Ex-ante identification of policy interventions to secure a functioning ecological infrastructure: A participatory Bayesian Network approach in Switzerland.

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PLUS
PLANNING OF LANDSCAPE AND URBAN SYSTEMS

ValPar.CH

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Research context: ValPar.CH

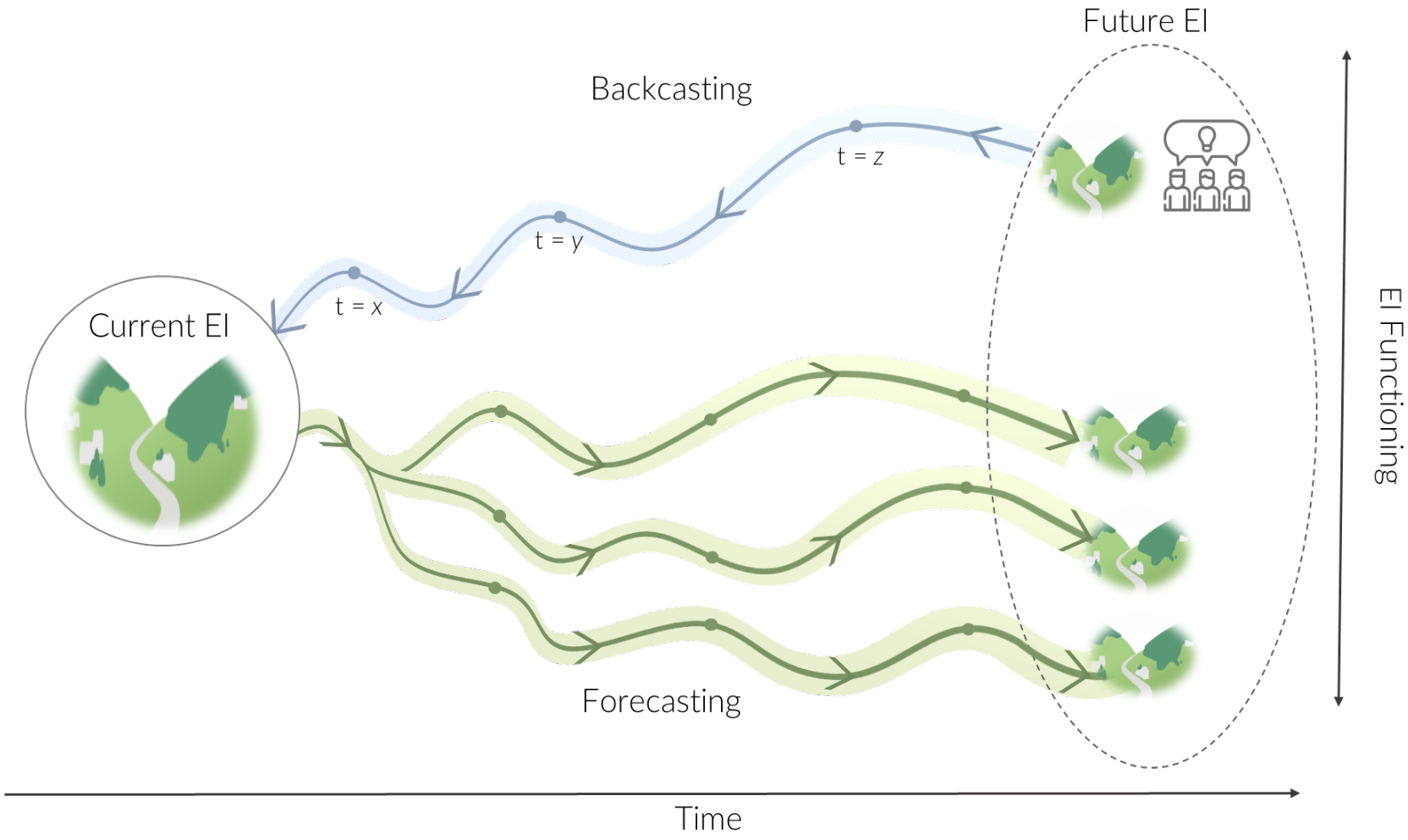
Goal: Assess the added value of a functioning Ecological Infrastructure for Switzerland.

Definition: “Ecological Infrastructure (EI) refers to the natural or semi-natural structural elements of ecosystems and landscapes that are important for the provision of ecosystem services." (IPBES 2021)

Modelling EI: Pathways

Aim: Develop a model to identify resilient and sustainable EI development pathways to ensure a functioning EI for Switzerland in 2040 and 2060.

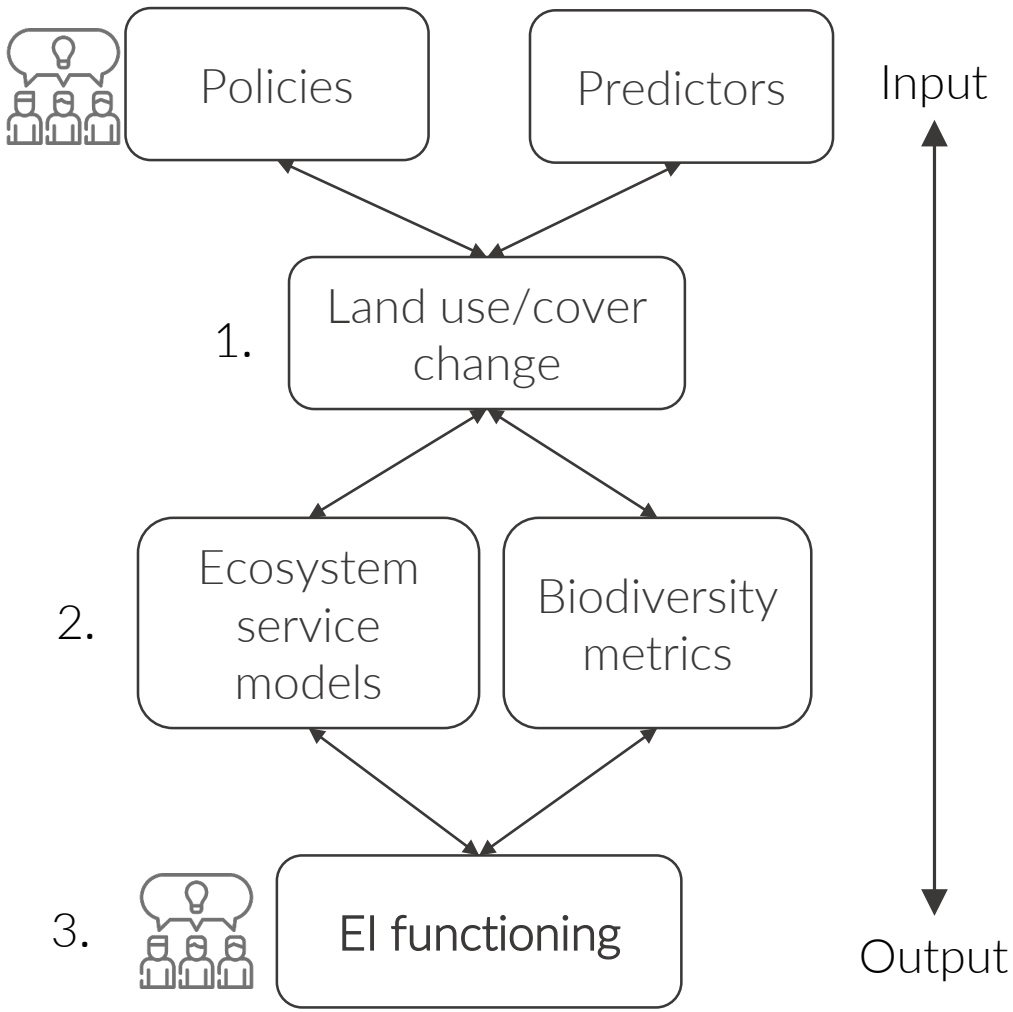
Caveat: Definition of functioning EI subjective upon stakeholders weighting of the importance of EI measures i.e. ecosystem services and biodiversity:

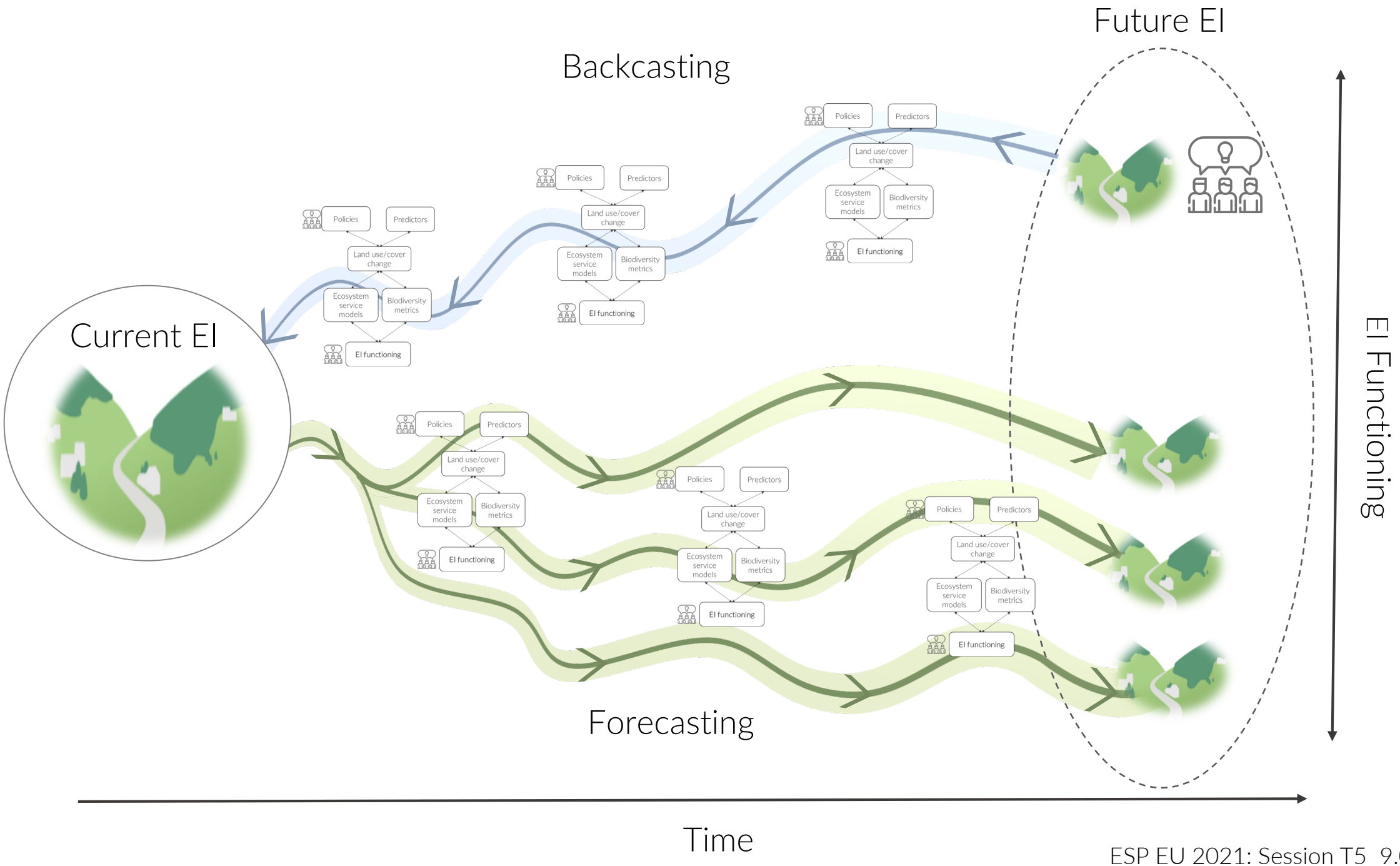


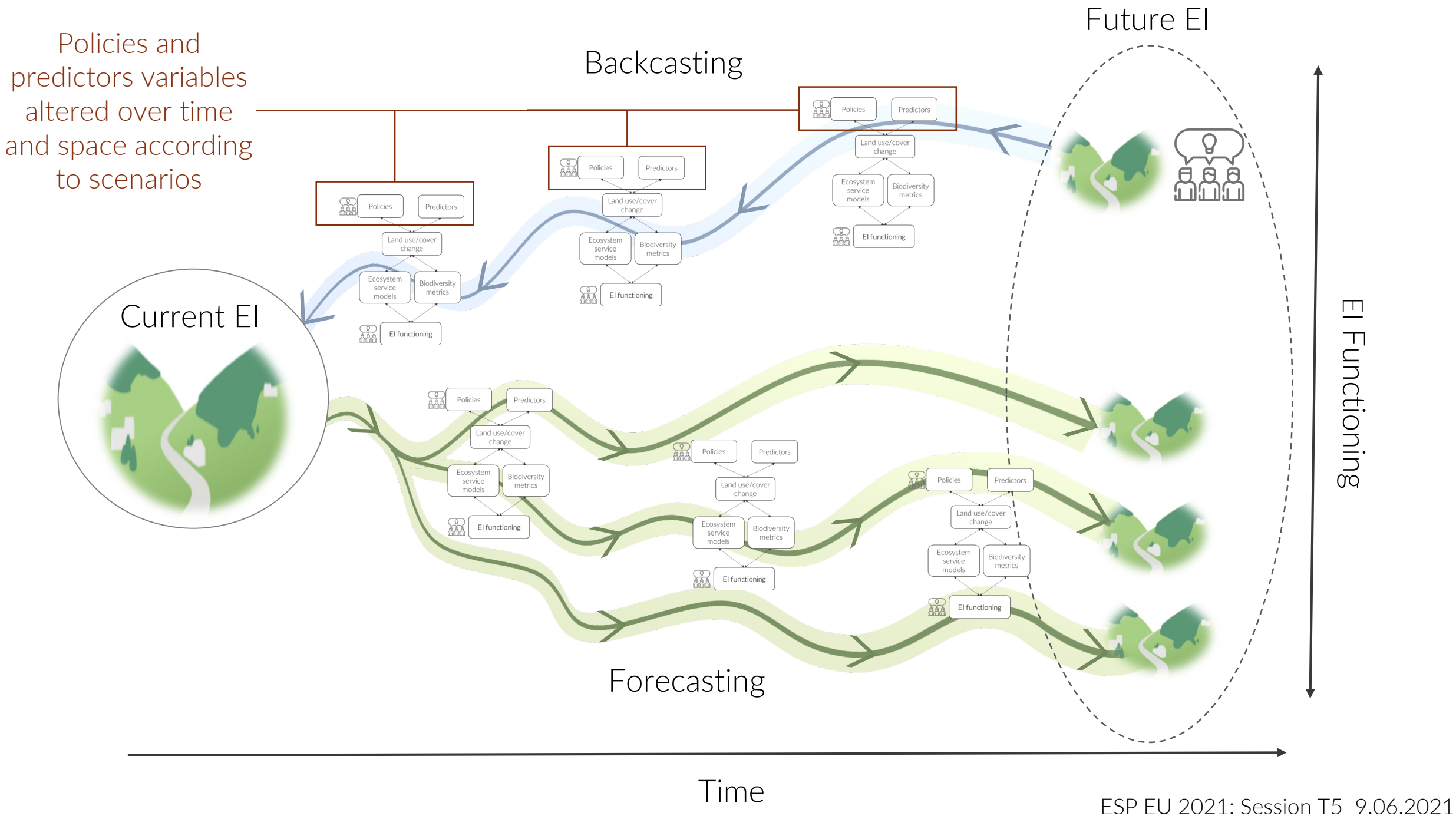
Modelling EI: Quantification

Modelling EI at the landscape level requires a framework of several components:

- Simulation of LULCC through policies and biophysical/socioeconomic predictors (Hewitt et al. 2017)
- LULCC as a predictor in models of ecosystem services (ES) and Biodiversity
- Stakeholder weighting of ES and Biodiversity metrics into a measure EI 'functionality'




Future EI
Backcasting
Current EI
Policies
Predictors
Land use/cover change
Ecosystem service models
Biodiversity metrics
EI functioning
Forecasting
EI Functioning
Time


Policies and predictors variables altered over time and space according to scenarios
Backcasting
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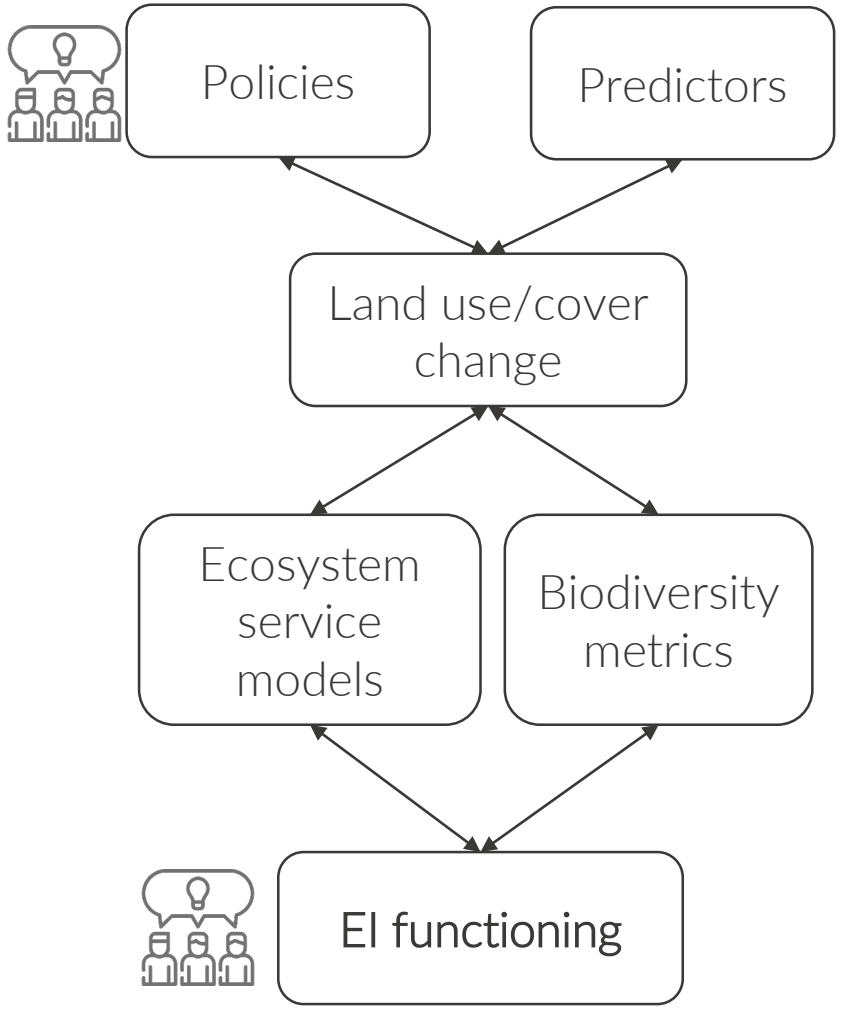
Time

Modelling EI: Quantification

- Dynamic, spatially explicit, Bayesian Network (BN)
- BN = Directed Acyclical Graph: Variables represented by nodes linked by arcs representing casual relationships.
- Relationships defined by user: Can incorporate numerical or categorical data, Empirical models and Expert elicited information
- Propagation occurs via Bayes theorem.



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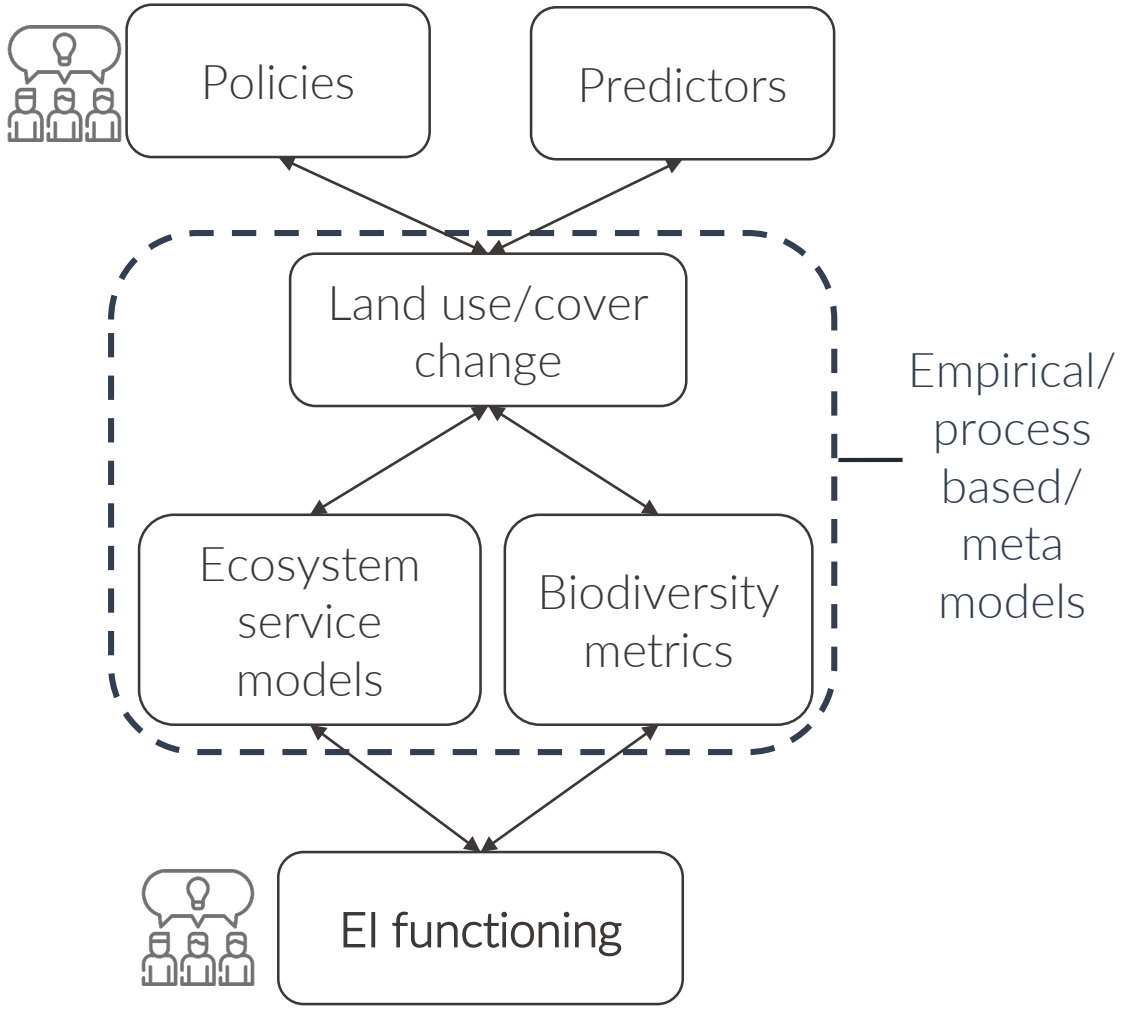

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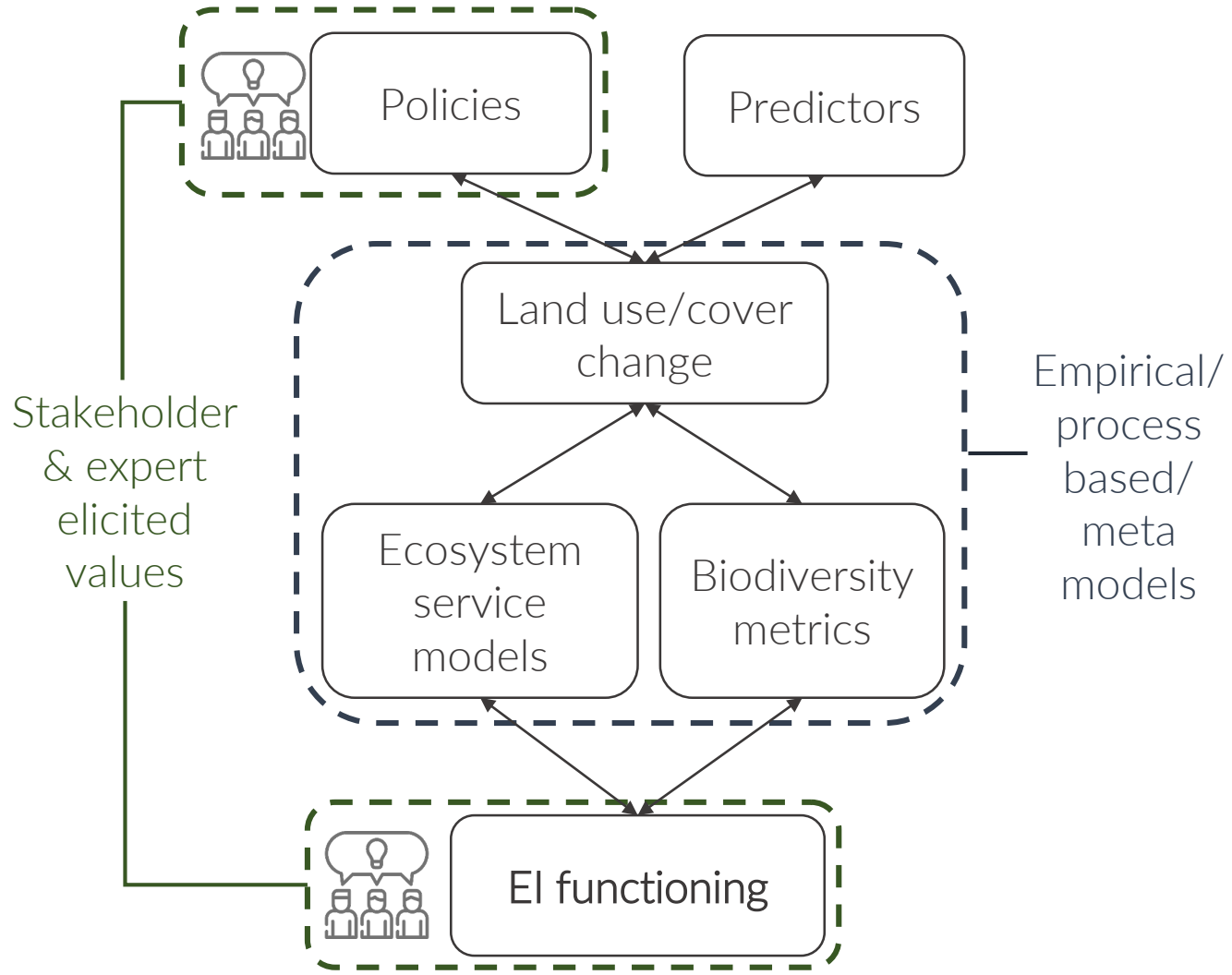
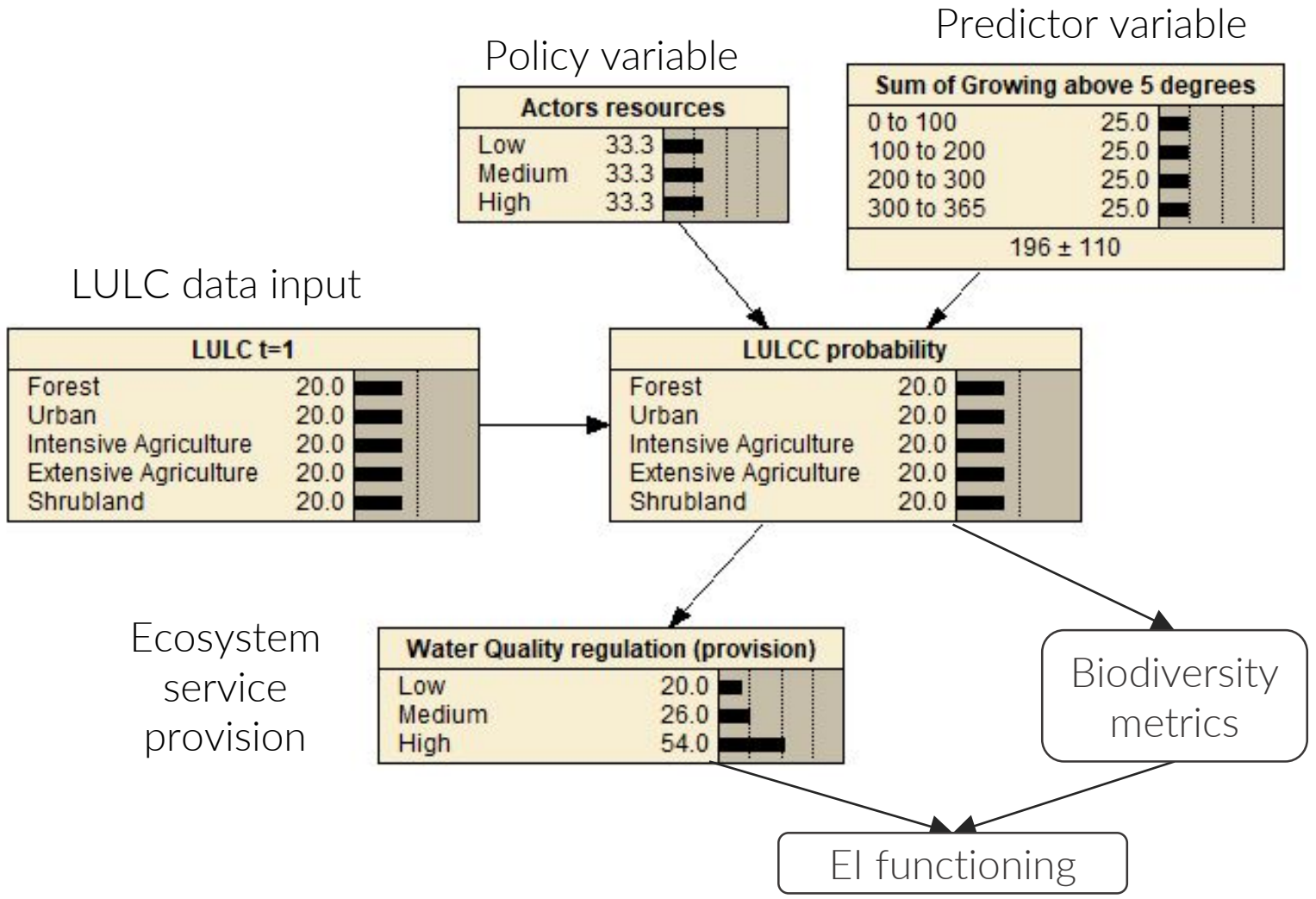


Bayesian Networks: Propagation

No data (evidence) added:

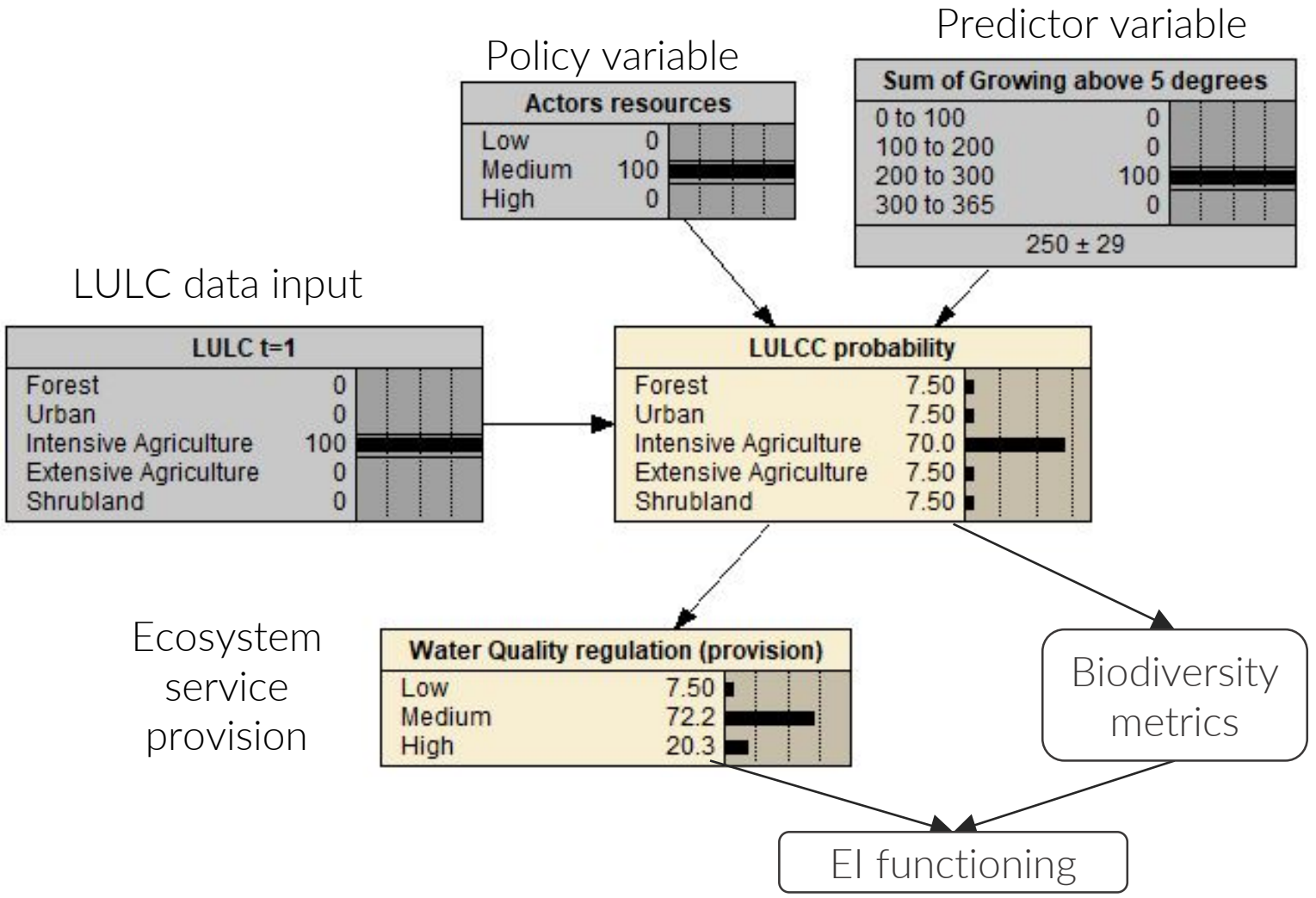
- Input nodes display a uniform probability across states.
- Output nodes display probabilities in accordance with the relationships specified in the arcs.



Bayesian Networks: Propagation

Forward propagation:

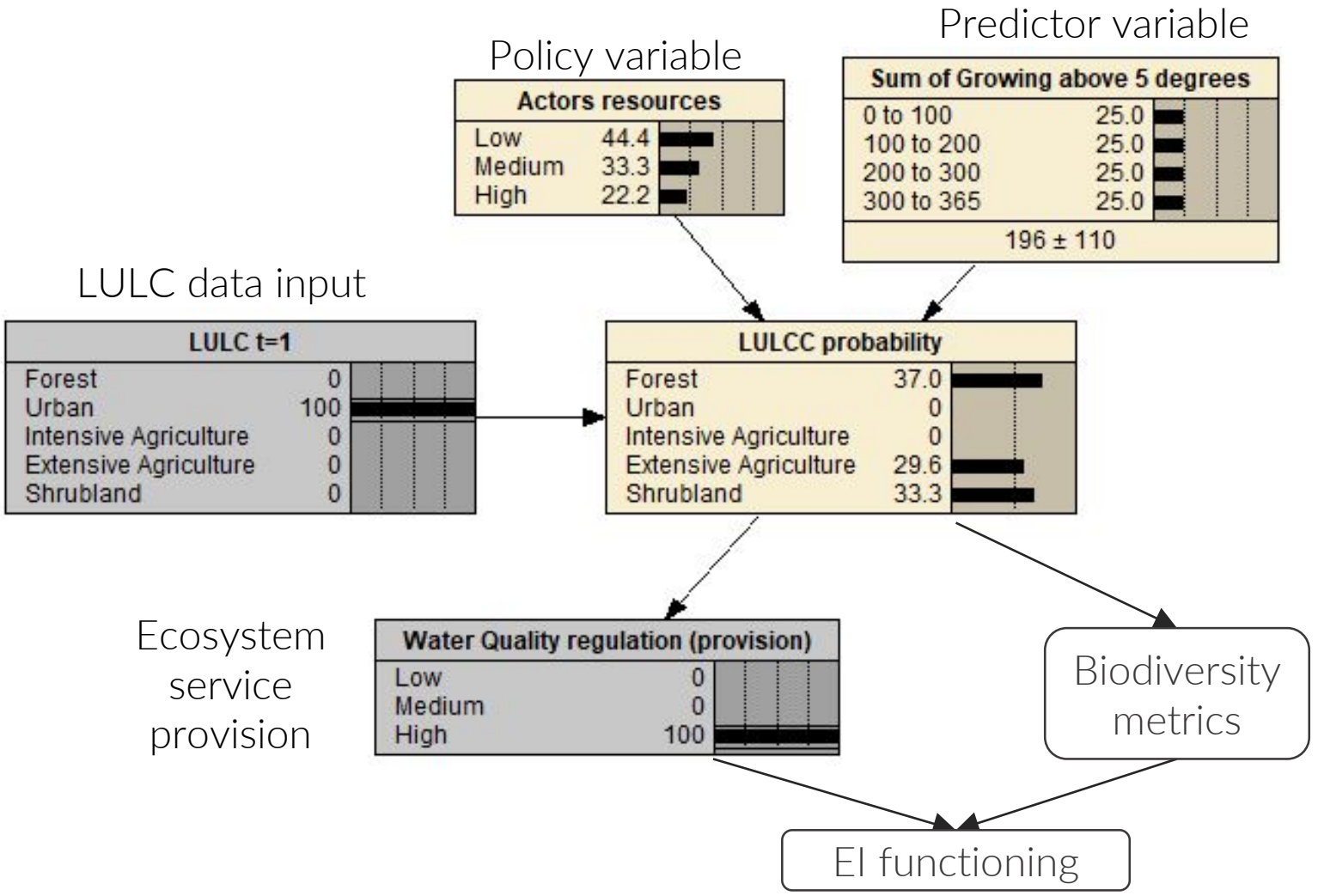
- **Input data added**: Effect is propagated 'forward' to determine state values in the outputs.
- **Forecasting**: Alter input data to represent scenarios of socio-economic and climatic change and observe impact on EI functioning



Bayesian Networks: Propagation

Backwards propagation:

- Instantiating values in output nodes: Effect is propagated 'backwards' to input nodes.
- Backcasting: Instantiate qualities of functioning EI according to stakeholders visions to understand nature/timing of policy interventions needed to achieve them.



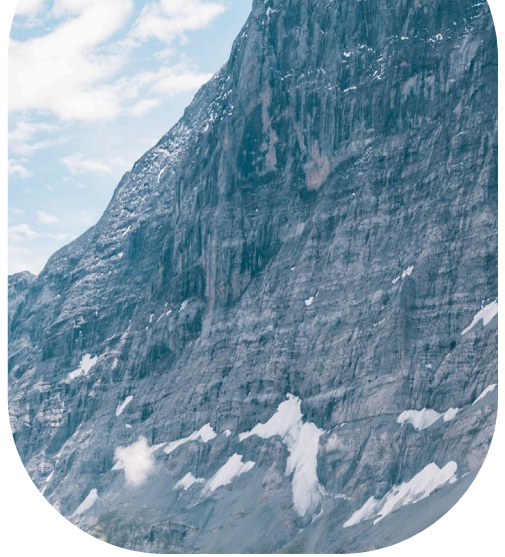
Contributions of research

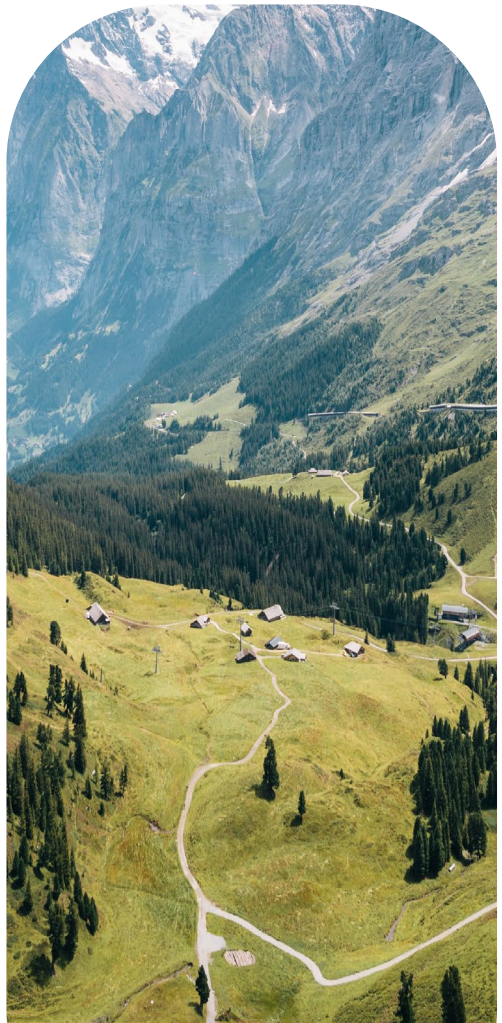
Scientific

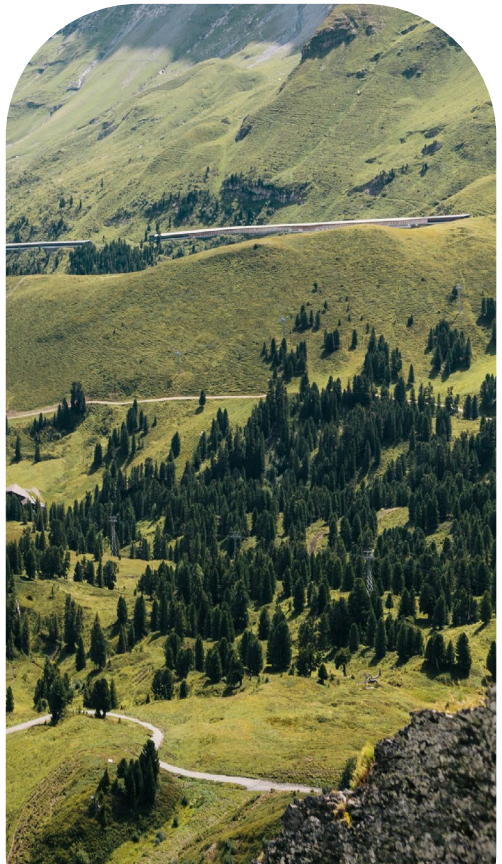
- Operationalization of a definition of functioning EI within a holistic modelling framework (outcomes of biodiversity and ES provision).
- Participatory backcasting as a means of ensuring that model output is relevant and understood by stakeholders.

Applied

- Recommendations for decision makers of robust strategies, inclusive of risk, to secure the long term functioning of EI in Switzerland
- Participation of stakeholders to boost confidence and engagement in institutions and policies responsible for managing EI.







Thank you for listening.

For more information on the ValPar.CH project:
https://valpar.ch/index_de.php

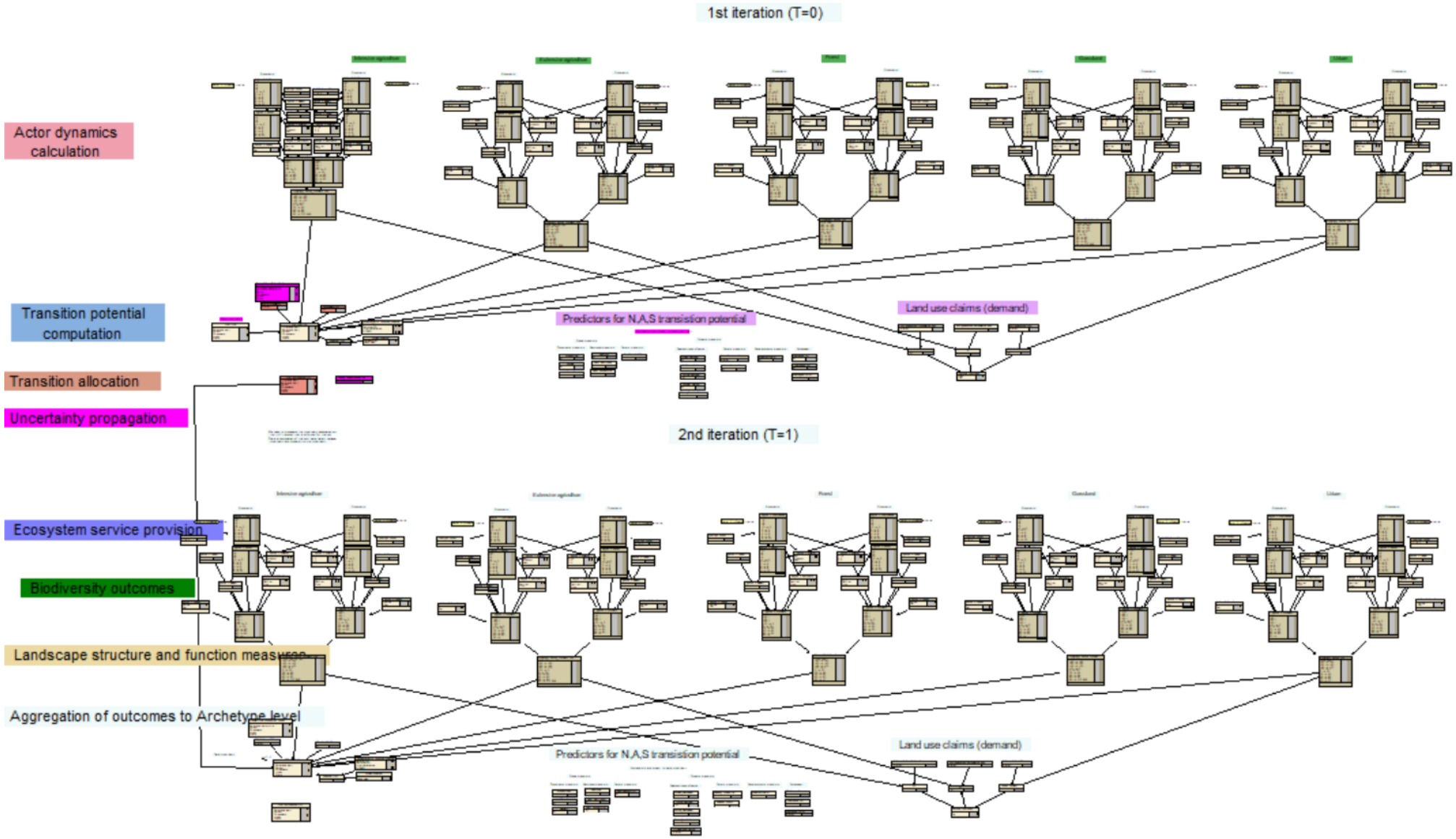
Our research in ETH PLUS:
https://plus.ethz.ch/

Bibliography

Hewitt, R. J. 2018. 'A Short Presentation of the Actor, Policy, and Land Use Simulator (APoLUS)'. In *Geomatic Approaches for Modeling Land Change Scenarios*, edited by María Teresa Camacho Olmedo, Martin Paegelow, Jean-François Mas, and Francisco Escobar, 475–80. Lecture Notes in Geoinformation and Cartography. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-60801-3_32.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2021. Glossary: Ecological Infrastructure. URL: https://ipbes.net/glossary/ecological-infrastructure.

Modelling EI: full model



Modelling EI: Ecosystem services

Service category	IPBES Designation
Regulation	Habitat creation and maintenance
Regulation	Pollination and dispersal of seeds
Regulation	Regulation of air quality
Regulation	Regulation of climate
Regulation	Regulation of freshwater quantity, location and timing
Regulation	Regulation of freshwater quality
Regulation	Formation, protection and decontamination of soils
Regulation	Regulation of hazards and extreme events
Regulation	Regulation of organisms detrimental to humans
Material	Energy
Material	Food and feed
Material	Materials and assistance
Material	Medicinal, biochemical and genetic ressources
Non-Material	Learning and inspiration
Non-Material	Physical and psychological experiences
Non-Material	Supporting identities

Modelling EI: Predictors

Biophysical	Soil pH
Biophysical	Soil nutrients
Biophysical	Soil moisture
Biophysical	Soil moisture variability
Biophysical	Soil aeration
Biophysical	Soil humus
Socio-economic	Human population density
Socio-economic	Change in average population per municipality
Socio-economic	No. of employees in primary sector per municipality
Socio-economic	No. of employees in the secondary and tertiary sectors (combined) per municipality
Socio-economic	Change in no. of employees in primary sector per municipality
Socio-economic	Change in no. of employees in the secondary and tertiary sectors (combined) per municipality
Socio-economic	No. of full time equivalent employees in primary sector
Topography	DEM
Topography	ASPECT
Topography	SLOPE
Topography	HILLSHADE
Topography	Light
Transport	noise pollution index
Transport	Public transport accessibility (quality classes)
Transport	Public transport accessibility (quality classes) fro 2013
Transport	distance to roads
Hydrological features	Distance to lakes (mean dist to all lakes of different categories)
Hydrological features	Distance to river (mean distance (agg. From 25m data to rivers of all Strahler classes)
Climatic	Continentality
Climatic	Annual mean temperature for 1985 period (Bioclim: bio1: Averaged over: 1981-1990)
Climatic	Average annual precipitation for 1985 period (Bioclim: bio12: Averaged over: 1981-1990)
Climatic	Sum of growing days above 0 degrees for 1985 period (Bioclim: gdd0 : Averaged over: 1981-1990)
Climatic	Sum of growing days above 3 degrees for 1985 period (Bioclim: gdd3 : Averaged over: 1981-1990)
Climatic	Sum of growing days above 5 degrees for 1985 period (Bioclim: gdd5 : Averaged over: 1981-1990)