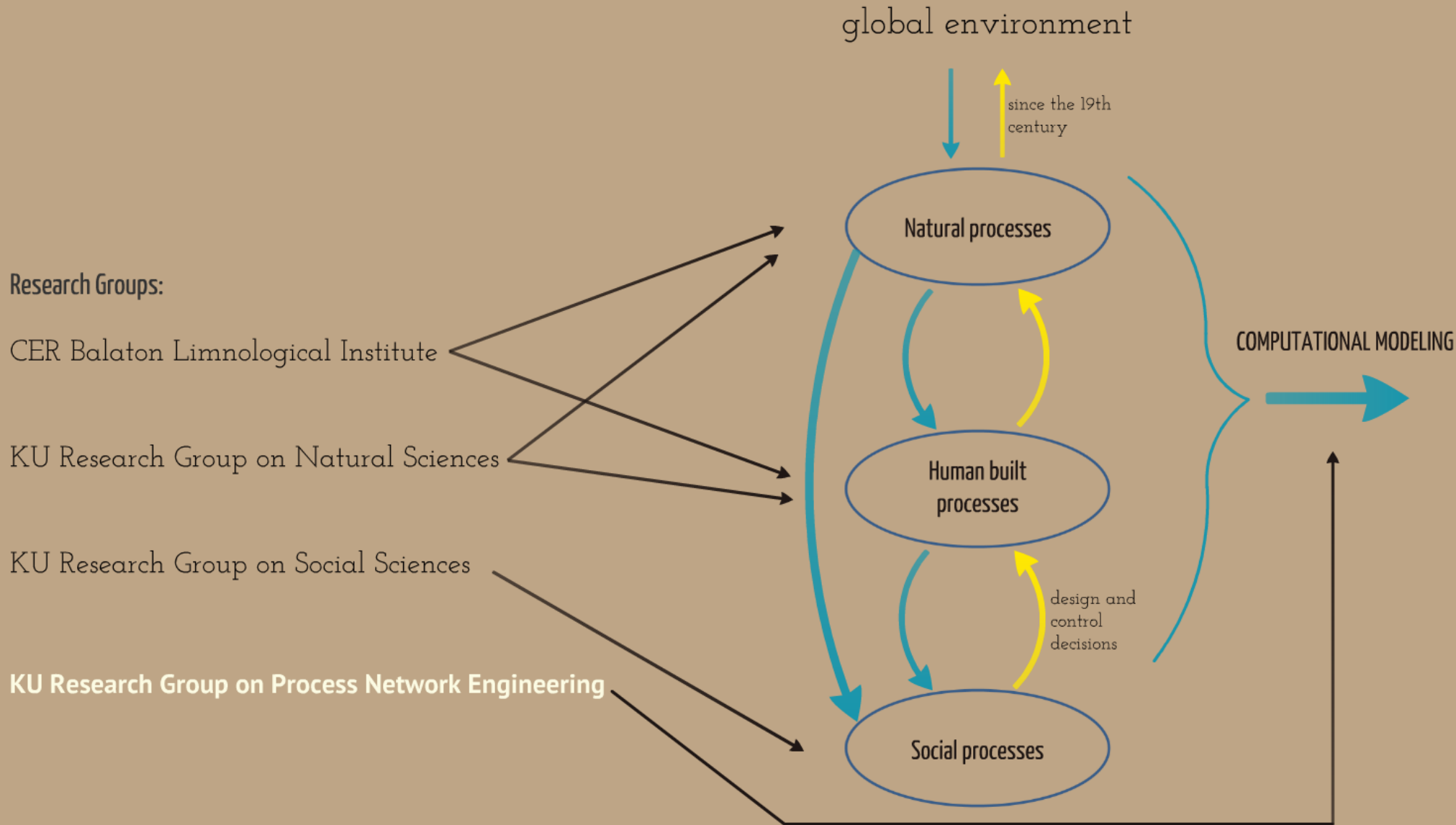
## Research Groups:

CER Balaton Limnological Institute

KU Research Group on Natural Sciences

KU Research Group on Social Sciences

**KU Research Group on Process Network Engineering**

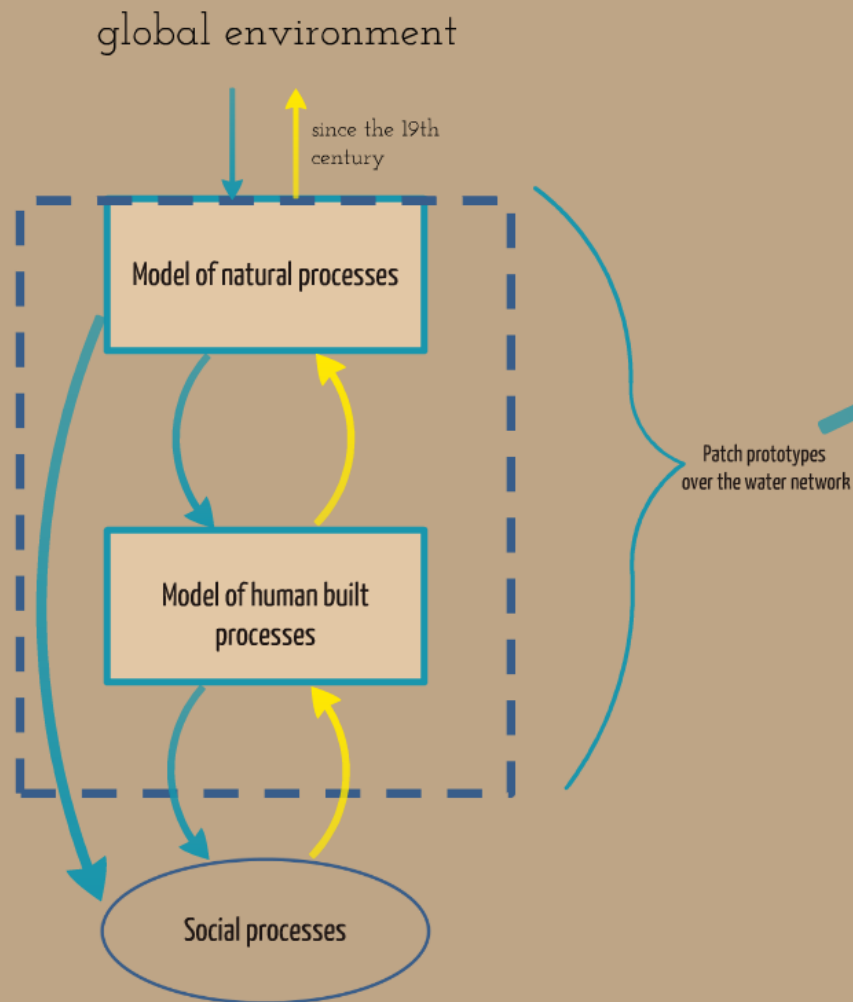


## Methodological elements of the ongoing work

- 1) Prototyped patch types linked to the compartments of the water network
- 2) Direct Computer Mapping of process models onto an executable computer code
- 3) Optionally multiobjective evaluation feedback between the human decisions and the detailed process model

**Today: oversimplified illustration of preliminary work**

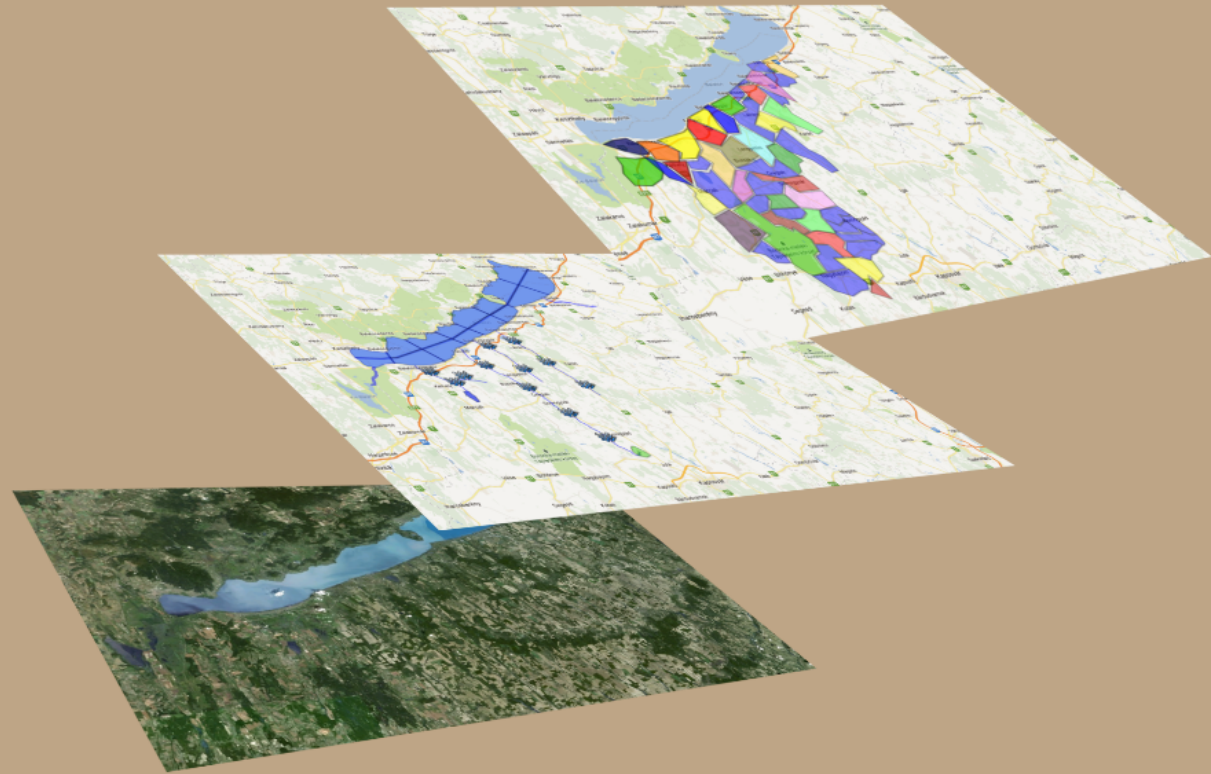
# 1) Prototyped patches





## Principles of patch model

- **Coherence**: Compartmentalized dynamic network of water flows and water bodies
- **Completeness**: Complete and disjoint covering of the studied area by modelled typical patches
- **Complexity reduction**: detailed models are prepared only for some representative prototypes, while the calculation and assessment of the similar patches is solved by simple multiplication rules.



### Water patches:

- flow sections
- lake compartments
- natural lakes
- marshes
- reservoirs,
- fishponds, etc.

### Land patches:

- agricultural areas
- forests
- fields
- villages, towns, resorts, etc.

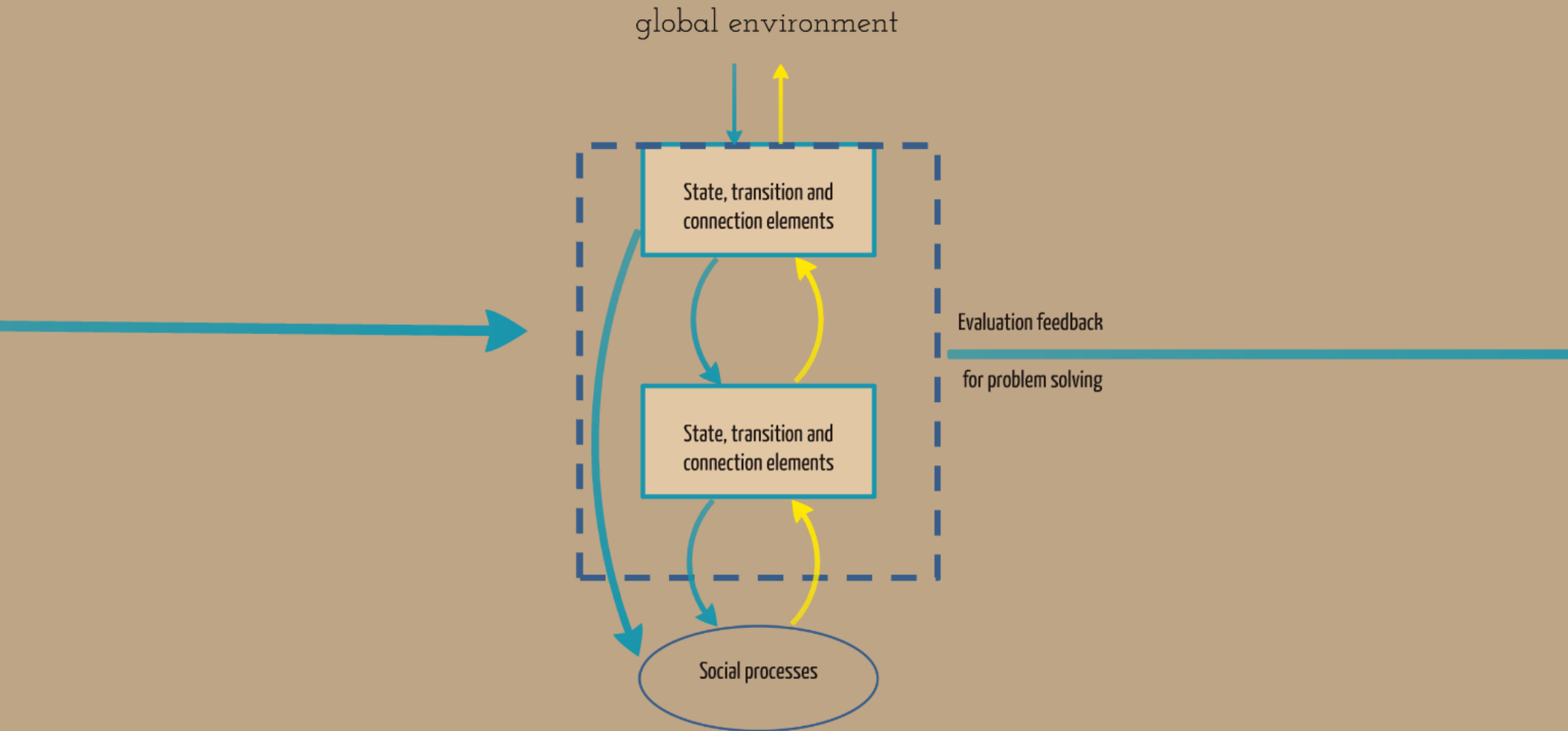
**Comment:** every patch belongs to one and only one water flow or body

## Methodological elements of the ongoing work

- 1) Prototyped patch types linked to the compartments of the water network
- 2) Direct Computer Mapping of process models onto an executable computer code
- 3) Optionally multiobjective evaluation feedback between the human decisions and the detailed process model

**Today: oversimplified illustration of preliminary work**

## 2) Direct Computer Mapping

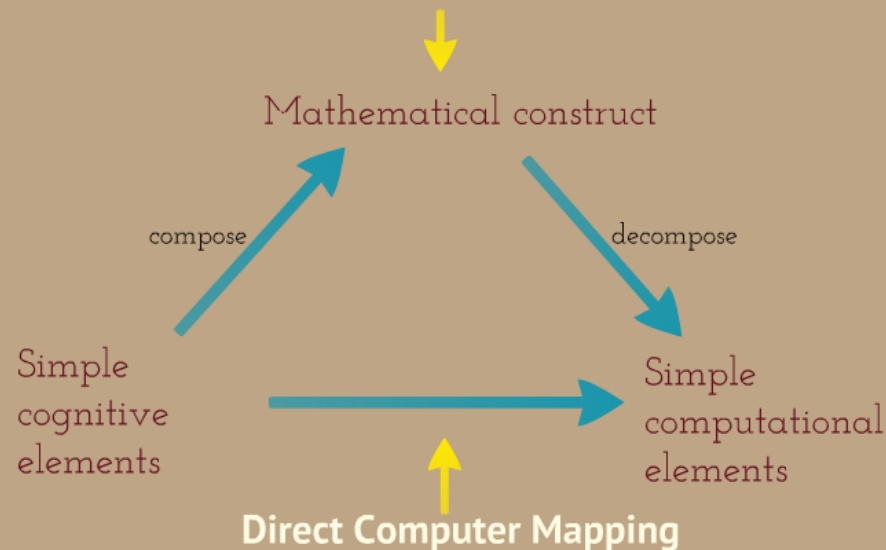


# Principles of Direct Computer Mapping of process models

## Conventional approach

Continuous: balance equations (ODE, PDE, DAE, PDAE)

Discrete: rules (STN, DEVS)



Let the computer know the very building elements and structures, directly:

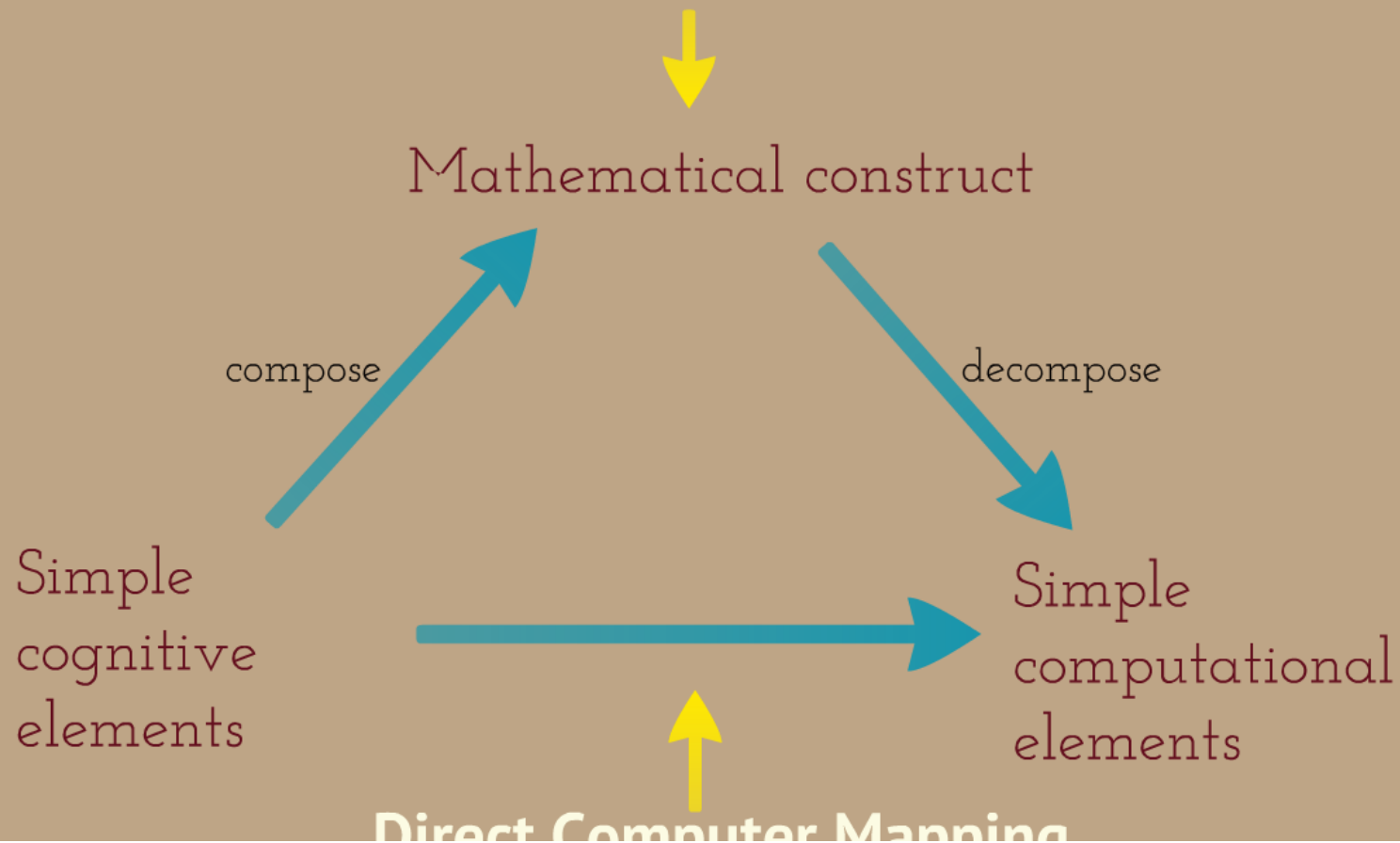
- by mapping the elementary models onto an executable (declarative) code,
- by restricting the model to stay in the feasibility domain,
- to get a common representation for conservation law based and informational processes.

Complex multiscale, hybrid models can be solved.

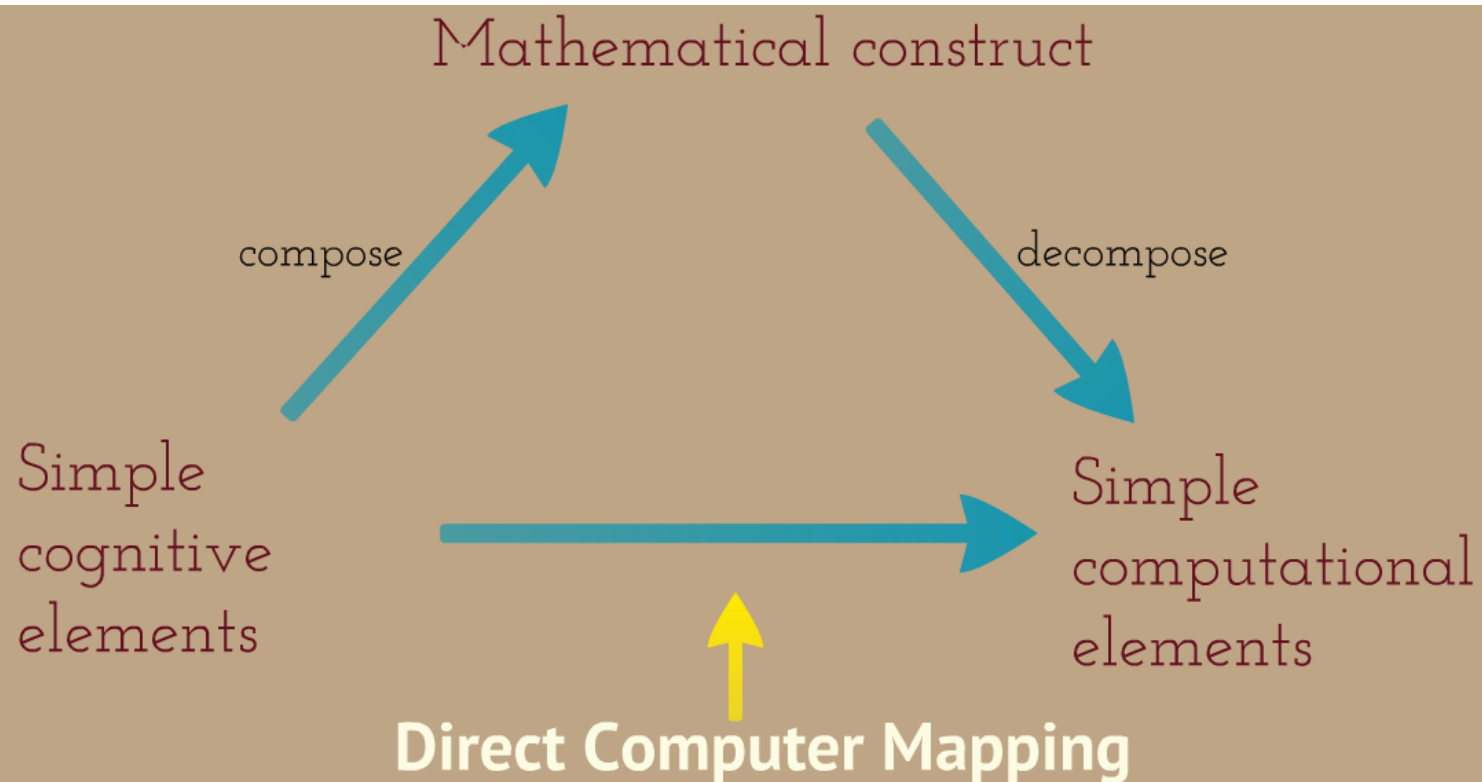
# Principles of Direct Computer Mapping of process models

## Conventional approach

Continuous: balance equations (ODE, PDE, DAE, PDAE)  
Discrete: rules (STN, DEVS)







Let the computer know the very building elements and structures, directly:

- by mapping the elementary models onto an executable (declarative) code,
- by restricting the model to stay in the feasibility domain,
- to get a common representation for conservation law based and informational processes.

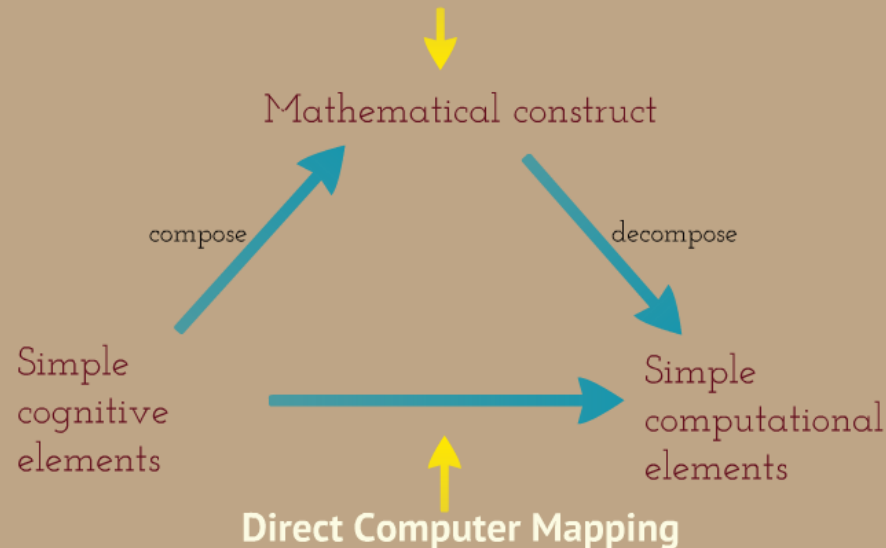
Complex multiscale, hybrid models can be solved.

# Principles of Direct Computer Mapping of process models

## Conventional approach

Continuous: balance equations (ODE, PDE, DAE, PDAE)

Discrete: rules (STN, DEVS)



Let the computer know the very building elements and structures, directly:

- by mapping the elementary models onto an executable (declarative) code,
- by restricting the model to stay in the feasibility domain,
- to get a common representation for conservation law based and informational processes.

Complex multiscale, hybrid models can be solved.

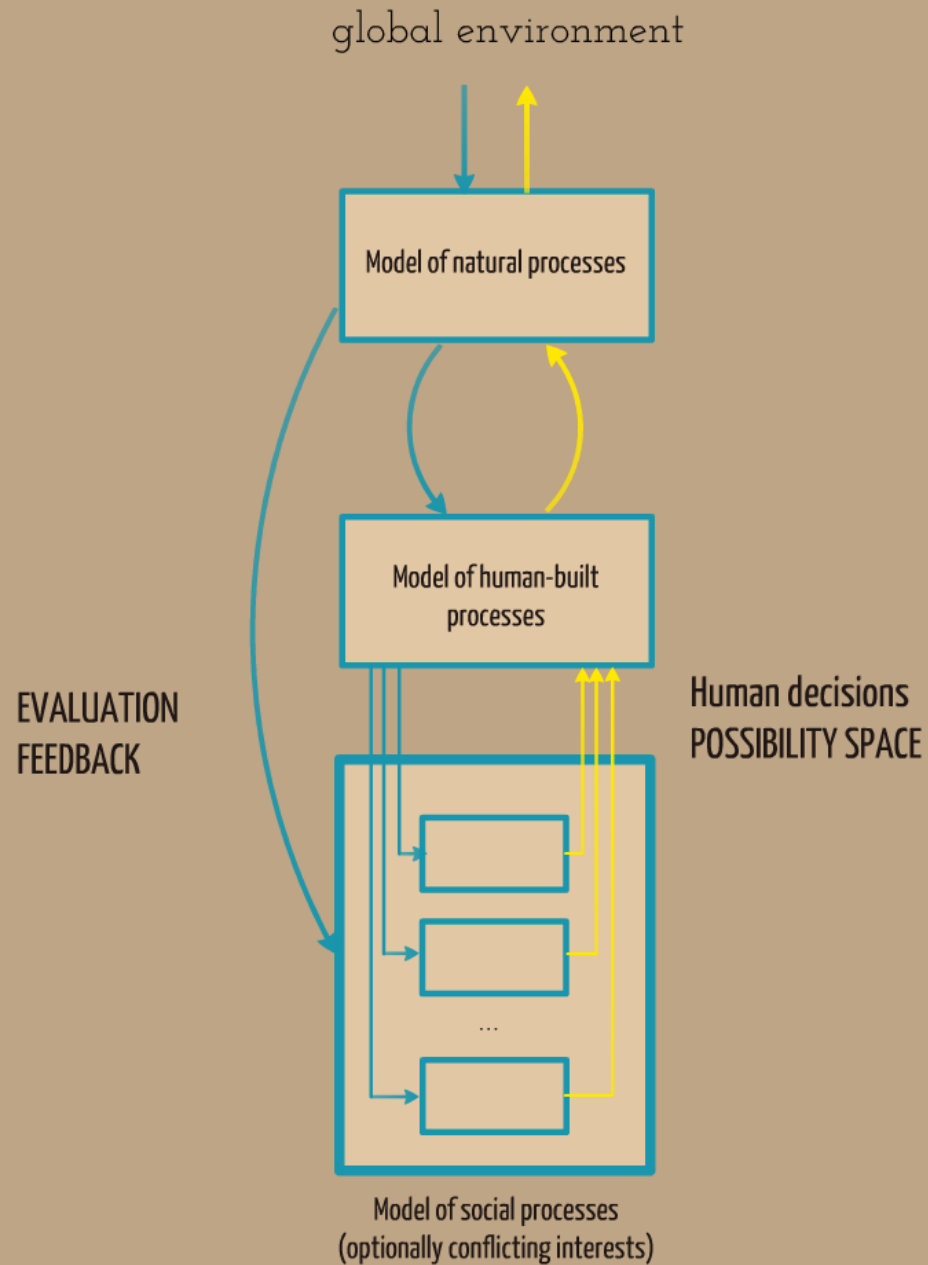
Simplified illustration

## Methodological elements of the ongoing work

- 1) Prototyped patch types linked to the compartments of the water network
- 2) Direct Computer Mapping of process models onto an executable computer code
- 3) Optionally multiobjective evaluation feedback between the human decisions and the detailed process model


**Today: oversimplified illustration of preliminary work**

### 3) Evaluation feedback



## Principles of human problem solving by evaluation feedback

Problem solving:  
identification  
control  
design, planning, scheduling



"optimization"

Conventional approach:  
exact optimization of  
simplified models  
(mathematical programming,  
e.g. MINLP)

Evaluation feedback approach:  
robust evaluation feedback  
between the most detailed model  
and an inexact (sub)optimizer (e.g.  
genetic algorithm)



Conventional approach:  
exact optimization of  
simplified models  
(mathematical programming,  
e.g. MINLP)

## Principles of human problem solving by evaluation feedback

## Problem solving:

identification

control

design, planning, scheduling

```
> "optimization"
```

onal approach:  
optimization of


## Evaluation feedback approach

scheduling } optimization

Evaluation feedback approach:  
robust evaluation feedback  
between the most detailed model  
and an inexact (sub)optimizer (e.g.  
genetic algorithm)

## Principles of human problem solving by evaluation feedback

Problem solving:  
identification  
control  
design, planning, scheduling



"optimization"

Conventional approach:  
exact optimization of  
simplified models  
(mathematical programming,  
e.g. MINLP)

Evaluation feedback approach:  
robust evaluation feedback  
between the most detailed model  
and an inexact (sub)optimizer (e.g.  
genetic algorithm)

## PREPARATION

SIMULATOR

Determines the possible  
ranges and sets of  
possibility space

OPTIMATOR

Determines the  
number of evaluation

(DCM, including  
configuration  
and evaluations)

## EVOLUTIONARY CYCLE

(optionally  
multicriteria  
GA)

Suggest  
coding of  
variants

Reports about  
evaluation



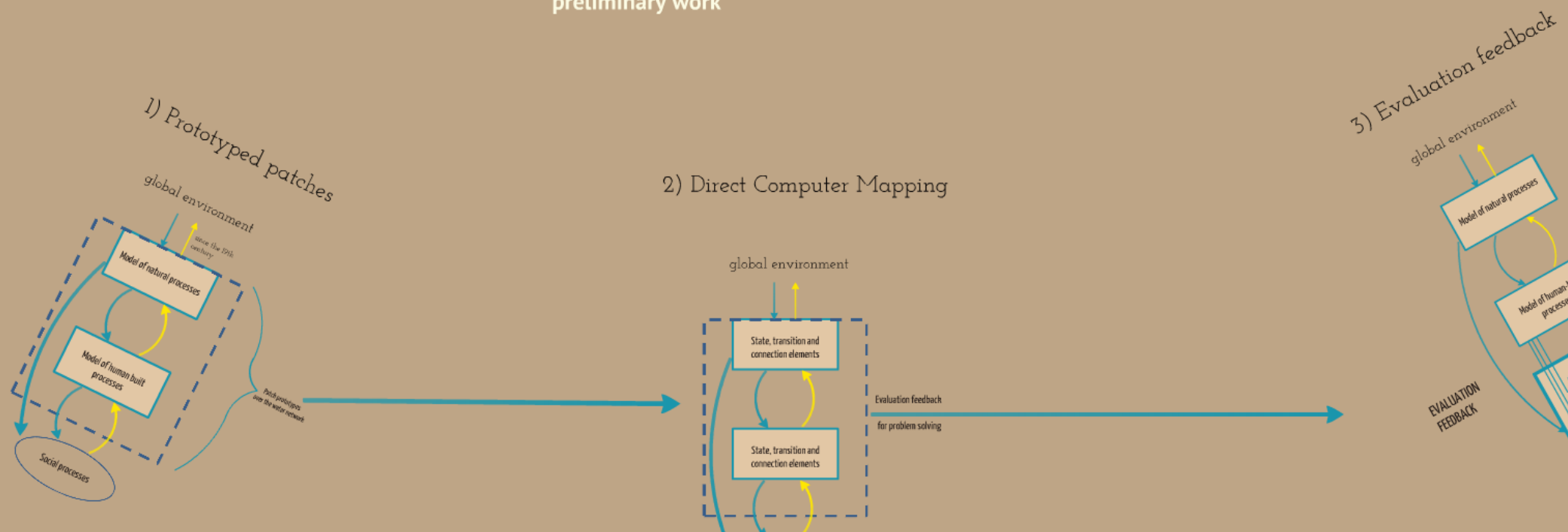
Simplified illustration



## Methodological elements of the ongoing work

- 1) Prototyped patch types linked to the compartments of the water network
- 2) Direct Computer Mapping of process models onto an executable computer code
- 3) Optionally multiobjective evaluation feedback between the human decisions and the detailed process model

Today: oversimplified illustration of preliminary work



## Preliminary experiences

- Prototyped patches linked to the water network can help the multidisciplinary thinking together.
- Direct Computer Mapping proved to be able to build consistent complex models from various knowledge sources stepwise.
- Multi-objective evaluation feedback might support the evolution of compromise solutions of partial interests in the development of the feasible scenarios.
- Ideal goal: to elaborate a methodology for Computational Sustainability