Telecoupling Toolbox: Integrated Tools for Sustainability Science

February 26th, 2019

Webinar series
Telecoupling: A New Frontier for Global Sustainability

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Telecoupling: A New Frontier for Global Sustainability

- February 19th, 2019: Telecoupling 101: Concepts, Terminology, and Published Case Studies

- **February 26th, 2019: Telecoupling Toolbox: Integrated Tools for Sustainability Science**

- **March 12th, 2019: Telecoupling GeoApp: Cloud-based Platform Overview and Widgets**

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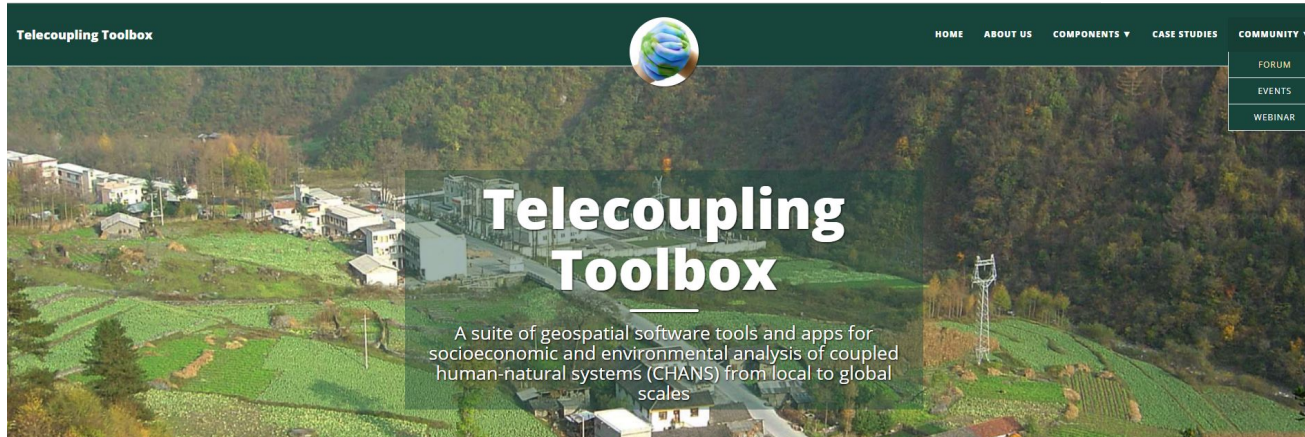
WEBINAR REGISTRATION AVAILABLE @

https://telecouplingtoolbox.org/webinar

POLL 1

Online Presence

- **http://csis.msu.edu/telecoupling**

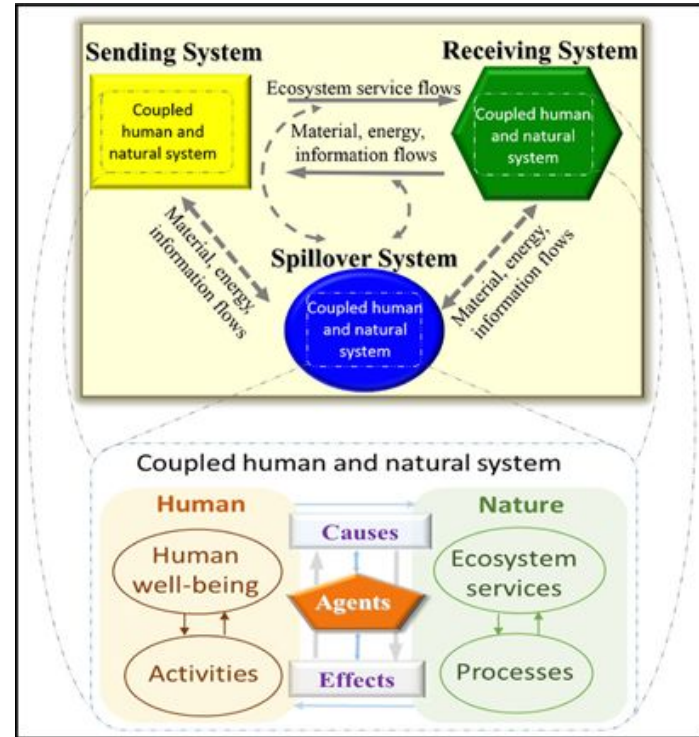- **https://telecouplingtoolbox.org/**

OPEN
COMMUNITY
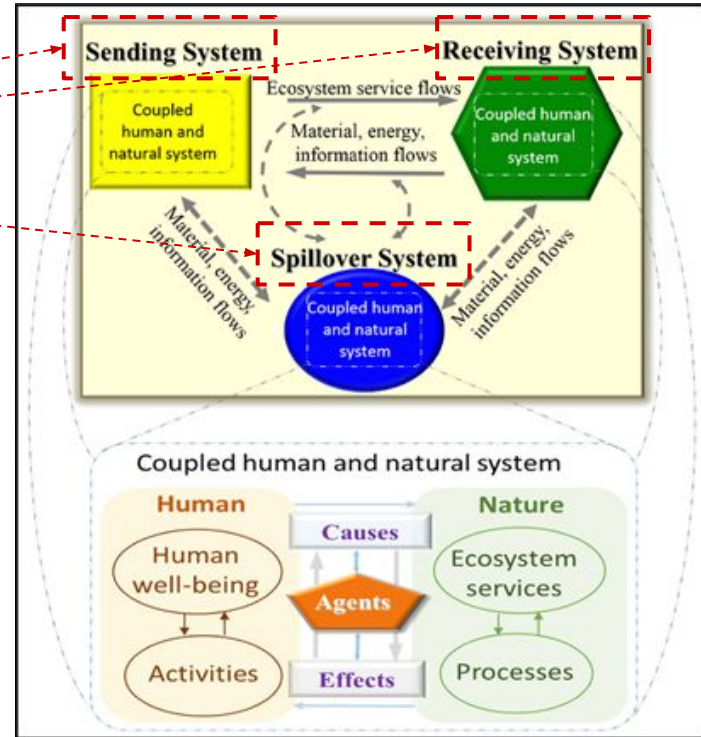FORUM

Telecoupling Framework (quick recap)

- Systems
- Flows
- Agents
- Causes
- Effects
  (environmental / socioeconomic)

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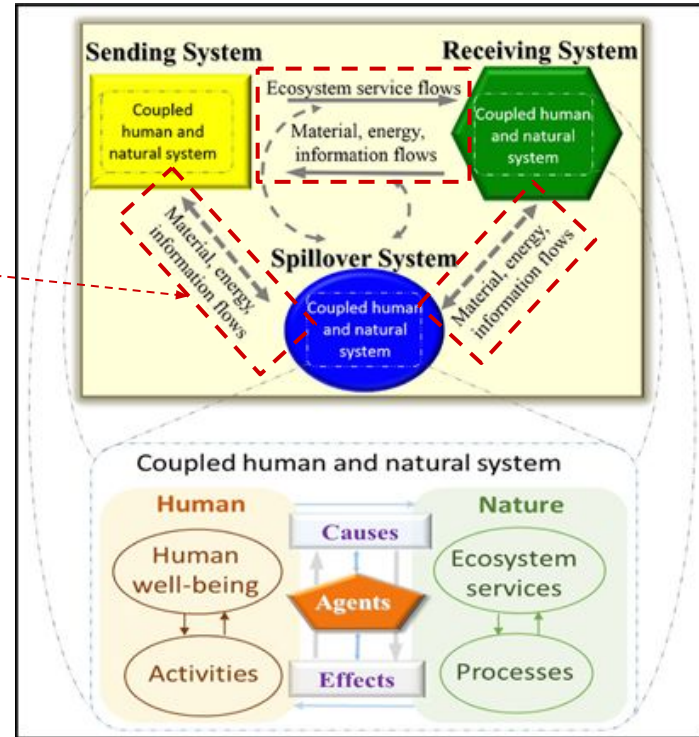# *Telecoupling Framework (quick recap)*

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- Causes
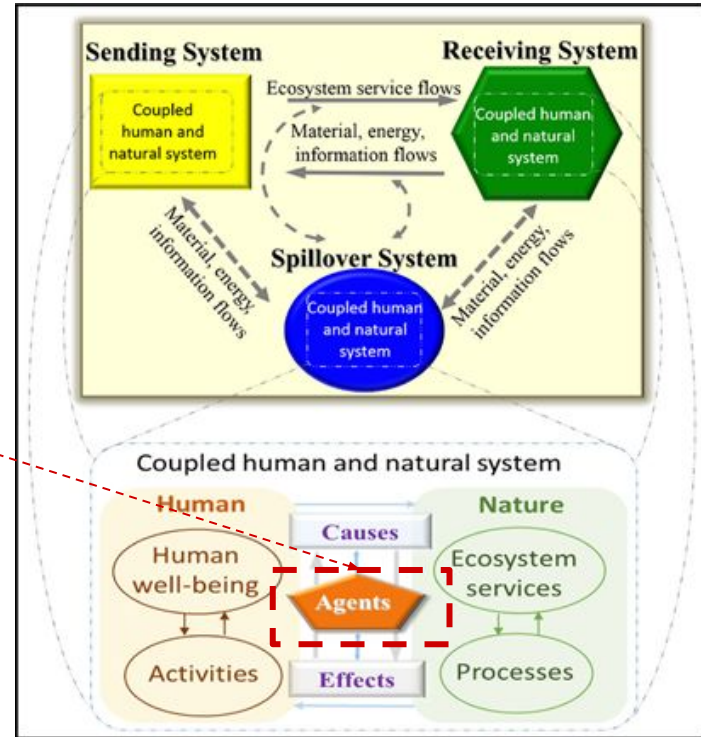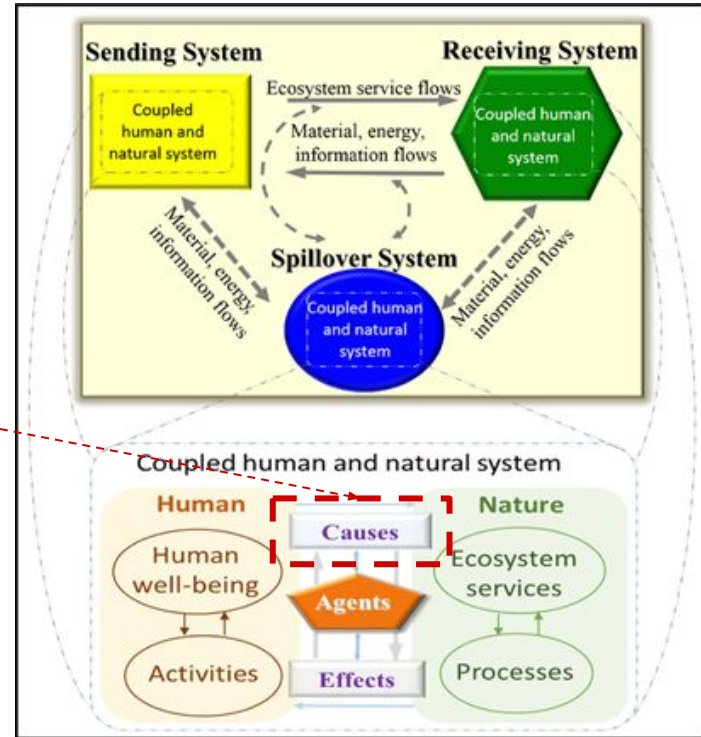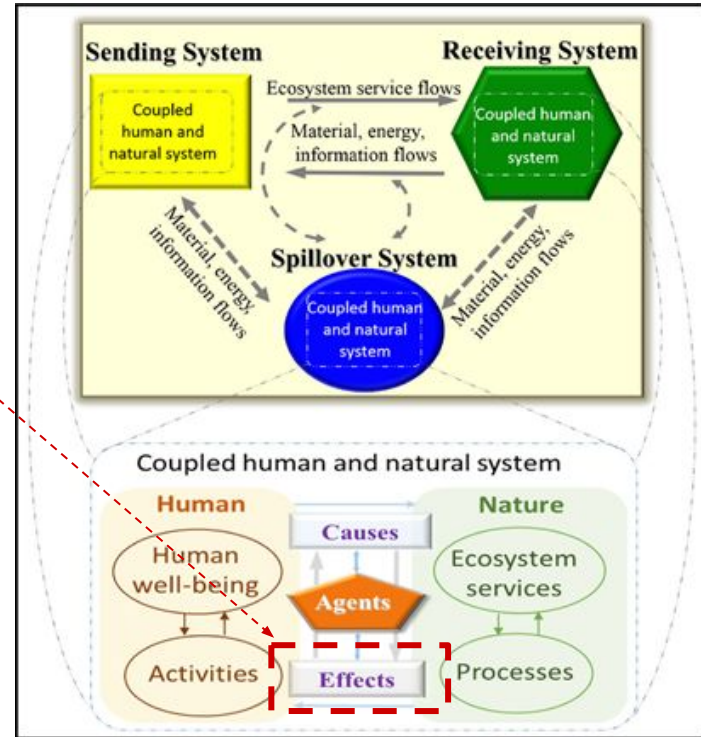- **Effects
(environmental / socioeconomic)**

Multi-level Approach

"*Part of the problem is that we have studied these phenomena in separate boxes to which we have given special names—politics, economics, the social structure, culture—without seeing that these boxes are constructs more of our imagination than of reality. The phenomena dealt with in these separate boxes are so* **closely intermeshed that each presumes the other, each affects the other, each is incomprehensible without taking into account the other boxes**.*"—Immanuel Wallerstein 2004: World-Systems Analysis*
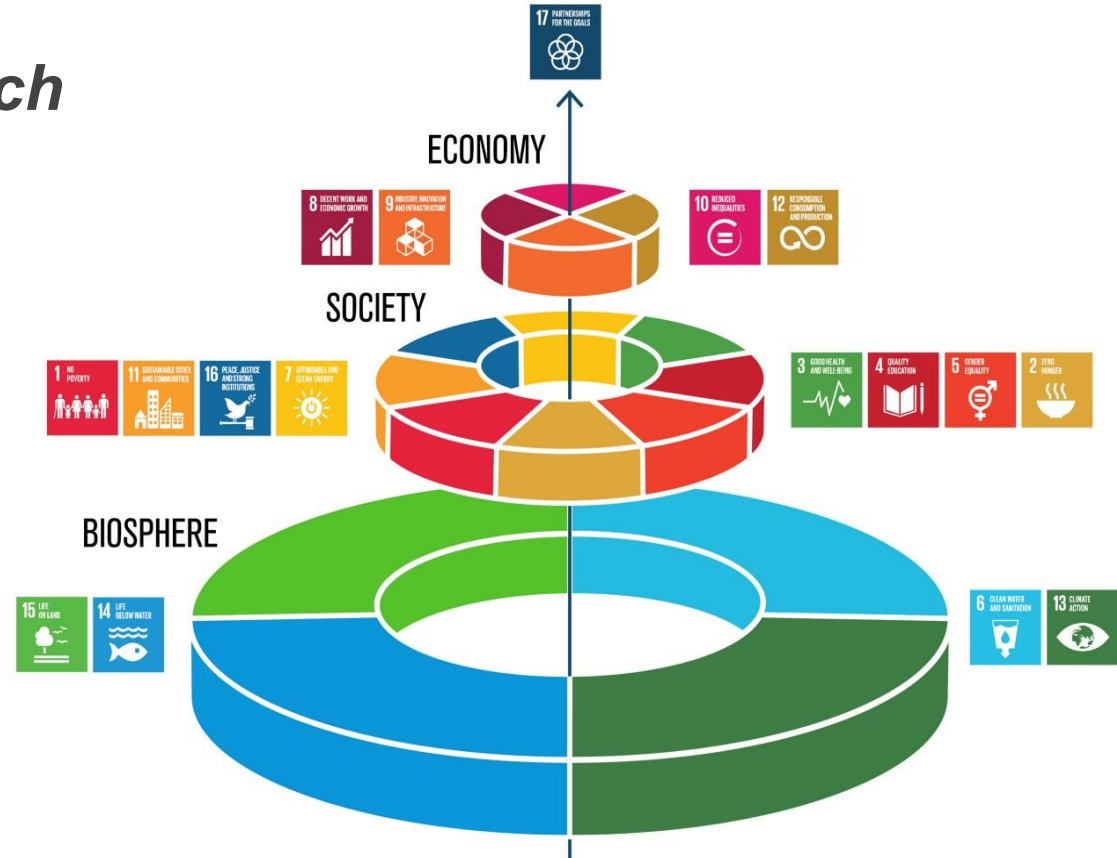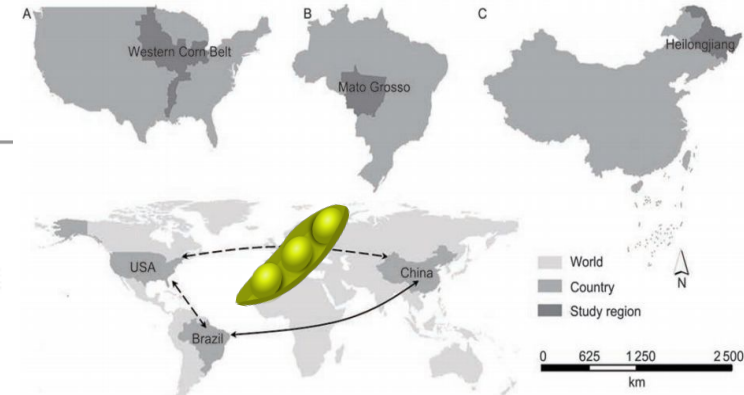

ECONOMY

SOCIETY

BIOSPHERE

Illustration: Azote Images for Stockholm Resilience Centre—How food connects all of the SDG's

Graphics by Jerker Lokrantz/Azote

Telecoupling Framework (example)

Systems	Agents	Flows	Causes	Effects
Sending • Brazil **Receiving** • China **Spillover**	• soybean producers • soybean consumers • governments • trade companies	**Material/ Energy** • soybeans from Brazil to China • money from China to Brazil • fossil fuels in transportation **Information** • prices • agricultural techniques	**Economic** • China's demand for soybeans **Political** • government interest in soybean investment **Technological** • improved tropical agricultural technology **Ecological** • differences in climate for growing soybeans **Cultural** • Chinese preference for soybeans and diet shift towards meats	**Environmental** • loss of biodiversity and ecosystem services • CO_2 emissions • Change in using fertilizers for more intensive farming **Socioeconomic** • land use change (e.g. conversion of soybean land to corn field in China due to lower price of soybean from Brazil) • food security • displacement of local people in Brazil • farmers' income • change in food prices

POLL 2

Existing Tools & Applications

Existing Tools & Applications - InVEST

Model	ES Type
Habitat Quality	Supporting ES
Habitat Risk Assessment	Supporting ES
Forest Carbon Edge Effect	Final ES
Coastal Blue Carbon	Final ES
Annual Water Yield	Final ES
...	...

InVEST

integrated valuation of ecosystem services and tradeoffs

https://naturalcapitalproject.stanford.edu/invest/

Existing Tools & Applications - EnviroAtlas

Geospatial Toolboxes	Type
Dasymetric Toolbox	ArcGIS 10.3
Analytical Tools Interface for Landscape Assessments (ATtILA)	ArcGIS 10.5.1 or less
Ecosystem Rarity Toolbox	ArcGIS 10.3
Automated Geospatial Watershed Assessment (AGWA)	AGWA Modeling Tool

https://www.epa.gov/enviroatlas/enviroatlas-tools

Existing Tools & Applications - ARIES

Components	Type
ARIES explorer (user side)	Web interface *(not yet publicly available)*
k.LAB software (modeler side)	Set of tools *(in-person trainings)*

ARIES
ARtificial Intelligence
for Ecosystem Services

http://aries.integratedmodelling.org/

http://www.integratedmodelling.org/

Existing Tools & Applications - LUCI

Ecosystem Services
Agricultural Production
Erosion Risk and Sediment Delivery
Carbon Sequestration
Flood Mitigation
Habitat Provision
Water Quality - Nitrogen and Phosphorus

LUCI
LAND UTILISATION & CAPABILITY INDICATOR

https://www.lucitools.org/

Existing Tools & Applications - SolVES

Toolbox Version (SolVES 3.0)
ArcGIS 10.x *(unclear the ongoing support for ArcGIS)*
Requires installation of MaxEnt
.NET framework
Java

SolVES
Social Values for Ecosystem Services

https://solves.cr.usgs.gov/

ESRI

- Developed by the USGS Geosciences and Environmental Change Science Center (GECSC)
- Incorporates quantified and spatially explicit social-values information into ecosystem service assessments

Existing Tools & Applications - EcoServ-GIS

Toolkit Version (EcoServ-GIS 3.3)
ArcGIS Desktop (10.2.2 onwards) with the Spatial Analyst Extension (Advanced Licence)
Maps ecosystem services at county or regional scale
Regulating and cultural ecosystem services
"More simplified process models" -compared to InVEST

https://ecosystemsknowledge.net/ecoserv-gis

- "More simplified process models" (compared to InVEST)
- Reduces the need for academic or specialist input

Telecoupling Toolbox - Systems Integration Approach

What's in the Toolbox?

Desktop GIS Tools

ArcGIS
Toolbox
(v2.3)

Web-based GIS Application

GeoApp

Telecoupling Toolbox - Main Characteristics

Spatially-explicit

- A spatial location is assigned to most components of the telecoupling framework (systems, agents, flows, causes, effects)

Telecoupling Toolbox - Main Characteristics

Multi-scale

- The spatial resolution of analysis is flexible, allowing users to address questions at local, regional, or global scales (intrinsic property of a GIS system)
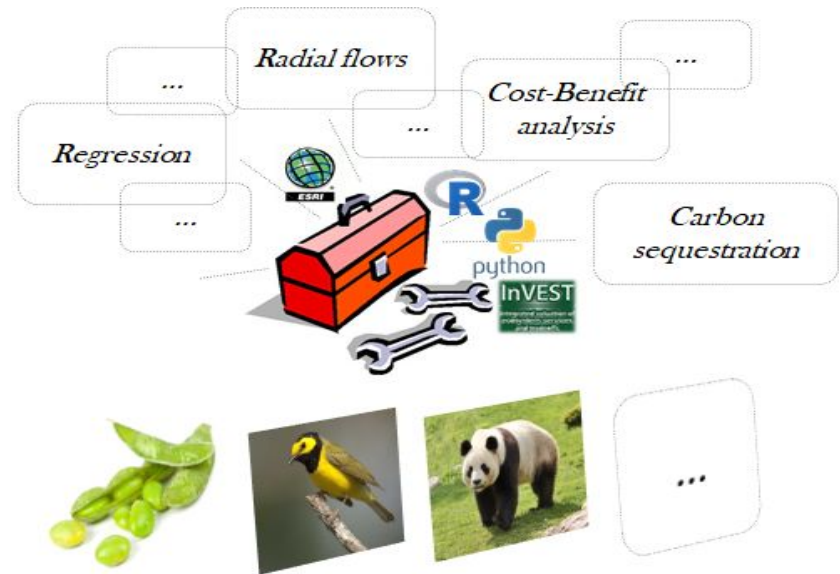
Telecoupling Toolbox - Main Characteristics

Modular - Extendible

- Can be expanded to include as many quantitative/qualitative tools as needed (including 3rd party tool integrations)
- Re-use sub-module components across tools if needed

Telecoupling Toolbox - Main Characteristics

User-friendly & interactive

- Take full advantage of the interactive functionalities offered by the GIS software environment

Telecoupling Toolbox - Main Characteristics

Transparent

- Code is publicly shared and freely available on Github (https://github.com/MSU-CSIS/telecoupling-toolbox)

Telecoupling Toolbox - ArcGIS Toolbox (v2.3)

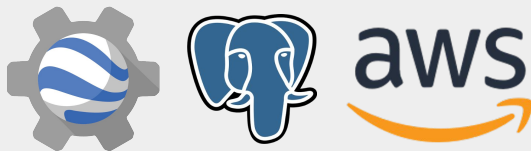| Pros	Cons
● Full control on layer symbology ● Adjust coordinate projections ● Integrate with other ArcGIS tools ● Can run lengthy processing tasks	● Windows OS only ● Annual paid license ● Proficiency in ArcGIS required ● Several installation steps (3rd party tools integrations) ● Runtime errors are system-dependent ● Execution time can vary (CPU/RAM)

Telecoupling Toolbox - GeoApp

Pros

- No software installation required
- Free and cross-platform
- Same experience for every user
- Scalable - load balance
- Integration with several publicly available GIS layers
- Interactive and dynamic experience
- No GEE authentication

Cons

- Requires internet connection
- Data preprocessing still needed
- Widgets cannot be modified by users
- Layer symbology is fixed
- Users cannot add raster data directly to basemap *(might change soon)*
- Only operational layers are permanent *(browser session cannot restore output layers after re-opening)*

Telecoupling Toolbox - ArcGIS Toolbox (v2.3)

LIVE DEMO

Thank you!
Q&A

https://www.surveymonkey.com/r/LQ2KRLM

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FrancescoTonini.com

f-tonini (github)

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Reference Publications

- McCord, P., Tonini, F., and Liu, J. (2018). Making strides in sustainable development with the Telecoupling GeoApp. Science Trends, September 6, 2018.https://sciencetrends.com/making-strides-in-sustainable-development-with-the-telecoupling-geoapp/

- McCord, P., Tonini, F., and Liu, J. (2018). The Telecoupling GeoApp: A Web-GIS Application to Systematically Analyze Telecouplings and Sustainable Development. *Applied Geography*, 96, pp. 16-28. https://doi.org/10.1016/j.apgeog.2018.05.001

- Tonini, F., and Liu, J. (2017). Telecoupling Toolbox: Spatially explicit tools for studying telecoupled human and natural systems. *Ecology and Society*, 22 (4), pp. Art11.https://doi.org/10.5751/ES-09696-220411