

# Modelling and evaluating long-term impacts on ecosystem services: experiences from LTER-site research

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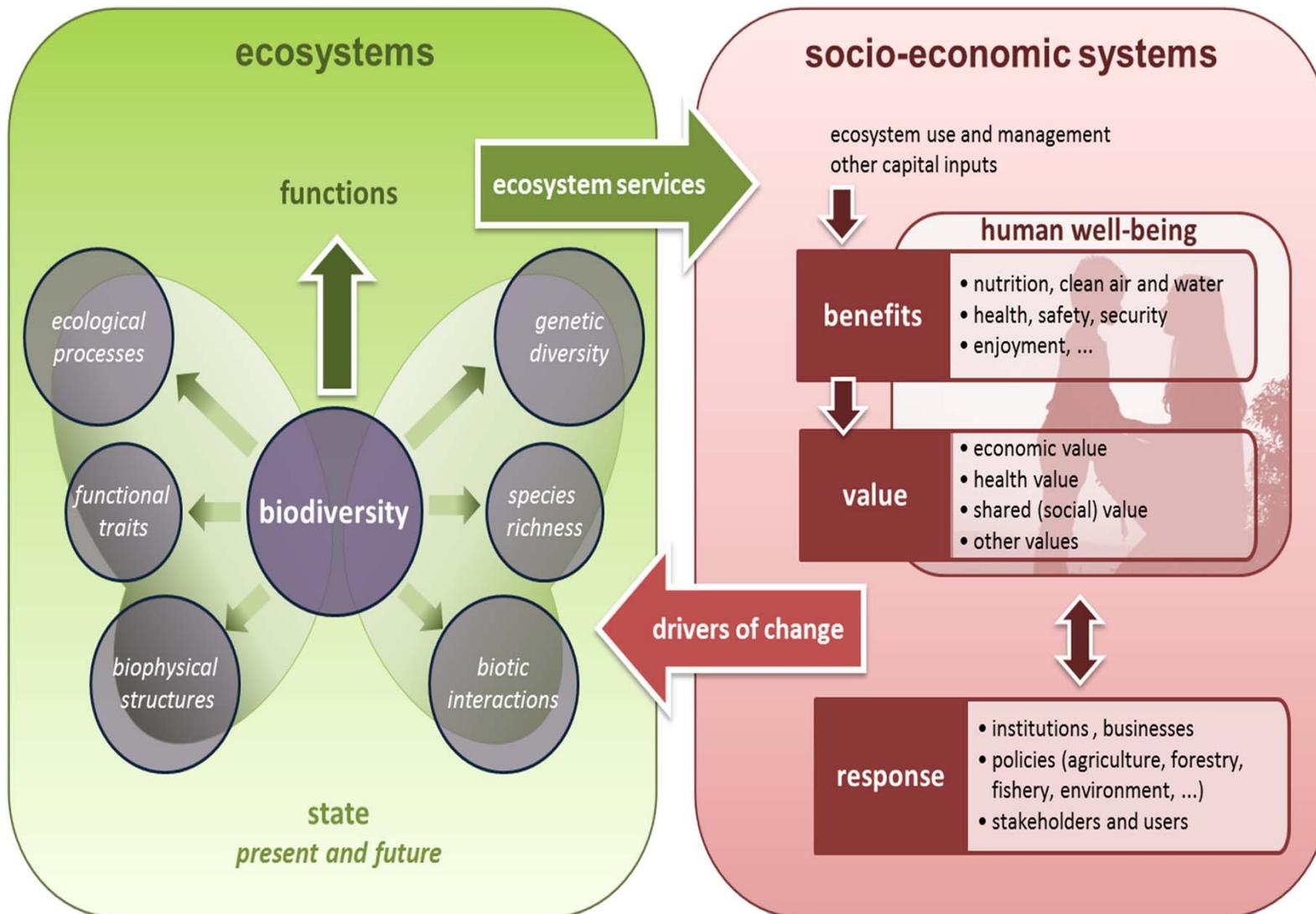
[www.syke.fi/projects/lter](http://www.syke.fi/projects/lter)

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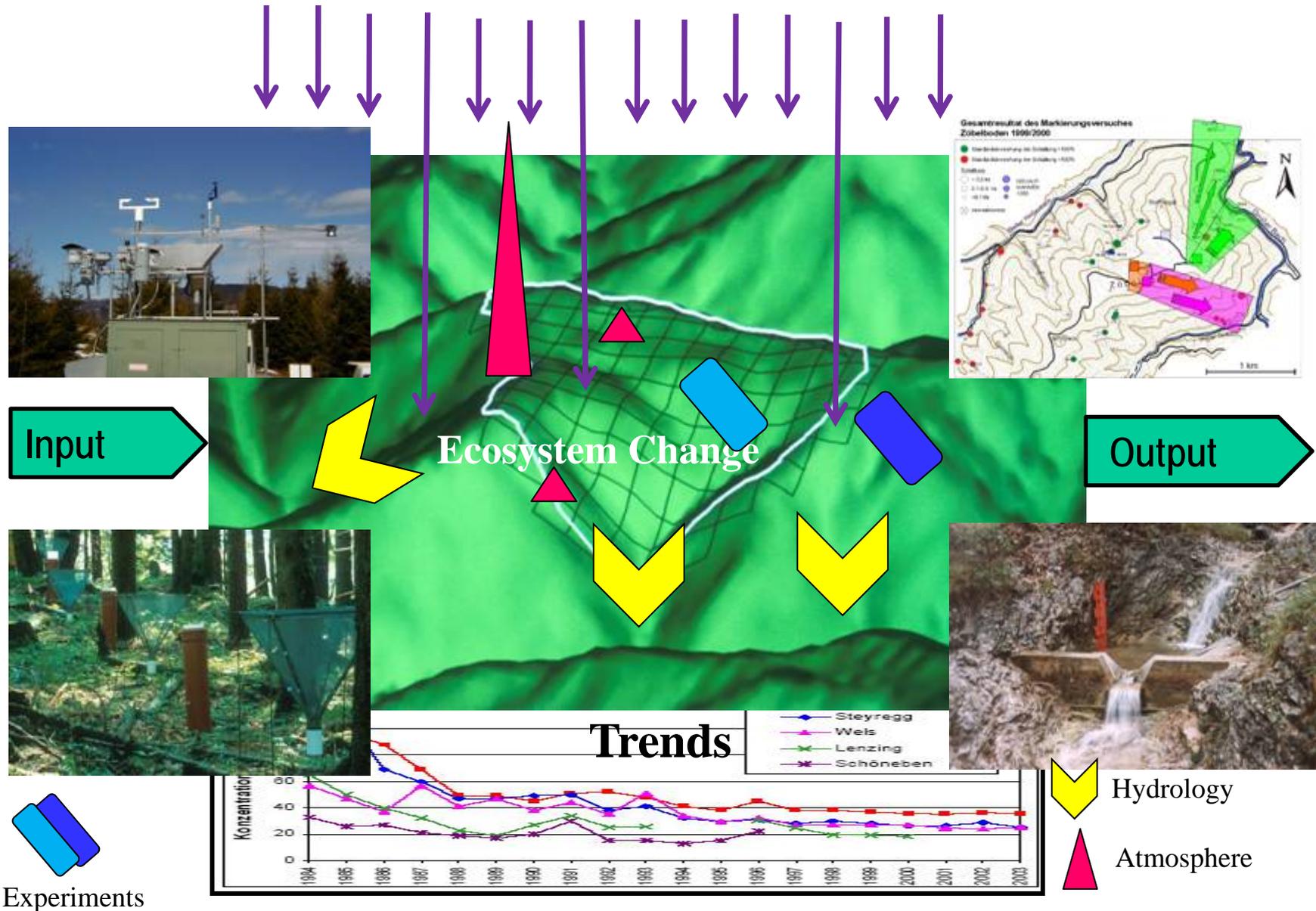
- Background on ecosystem service and LTER research
- Example based on Finnish experiences
- Example based on international LTER work
- Future perspectives

# Global challenges: Research areas to be supported by BD & ES research

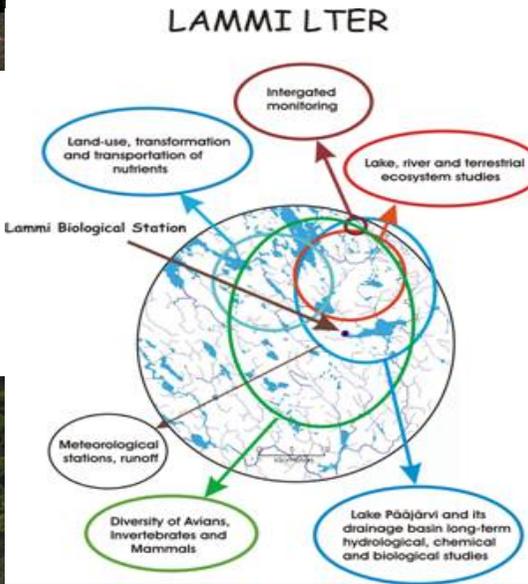




# LTER concept (Long-Term Ecological Research)



# Lammi LTER-site



# Finnish LTER-project (VACCIA)

- Studied the impacts of climate change in ecosystem services and livelihoods.
- Produced environmental change scenarios and developed modelling, GIS and database solutions to assess the changes and adaptation options.
- Based on the Finnish LTER-network.
- Generated information for:
  - Updating process of the Finnish national climate change adaptation strategy
  - Regional decision making
  - Contribution to EU-level scientific work

# Detailed information:

## ■ Synthesis paper:

Forsius, M. *et al.* (2013). Impacts and adaptation options of climate change on ecosystem services in Finland: a model based study. *Current Opinion in Environmental Sustainability* 5: 26-40. doi: <http://dx.doi.org/10.1016/j.cosust.2013.01.001>

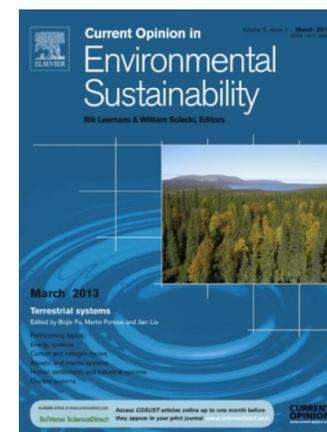
## ■ Synthesis report and subproject reports:

- Available at: [www.syke.fi/projects/vaccia](http://www.syke.fi/projects/vaccia)

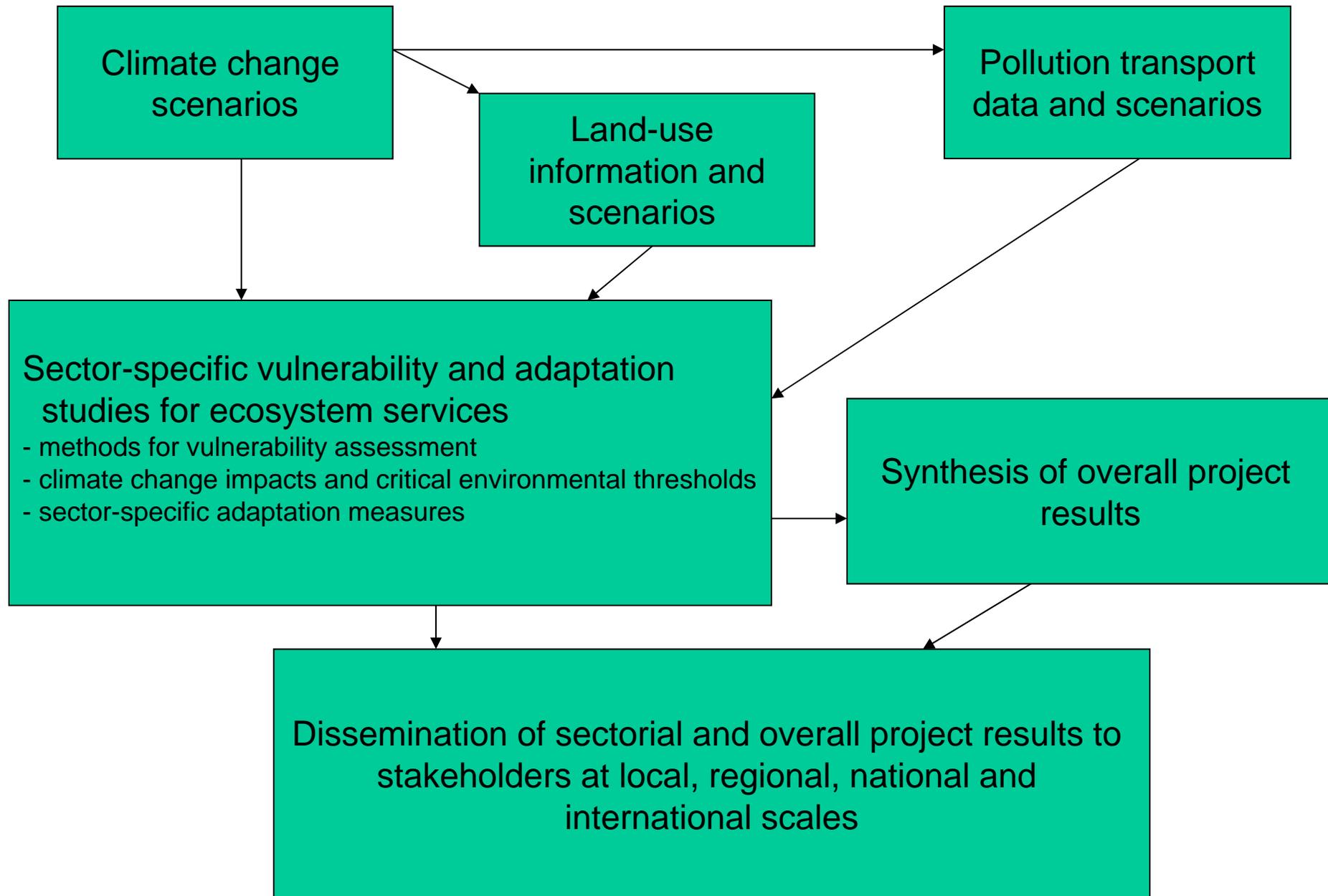
## ■ Special issue on ecosystem services:

Fu, B., Forsius, M. and Liu, J. (eds.) (2013). Ecosystem Services: climate change and policy impacts.

*Current Opinion in Environmental Sustainability* Vol 5, issue 1.  
doi: [http://dx.doi.org/10.1016/S1877-3435\(13\)00018-3](http://dx.doi.org/10.1016/S1877-3435(13)00018-3)



# Framework for VACCIA-project



(Forsius *et al.* 2013)

# Sectors in VACCIA-project

Coastal ecosystems

Lake and catchment ecosystems

Urban ecosystems

Ecosystems

Forest production

Agricultural production

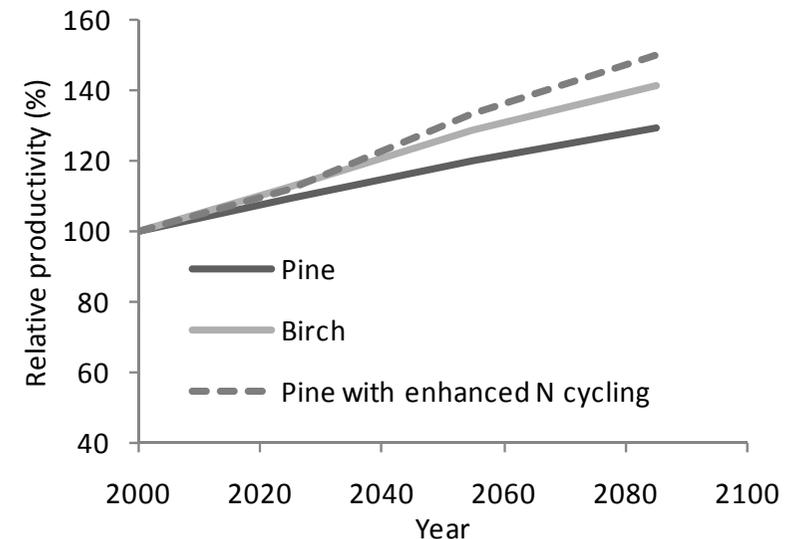
Fish production

Nature-based tourism

Livelihoods

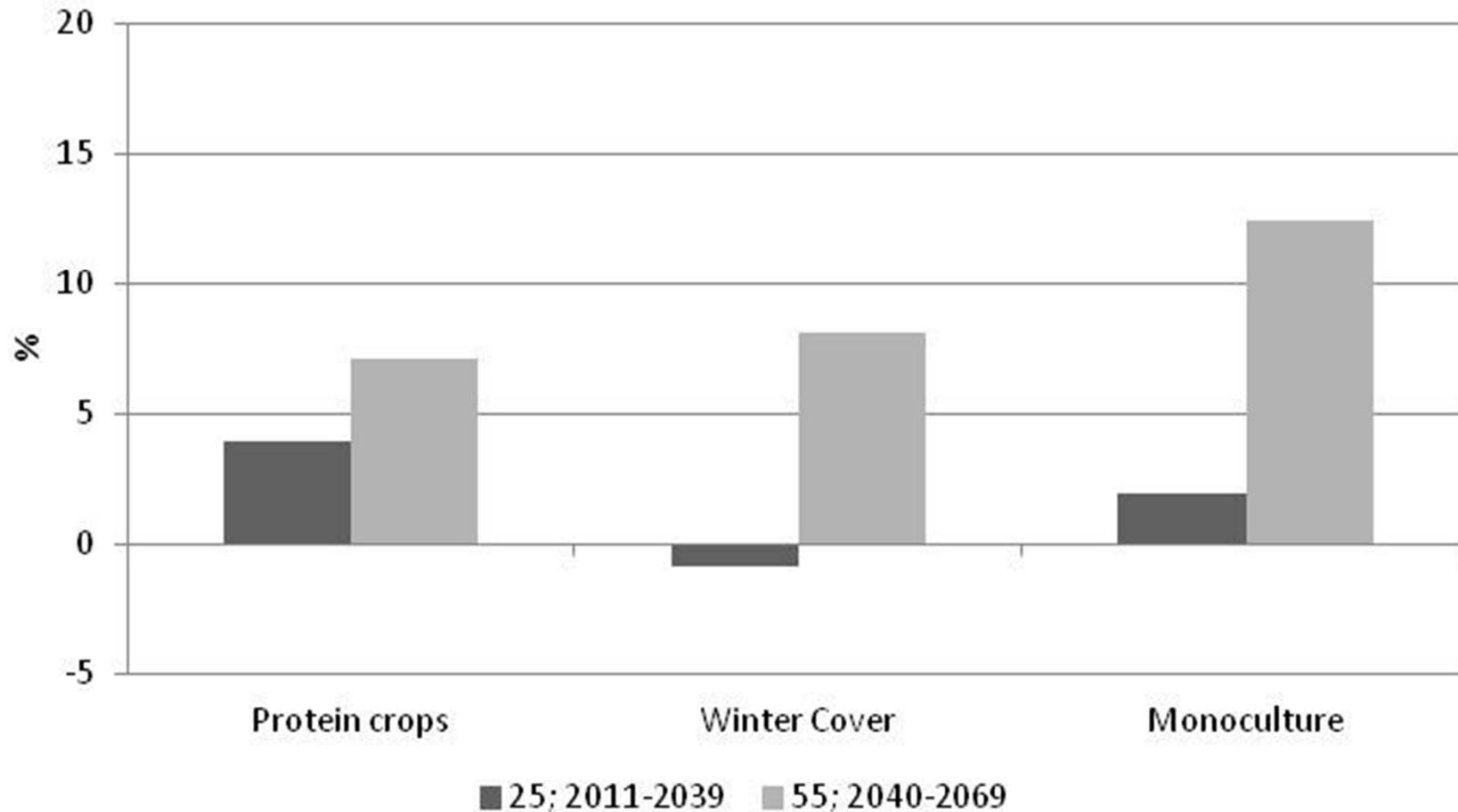
## Forest production: key results

- Results (medium change scenario)
  - Photosynthesis production of forests in south Finland will increase by ca 30%
  - Growth may increase up to 50% due to increasing soil decomposition and increase in availability of N
  - Extreme events will reduce the development of forest resources
- Recommendations for forestry
  - The rotation period maximizing yield may decrease to < 50 years for pine in southern Finland.
  - Growth of deciduous trees may increase even more
  - More emphasis has to be put on combating ground vegetation



(Nikinmaa et al.)

## Challenges for water protection efforts in the farming environment



4.11.2014

Simulated changes in suspended sediment transport in the Lepsämäenjoki LTER-area for three different storylines of future land use, compared to loads in baseline conditions (INCA-SED model)

(Forsius *et al.* 2013)

# Conclusions from VACCIA-project

- Climate change will have both positive and negative effects on key ecosystem services in Finnish conditions → results sector and scenario specific.
- Potentially benefitting: mainly provisioning services.
- Negatively impacted: endangered species, water quality, winter tourism.
- Adaptation measures needed even for potentially benefitting services.
- Adaptation measures mainly done at local/regional scale → need for high-resolution data.
- LTER-sites provide excellent platform for detailed studies on climate change impact and adaptation.

# The International Long Term Ecological Research (ILTER) network

- "Network of networks", i.e. global umbrella for regional and national LTER networks
- Incorporates also Long Term Socio-Ecological Research (LTSER)
- Located in wide array of ecosystems worldwide
- Contribute to solving international ecological and socio-economic problems, such as biodiversity loss, ecosystem degradation, climate change etc.



[www.ilternet.edu](http://www.ilternet.edu)

# Aims of ILTER based study

- 1) Study how the ILTER networks have contributed to understanding of linkages between climate change, biodiversity and ecosystem services.
- 2) Identify what kind of data is available, and what are the opportunities and gaps.
- 3) Highlight some findings for improving future ILTER network global-scale long-term integrative research.

Vihervaara, P. *et al.* 2013: Using long-term ecosystem service and biodiversity data to study the impacts and adaptation options in response to climate change: insights from the global ILTER sites network. *Current Opinion in Environmental Sustainability* 5:52-66



# Analysis of data

- 107 papers, 21 countries
- Classified features of the studies:
  - Country & year
  - Focus, type & output
  - Ecosystem type, ES type, cascade model stage
  - Relation to climate change
  - Spatial scale and disciplinary approach
  - Data type and time-frame

Country	Number of analysed articles
Brazil	5
China	1
Czech Republic	2
Finland	4
Germany	12
Hungary	1
Israel	4
Japan	21
Korea	1
Latvia	5
Malawi	1
Mexico	1
Mongolia	3
Romania	10
Slovakia	3
Slovenia	4
South Africa	1
Sweden	13
Thailand	2
United Kingdom	3
USA	8
Multinational	2

(Vihervaara *et al.* 2013)

# Highlights of the ILTER studies

- Long-term research forms the basis for detecting global ecosystem trends – “early warning system”.
- The ILTER network has access to unique global-scale datasets and results.
- ILTER provides views into impacts of climate change and other ecosystem changes on ecosystem services.
- ILTER focuses in particular in supporting and regulating services.
- Cooperation and data synthesis can integrate science into decision-making processes.

# Challenges, next steps

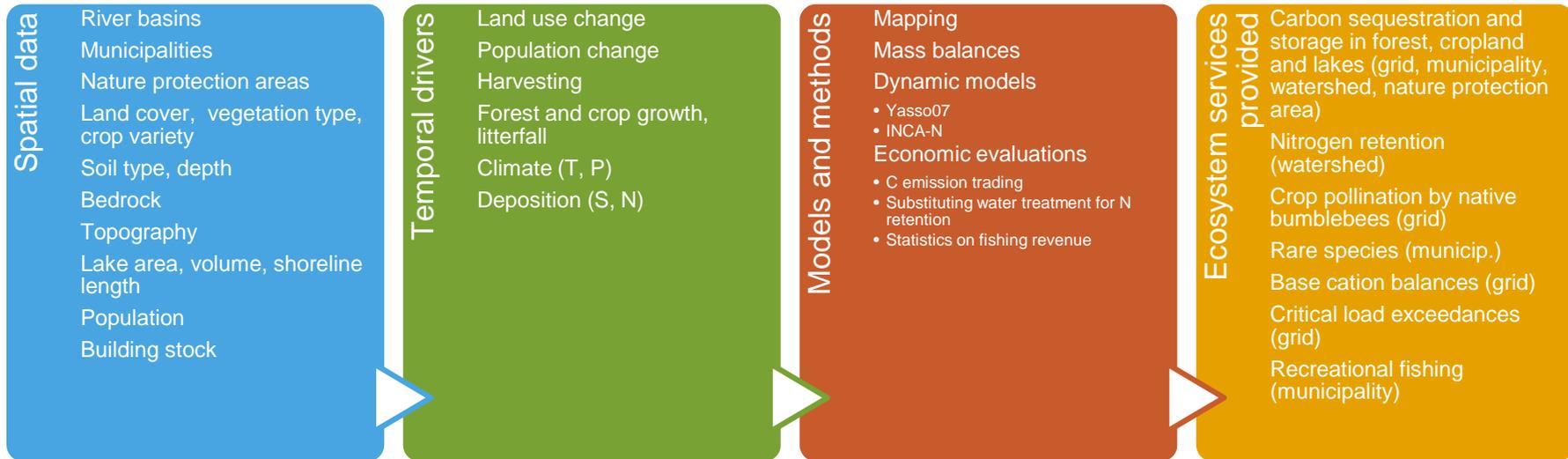
- Many studies were only local (site-based).
- The adoption of **standard methods** is critical to integrate ILTER research.
- **New forms of collaboration**, learning and coordination are needed across the ILTER network.
- The role of research–policy interface is increasing e.g. via IPBES, and global-scale ecosystem research networks are of great importance in supporting the way towards the solutions of future environmental challenges.
- **Modern infrastructures** for monitoring, Earth observation and ecosystem assessments, **open access databases**, and **virtual institutes for data analyses** are some examples in which the LTER networks can have a leading role.

(Vihervaara *et al.* 2013)

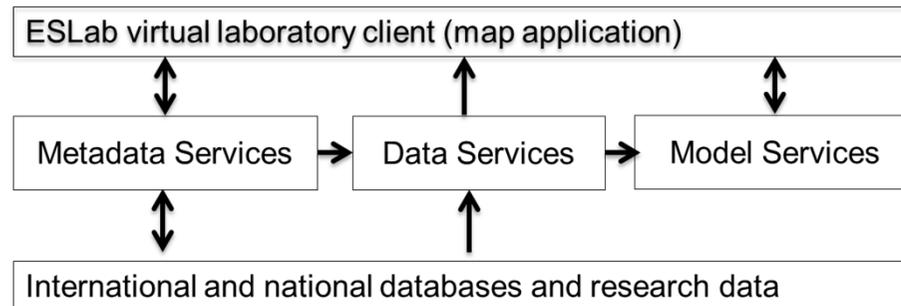
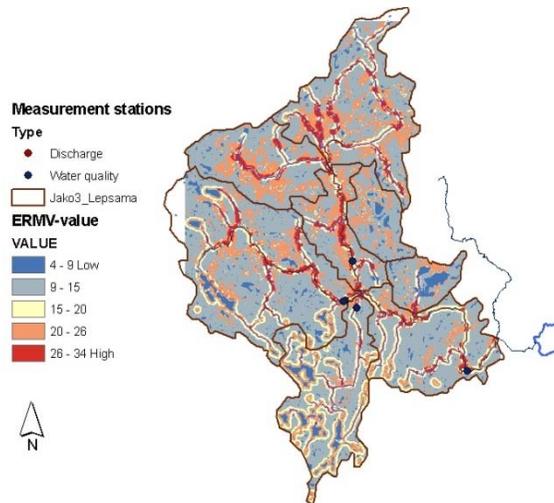
# Future perspectives regarding research on ecosystem processes/services

- Need to develop spatially explicit modelling systems for landscape-scale research
  - Quantitative data
  - Tradeoff analyses and valuation of ecosystem services
- Connection to remote sensing and large-scale modelling to enable up-scaling of results
  - Connection to GEOBON activities and Essential Biodiversity Variables (EBVs, Pereira *et al.* 2013, *Science* 339: 277-278).
  - Connection to Earth System modelling (e.g. LPJ-GUESS, JSBACH)
- Long-term vision: global-scale mechanistic general ecosystem models (GEM) (Harfoot *et al.* 2014, *PLoS Biol* 12(4))

# On-going work: development of spatial ecosystem service modelling system



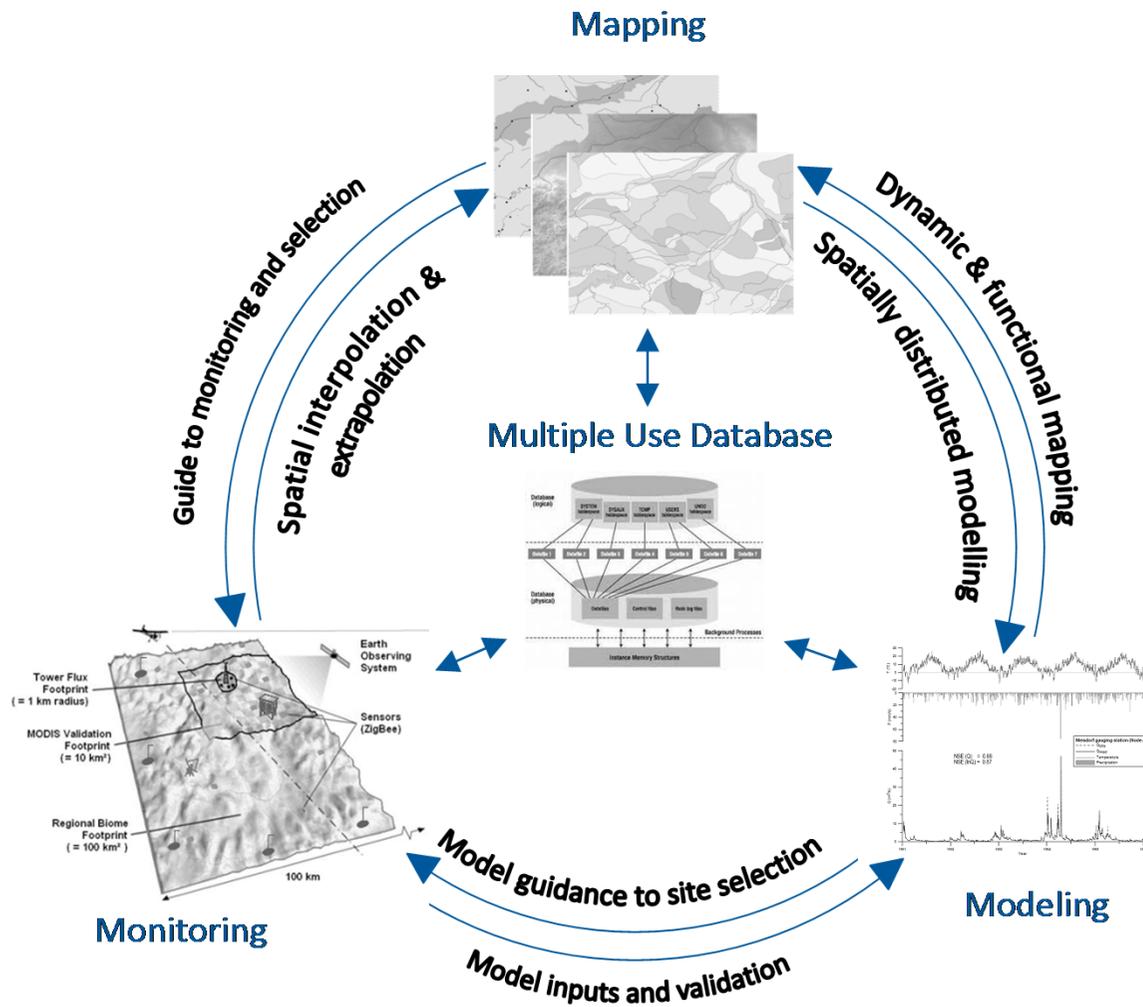
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(Holmberg *et al.* 2014, submitted)

# 4M Approach

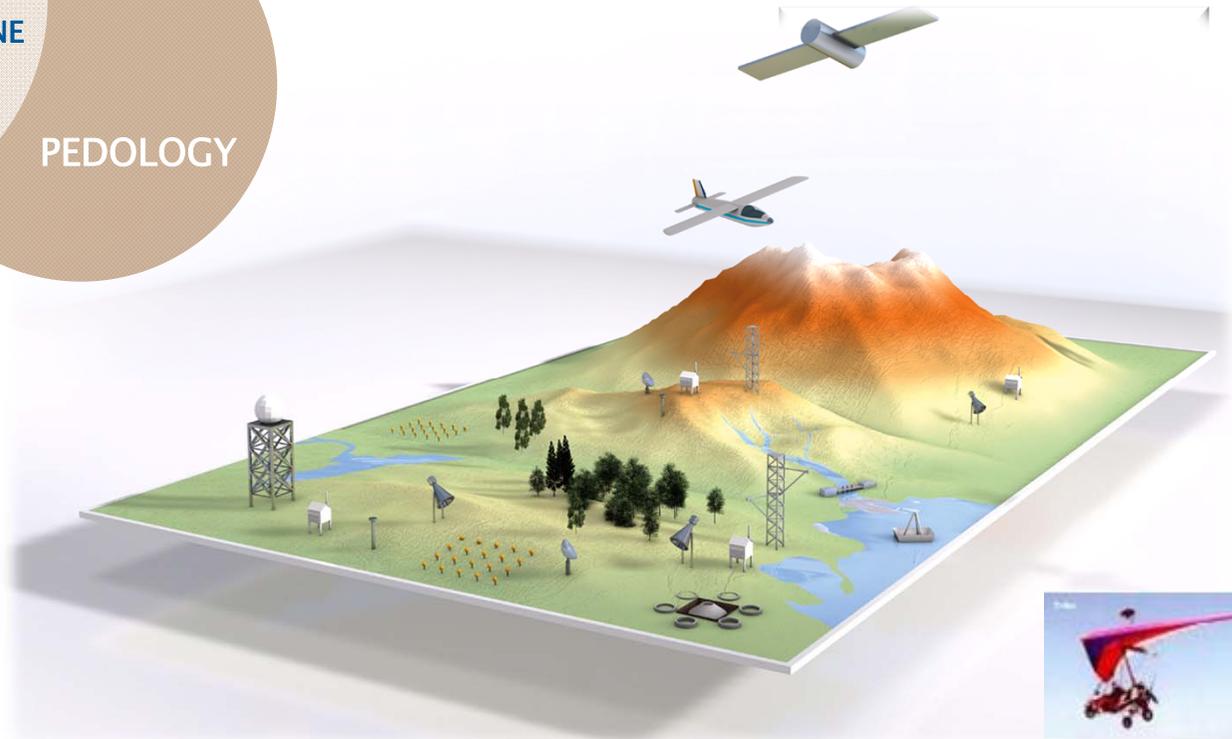
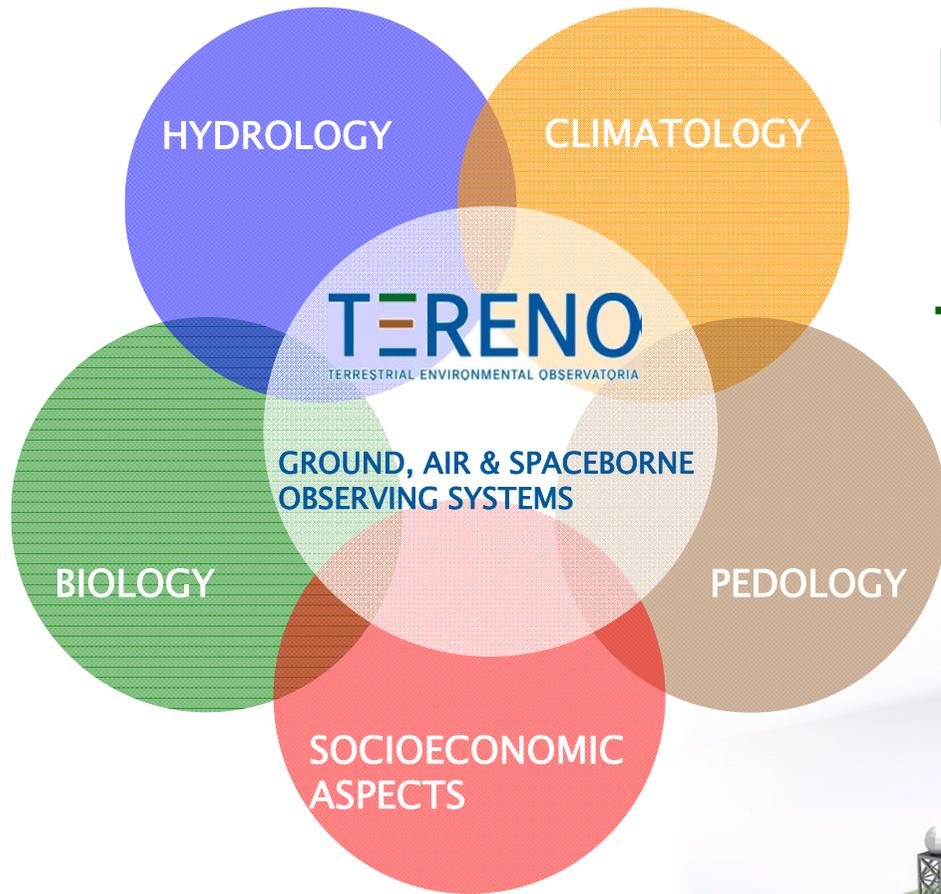
## Monitoring-Mapping-Modeling-Multiple Use Database



*Integrative loop of mapping, monitoring, modeling, and data mining as an integrated and evolutionary approach to address the complexity and dynamics of the terrestrial system across scales (modified and extended 3M approach from Lin, 2010,)*

*(Zacharias et al.)*

# Future vision: European network of TERENO-type sites



A scenic view of a river flowing through a forest. The river is in the foreground, with several large rocks in the water. The banks are lined with tall grasses and shrubs. The forest is dense with trees, many of which have turned vibrant orange and yellow, indicating autumn. The sky is a clear, pale blue.

**Thank you!**

**[www.syke.fi/projects/fter](http://www.syke.fi/projects/fter)**

**[www.syke.fi/projects/vaccia](http://www.syke.fi/projects/vaccia)**

**[www.syke.fi/projects/climes](http://www.syke.fi/projects/climes)**