International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

science for global insight

Systems Dynamics for Wicked Problems

Elena Rovenskaya
Program Director
Advanced Systems Analysis (ASA) Program
IIASA, Laxenburg, Austria

Arctic Synthesis Workshop, 17-19 April 2017
ARCUS, Washington DC

Social policy planning is a wicked problem

- Current policy making is based on government structure, silo mentality, nexus solutions needed
- No quantitative data available, or part of data missing
- Trial-and-error approach not applicable, validation not possible
- A “good” solution needed, not a right one
- Multiple good solutions possible

Sustainable development of the Arctic: a “**wicked++ problem**”?

Can models be useful to address wicked problems?

- A model can be useful if it is
  - Fully understandable
  - Trustable
  - Operates with relevant notions
  - Interactive
  - "(Co-)Owned" by users
  - Serve **sense-mak**ing and/or **decision-making**?

Can models be useful to address wicked problems?

- Co-design of a model together with stakeholders
  - Utilize expert knowledge
  - Many experts with diverse cognitive frameworks
  - Trust
- Limited time of interaction - how to make most out of it?
  - Visual images
  - Interactive/participatory process
  - On-line tools
- Results are needed very soon
  - Questions are not clearly formulated and evolve largely during the project
  - No time to develop a detailed and well-grounded model

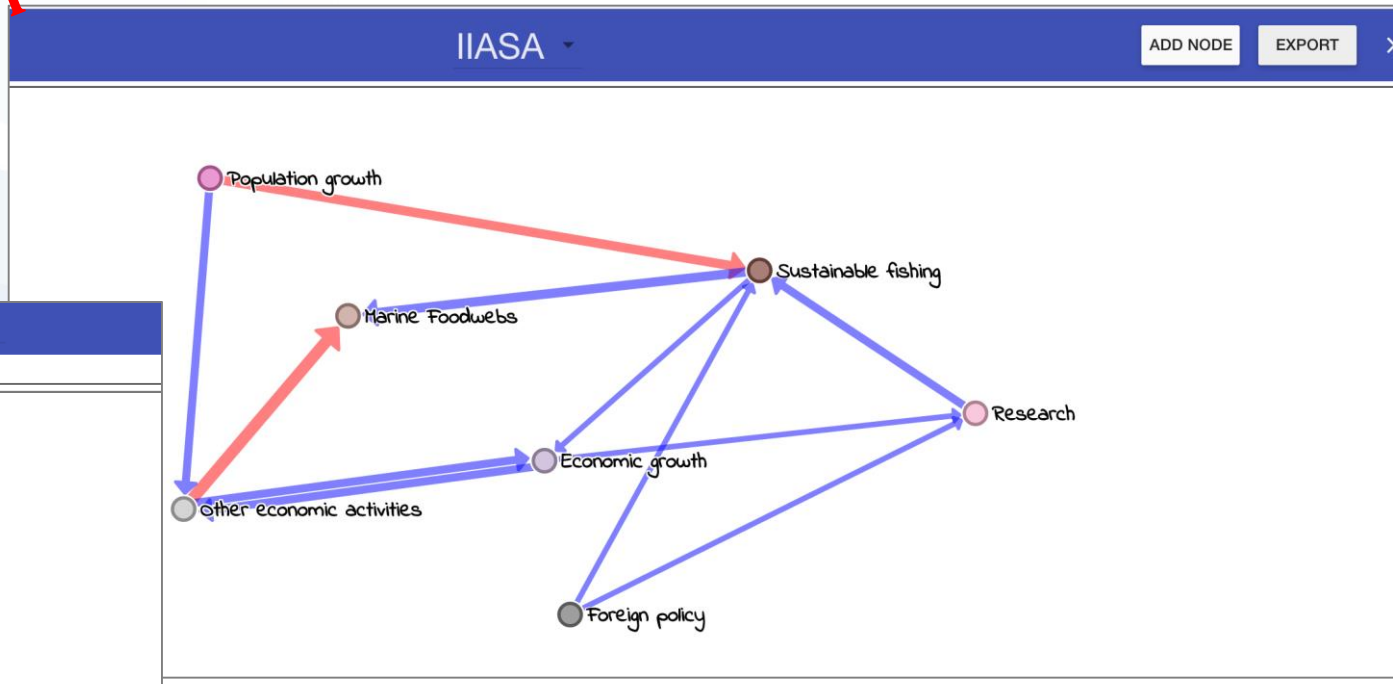
ASA/IIASA's experience

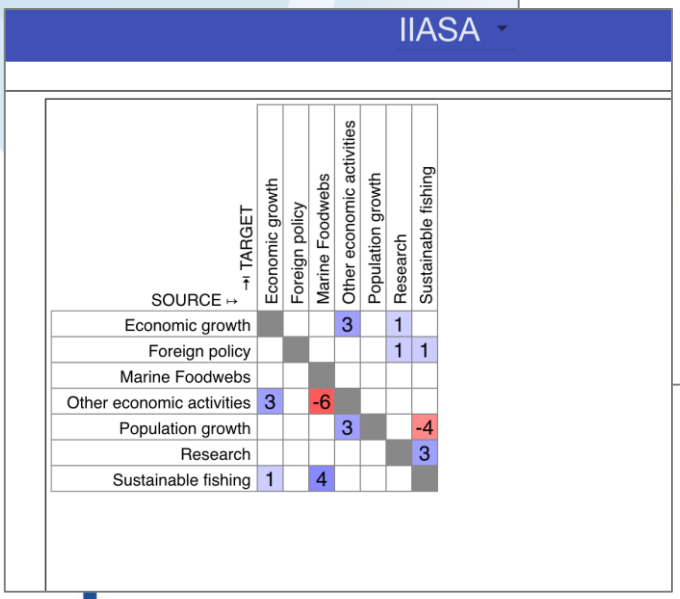
- Based on several projects with the Finnish government
- Different topics from regional economic growth to refugee problem
- Used "system maps" and system dynamics (SD)
- Lessons learned:
  - Systems thinking is often missing
  - Policy experts and policy makers find the approach enlightening
  - SD seems to be an appropriate methodology to analyze systems maps quantitatively
  - Variables to be used must go beyond clearly defined and measurable entities (!)

Step 1: System map

- Interactive tool combining a graph and a matrix representation:
  - First decide on nodes (variables)
  - Then assign links and their strengths

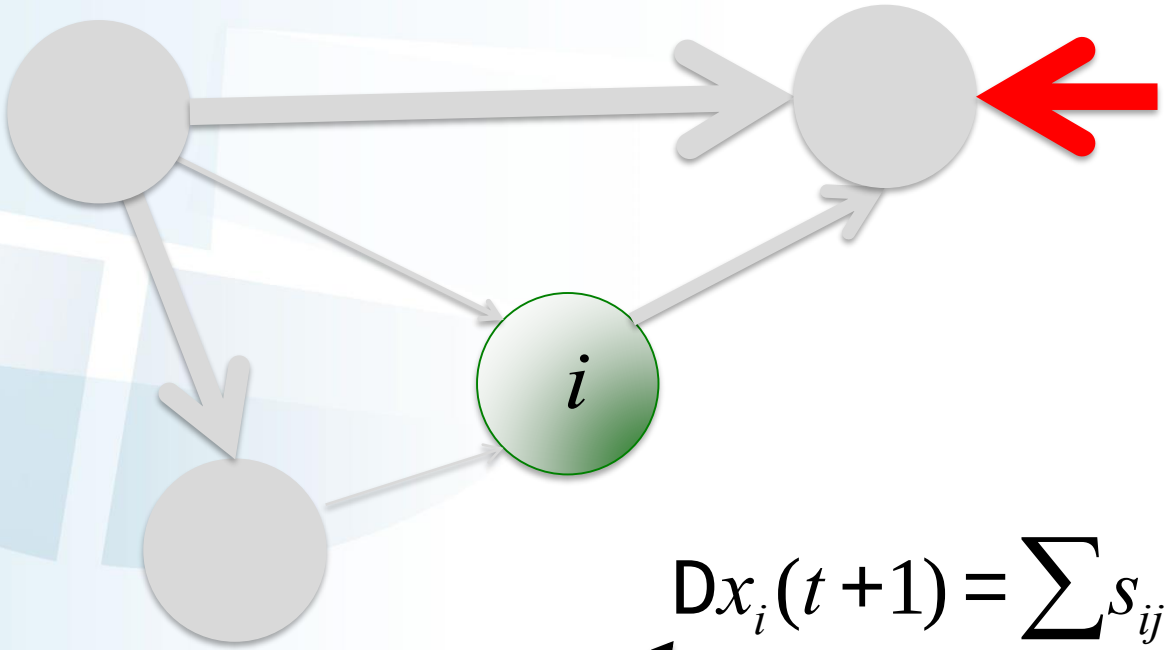
The choice depends on the research question!





Step 2: System dynamics

- Models interactions between variables based on the link strengths



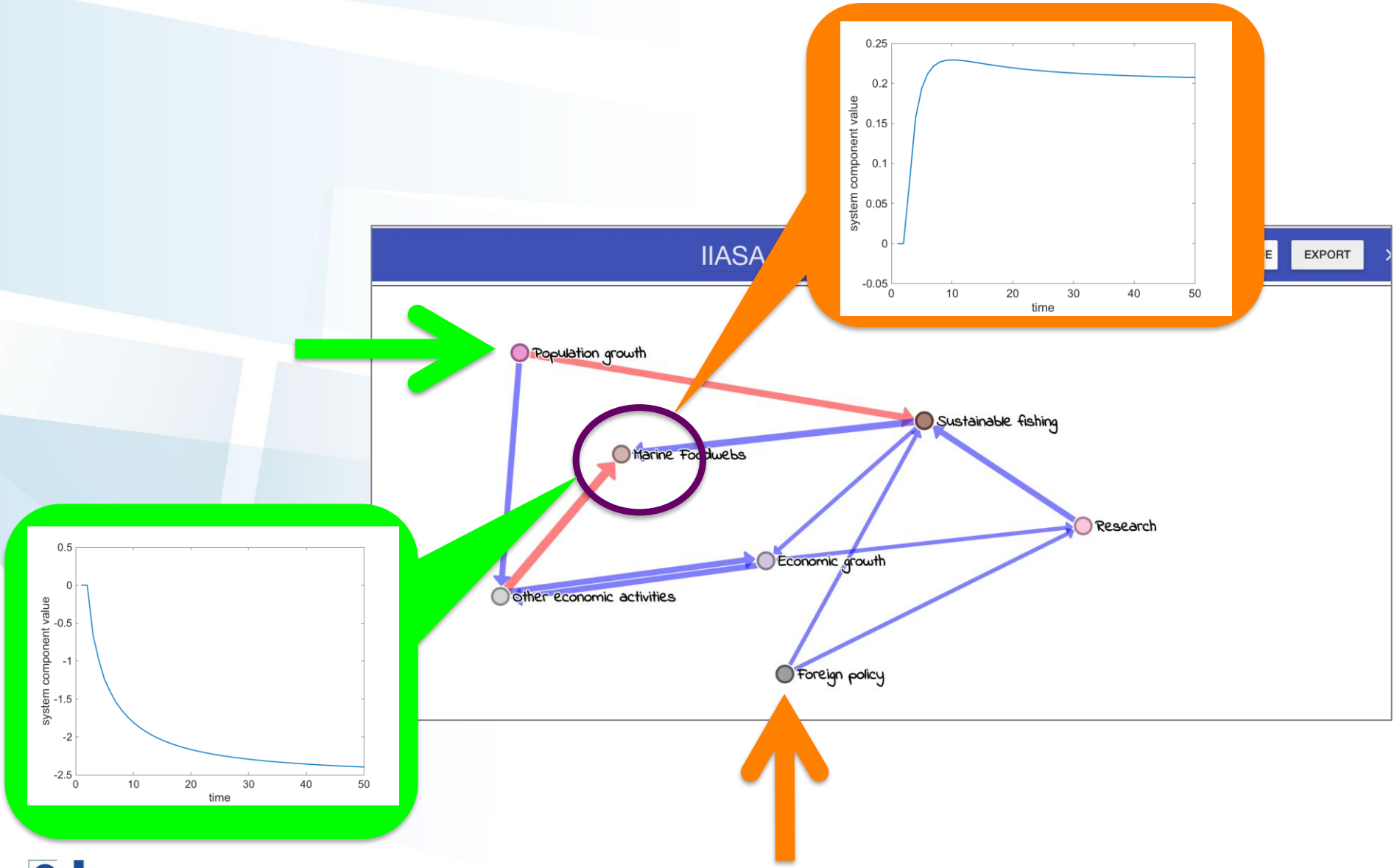
$$\Delta x_i(t+1) = \sum_j s_{ij} \Delta x_j(t) + u_i(t)$$

Change in the node's state

Link strengths

Policy intervention

Simulations: Example to illustrate



Issues, challenges and some ideas how to move forward

- **Multiplicity of experts, plurality of views – how to account? F(E[x])≠E[F(x)]!**
  - Processing individual system maps
- **How to choose experts for a participatory exercise, dependence of the results on the particular choice**
  - Studying robustness
- **Error detection, outlier removal, need to distinguish between different views and errors**
  - Crowd sourcing?
- **Definitions, variable units and link strengths**
  - Define variables as clearly as possible, units can be qualitative "scores" describing the state of a node, link strength matter only in relative terms
- **Interpretation of results**
  - Mostly comparative, numbers are not important, but trends are

Questions? Comments? Ideas?

Contact: Elena Rovenskaya
rovenska@iiasa.ac.at