Climate Services Ecosystems: an opportunity for optimization

Carmen Gonzalez Romero, Ángel G. Muñoz, Lisa Goddard, Asuncion Ledas St.Clair, Francisco Doblas- Reyes, Marta Terrado, and Dragana Bojovic
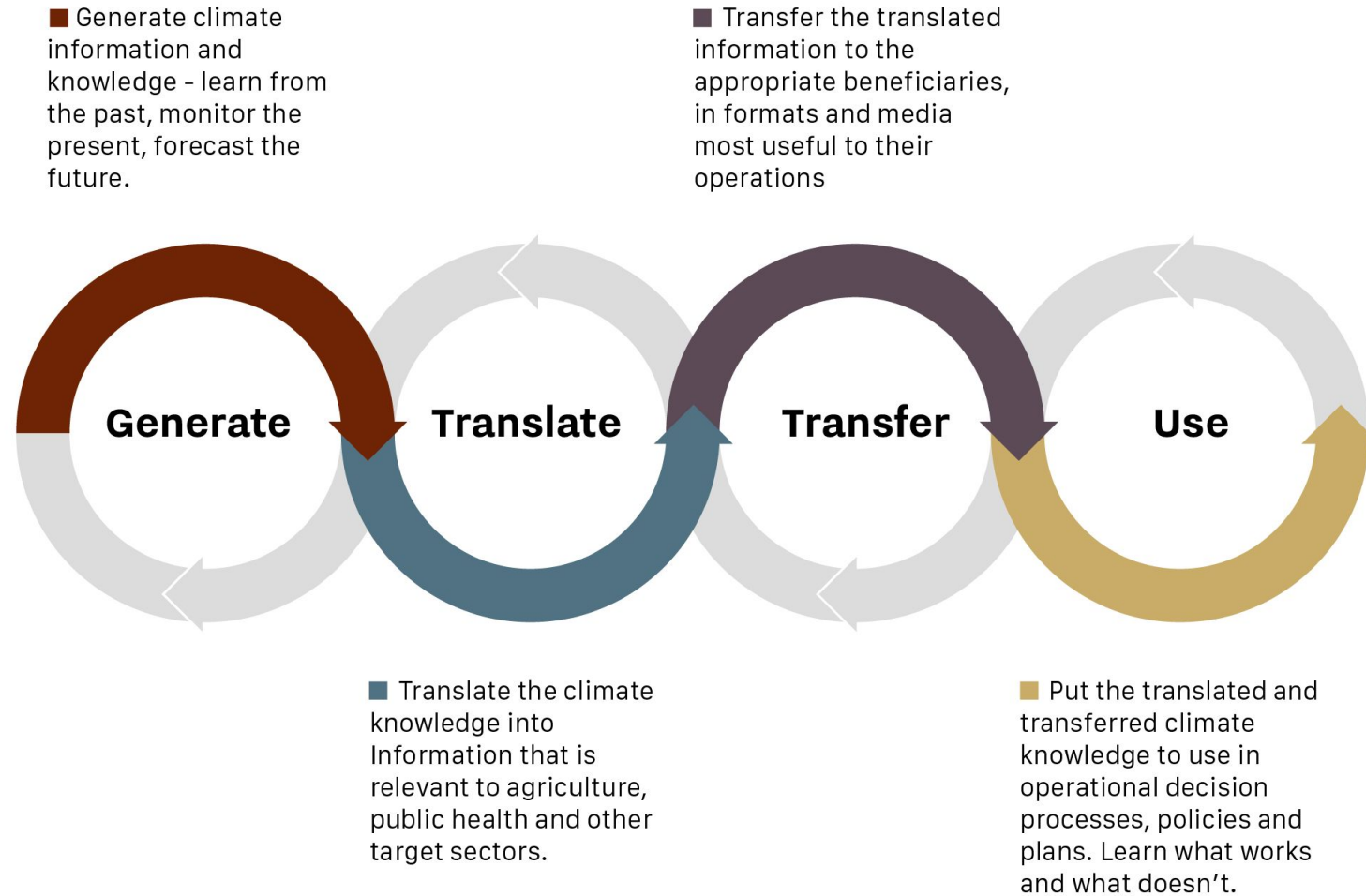EGU 2023
Tuesday, April 25th, 2023

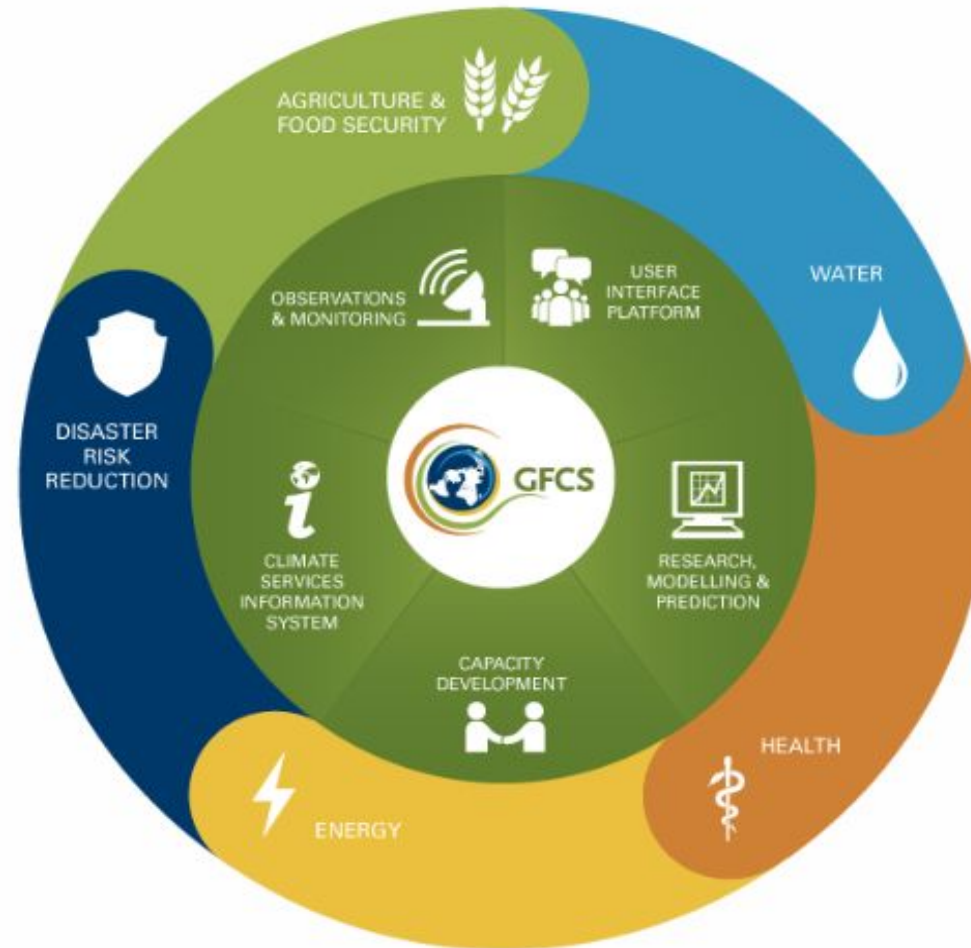The predecessors of climate service ecosystems

What are climate services and how have they evolved?

■ Generate climate information and knowledge – learn from the past, monitor the present, forecast the future.

■ Transfer the translated information to the appropriate beneficiaries, in formats and media most useful to their operations

Generate   **Translate**   **Transfer**   **Use**

■ Translate the climate knowledge into Information that is relevant to agriculture, public health and other target sectors.

■ Put the translated and transferred climate knowledge to use in operational decision processes, policies and plans. Learn what works and what doesn't.

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Source: The International Research Institute for Climate and Society (IRI)
Vaughn and Dessai (2014)

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

From a Global Framework of Climate Services to National Frameworks

Global Framework for Climate Services (Hewit, Mason and Walland, 2012). Source: WMO website.

From a Global Framework of Climate Services to National Frameworks

Step 1 Assess the baseline on climate services capacities at national level, to identify users and providers, map existing services and establish capacities

Step 2 Organize a national consultation workshop on climate services to bring together all relevant stakeholders and identify gaps and key elements for the development of a plan of action for NFCS implementation

Step 3 Develop a national strategic plan and costed action plan on climate services for establishment of the NFCS

Step 4 Endorse the strategic plan and a costed action plan with timelines for NFCS implementation

Step 5 Launch the NFCS, implement the national action plan on climate services and conduct rigorous M&E

Key point

Think about the national context:

- Do clear mandates exist clarifying who is responsible for different aspects of the chain for climate and weather information generation, tailoring, advisory services delivery and communication/feedback?
- Do institutional mandates sometimes overlap?
- Does a legal framework exist giving a mandate for joint work with technical expert colleagues among different line ministries?
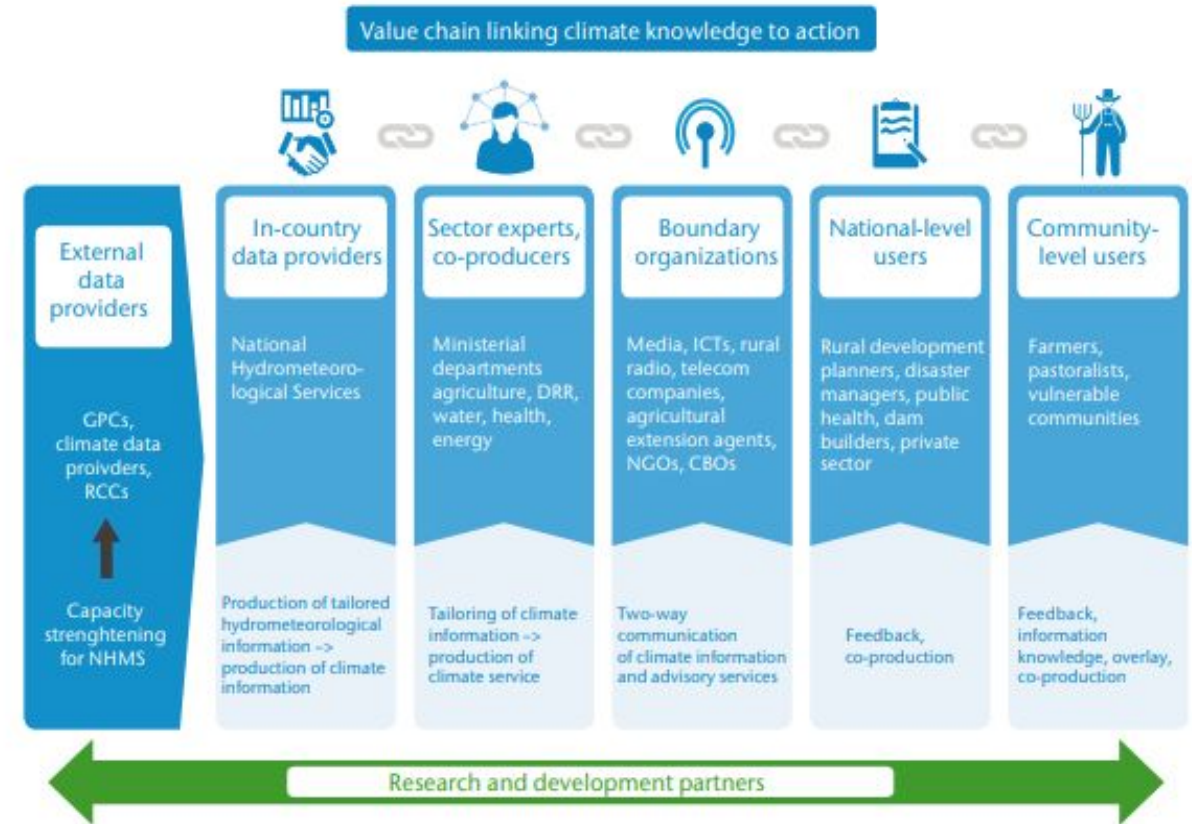
Five steps for establishing a NFCS. Source: WMO

Value chain linking climate knowledge to action

External data providers — GPCs, climate data providers, RCCs — Capacity strenghtening for NHMS

In-country data providers — National Hydrometeorological Services — Production of tailored hydrometeorological information -> production of climate information

Sector experts, co-producers — Ministerial departments agriculture, DRR, water, health, energy — Tailoring of climate information -> production of climate service

Boundary organizations — Media, ICTs, rural radio, telecom companies, agricultural extension agents, NGOs, CBOs — Two-way communication of climate information and advisory services

National-level users — Rural development planners, disaster managers, public health, dam builders, private sector — Feedback, co-production

Community-level users — Farmers, pastoralists, vulnerable communities — Feedback, information knowledge, overlay, co-production

Research and development partners

Bottom image: National value chain for climate services. Source: WMO

Barcelona Supercomputing Center Centro Nacional de Supercomputación

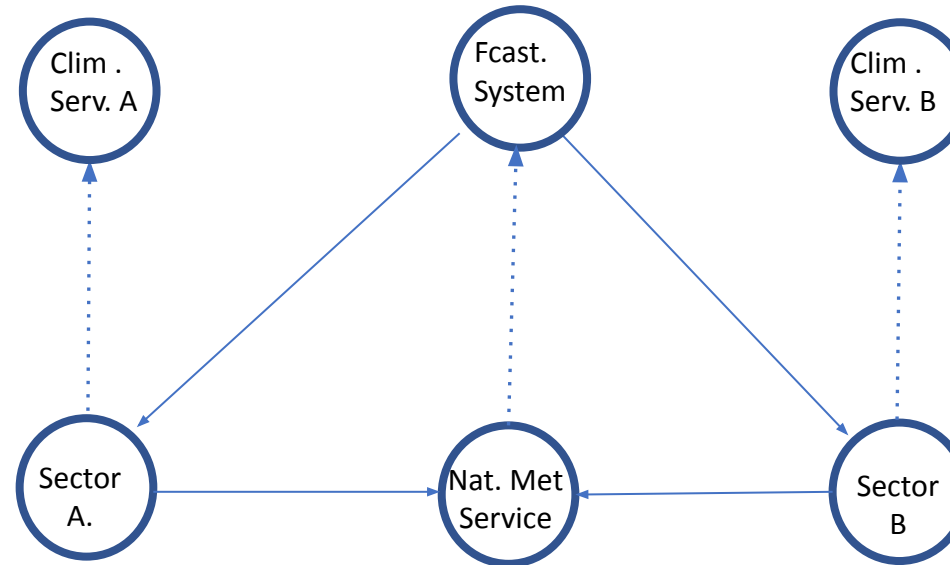ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

Definition of climate service ecosystem
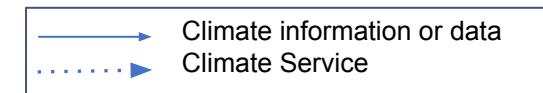
But what is a climate service ecosystem?

Example of climate service
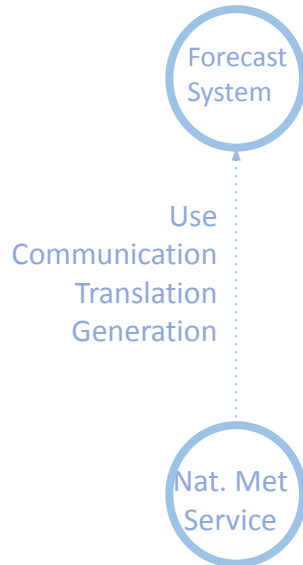
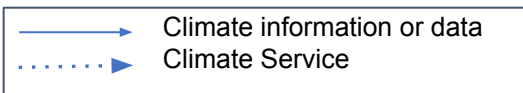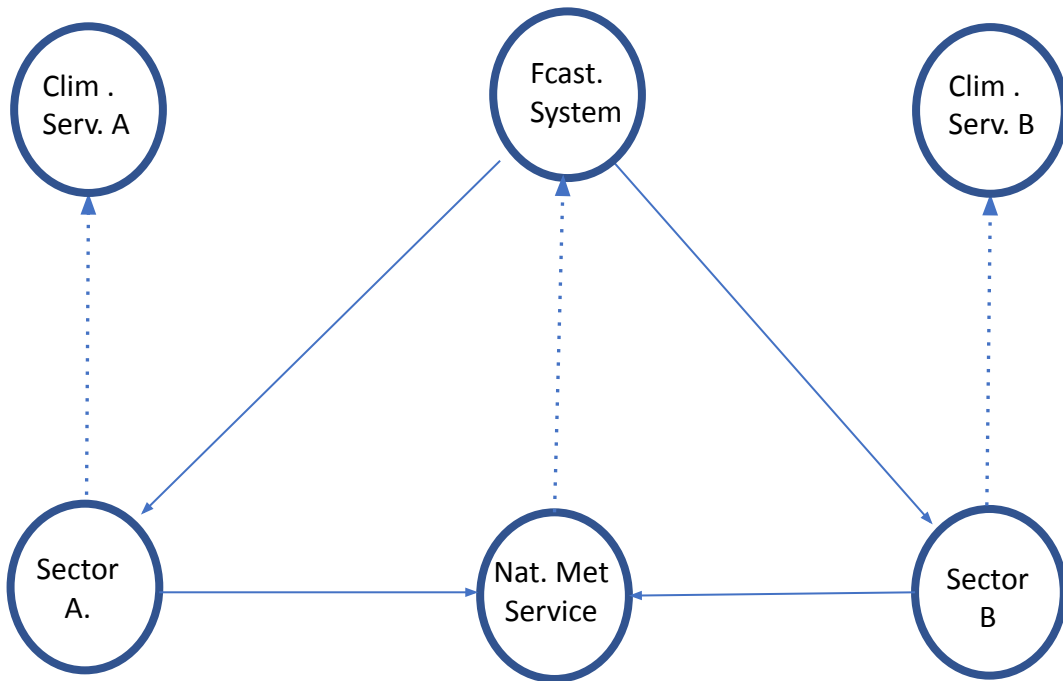**Example of climate service *ecosystem***

Climate services ecosystems don't consider sectors in silos, but as part of a system

*A self-adjusting, self-contained, **interconnected and interdependent** group of climate services that <u>increases the value</u> of the group within, in terms of **increased resilience** of the system and/or in terms of **cost-efficiencies.***

What are climate services ecosystems?

Example of climate service *ecosystem*

Legend:
- → Climate information or data
- ┈┈► Climate Service

*A self-adjusting, self-contained, **interconnected and interdependent** group of climate services that <u>increases the value</u> of the group within, in terms of **increased resilience** of the system and/or in terms of **cost-efficiencies.***

The **value** of the ecosystem of climate services is defined by the demand of each ecosystem, as long as:
- Increases resilience to shocks or crisis
- Orchestrates available resources

Requirements:
Interactions within the network:
- One climate service shared by 1+ entities or sectors, or
- Several climate services shared by several entities and sectors

What are climate services ecosystems?

Example of a NOT Pareto efficient climate service *ecosystem*

Example of a Pareto efficient climate service ecosystem
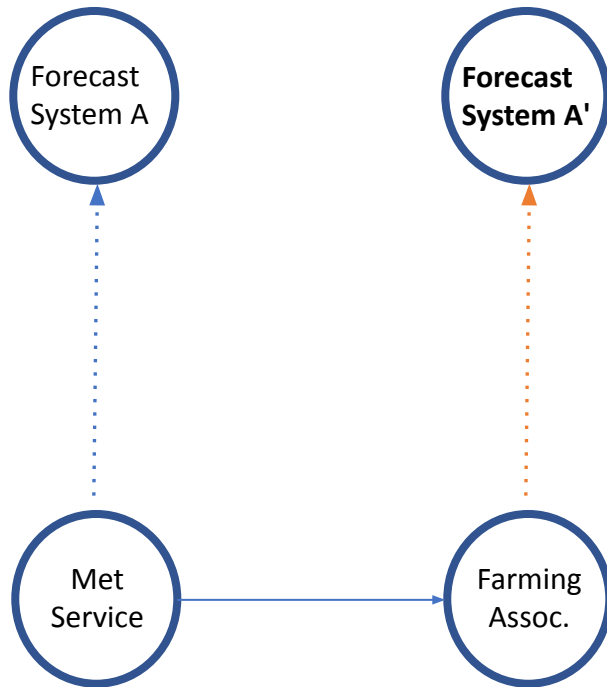
OPTIMIZATION OF RESOURCES

Forecast System A
Forecast System A'
Met Service
Farming Assoc.

Forecast System A
Plagues System
Met Service
Farming Assoc.

— Climate information or data from Nat. Met Service
— Climate information or data from a particular sector
····▶ Climate Service from Nat. Met Service
····▶ Climate Service from a particular sector

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Main elements of climate service ecosystem

Trajectories* this concept is analogous to the idea of *utility* in Economics

The **value** of the ecosystem, which is time-bounded, is determined by the own ecosystem based on the demand (objective).
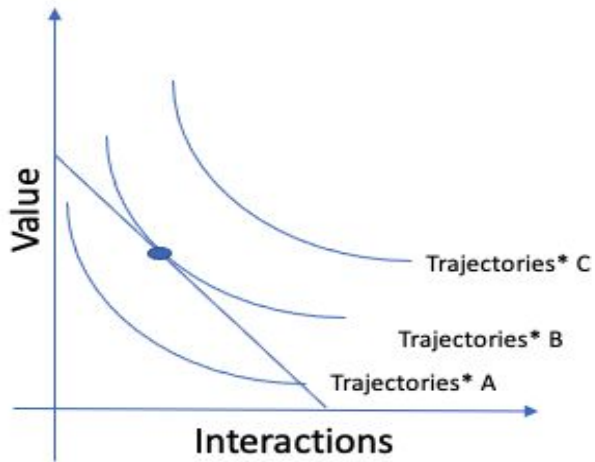
The **interactions** allow to understand how that value changes when the ecosystem is impacted by different shocks (climate related institutional, budget shocks, etc.).

The two images on the right show the Impact of Columbia World Project "ACToday" on the agriculture and food security network in Guatemala.

Pre- ACToday network
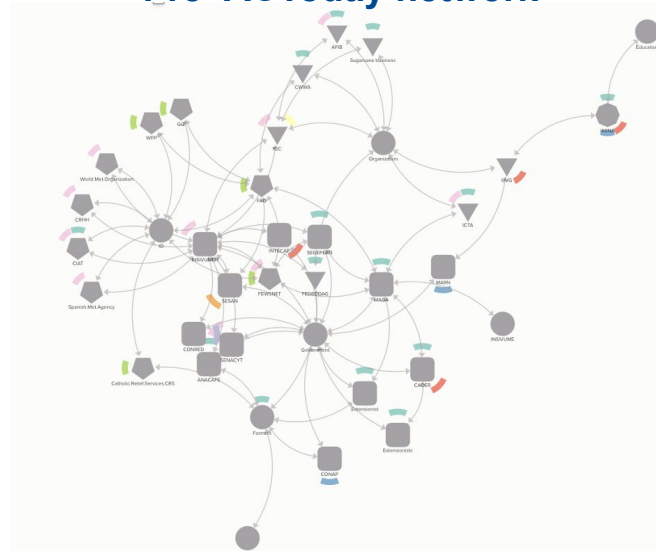
Post- ACToday network

Gonzalez Romero et al (unpublished) on ACToday project network analysis

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

ALMA MATER STUDIORUM
UNIVERSITA DI BOLOGNA

Climate services ecosystem allows us to analyse network topologies

Gonzalez Romero et al (unpublished) on ACToday project network analysis
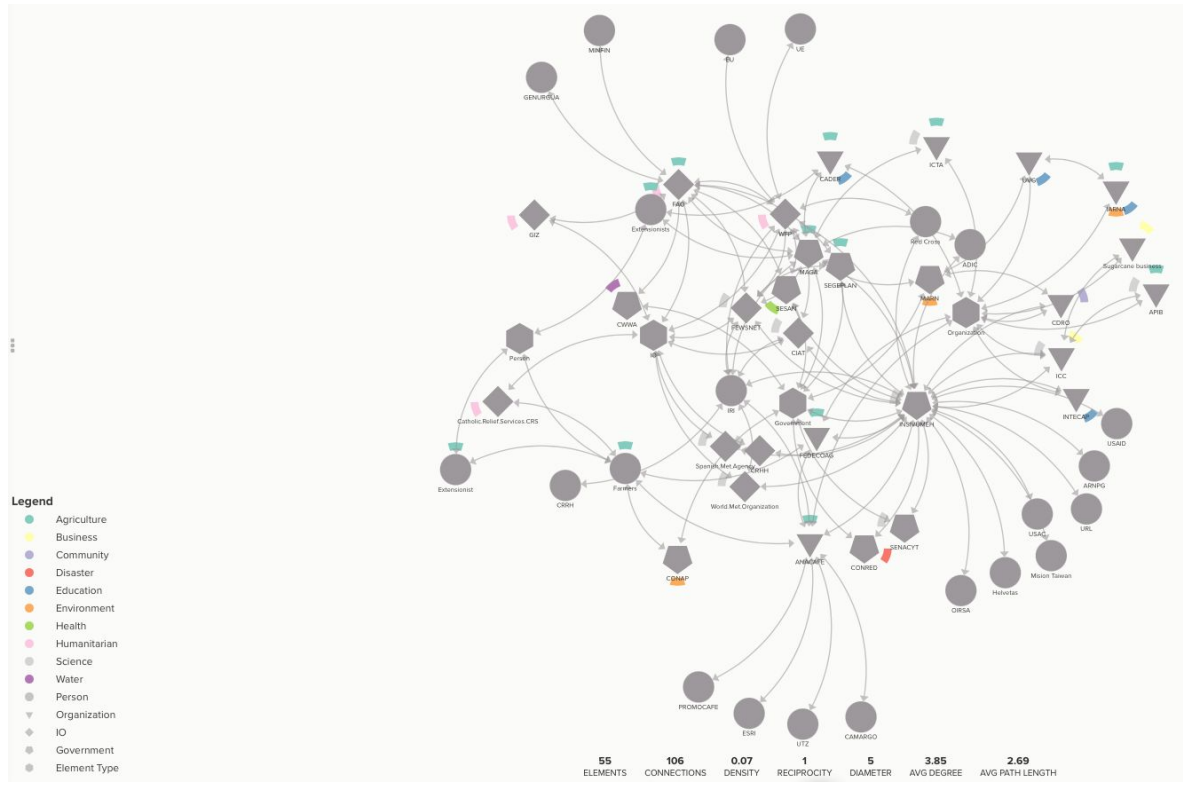
Centrality measures

- **Degree centrality**: how many people can this person reach directly?
- **Closeness centrality**: how quickly can particular nodes reach other nodes? (distance to all other nodes)
- **Betweenness centrality**: number of times a node acts as a bridge along the shortest path between two other nodes
- **Eigenvector centrality**: how well is this person connected to other well-connected people?
- **Cross-clique centrality**: determines the connectivity of a single node to different cliques

The more interconnected a climate service ecosystem is, the more resilient it is to crisis

# …but also to monitor the evolution of the ecosystems
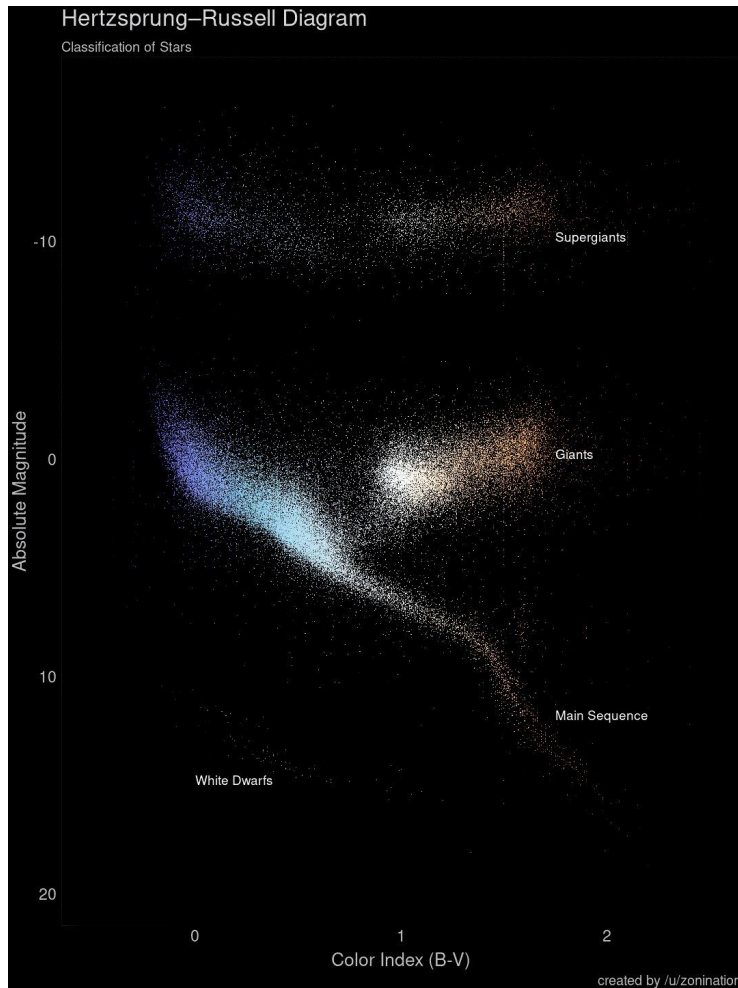
As in astrophysics, a Hertzsprung-Russell-like Diagram could be designed to analyse the **evolution** of climate services ecosystems, following the storyline approach, *assuming a non-random relationship between the value and the interactions within the ecosystem.*

We can analyse the relationship between interventions, shocks or crises, the network typology and stage (relationship between value and shocks or crisis).
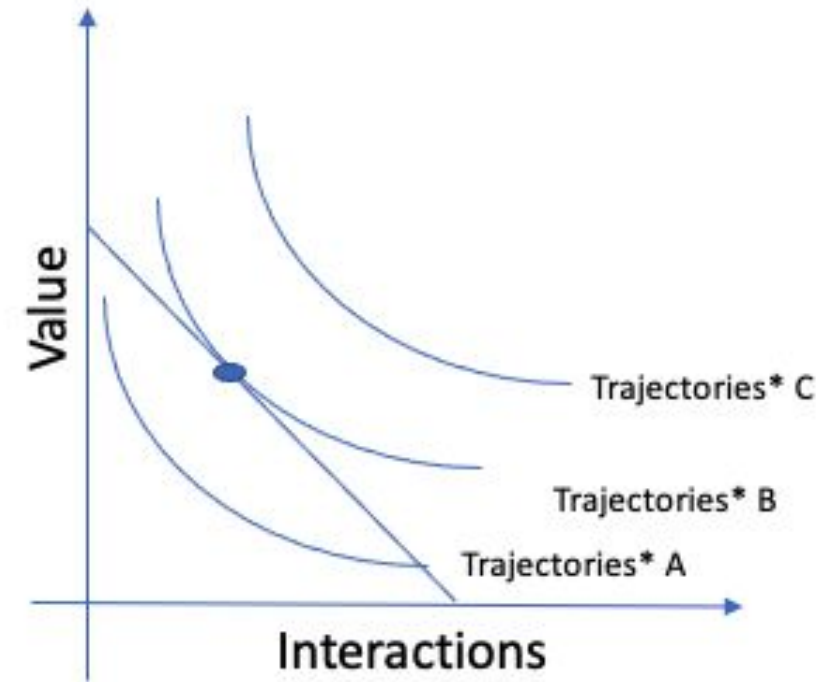
Trajectories* this concept is analogous to the idea of *utility* in Economics

…and more importantly, it can inform us of causality within the ecosystem
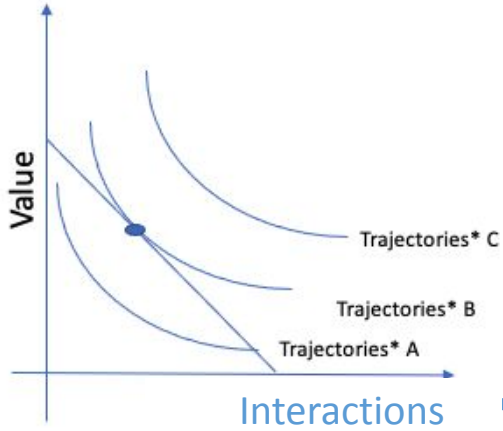
Interactions

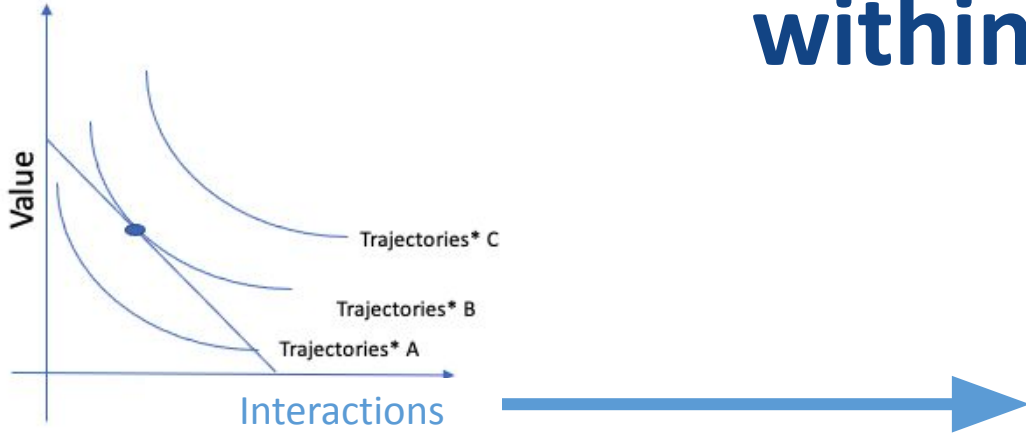Trajectories* this concept is analogous to the idea of *utility* in Economics

$$P(H|e) = \frac{P(e|H)\, P(H)}{P(e)}$$
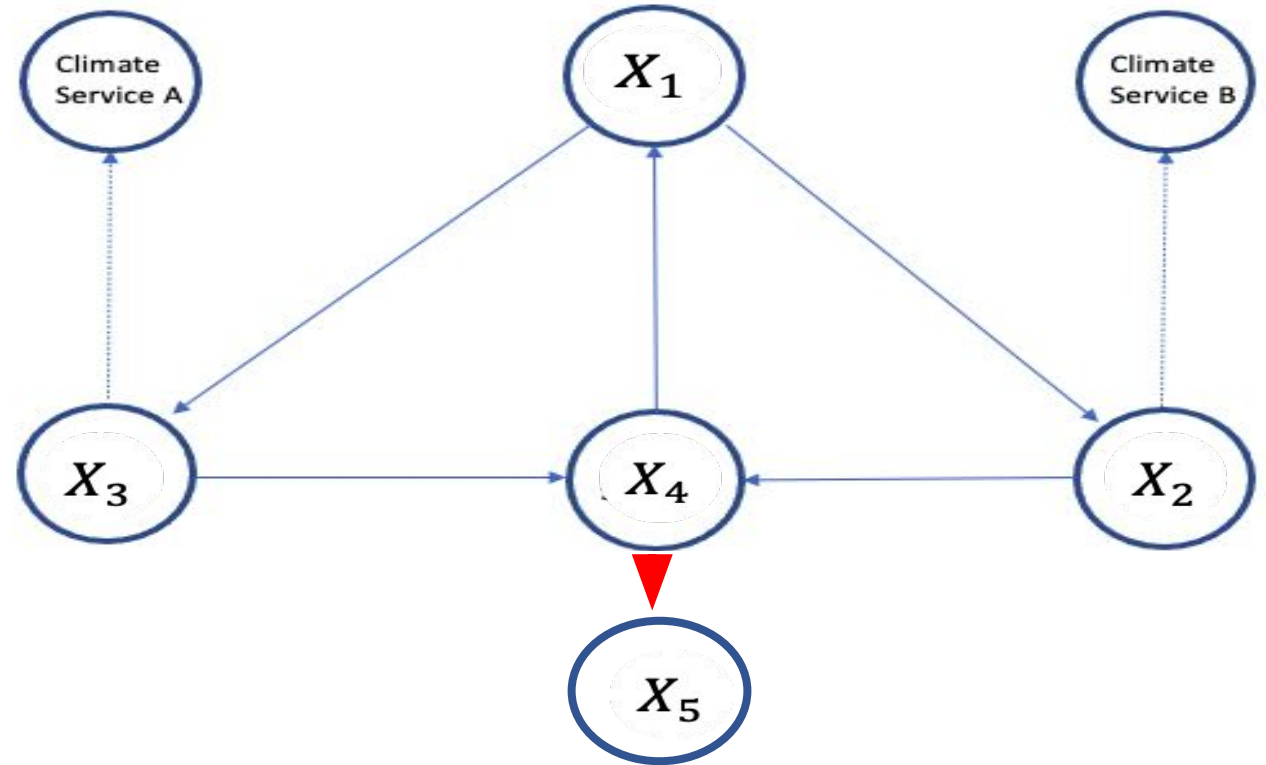
(Bayes's theorem)

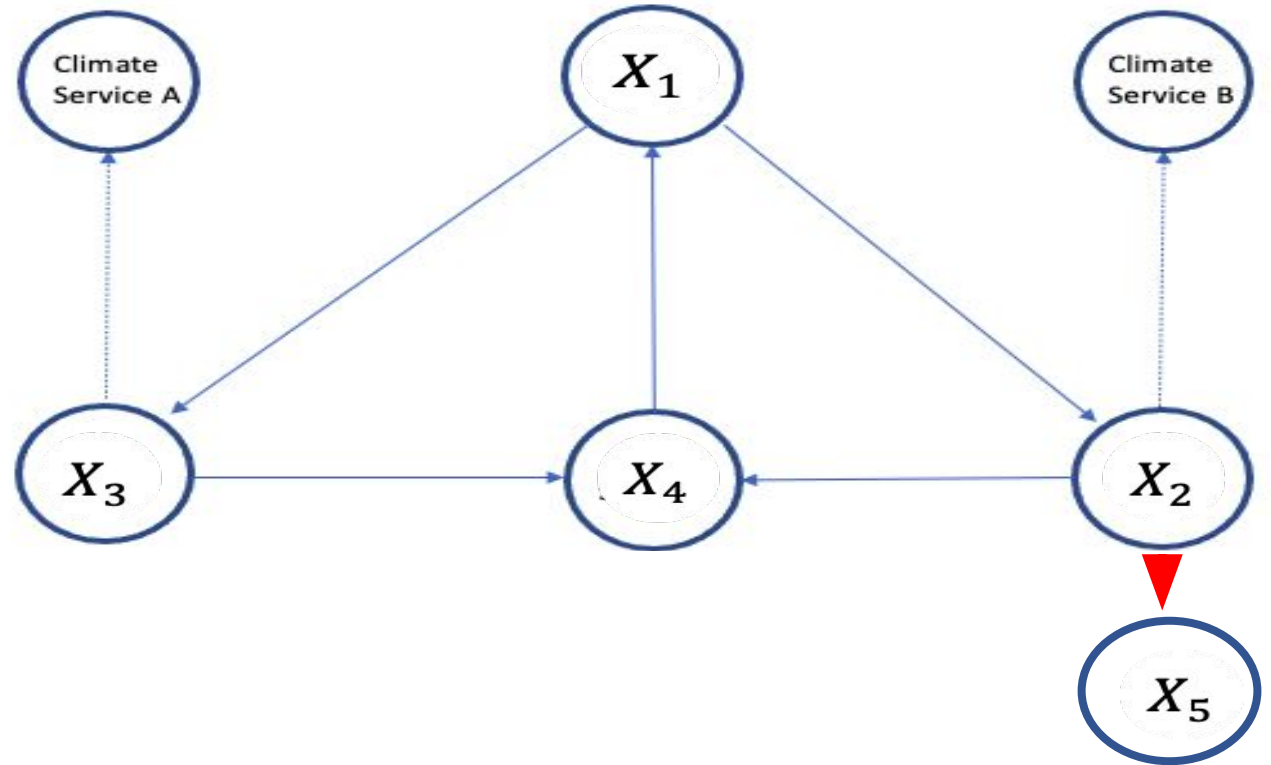$$P(X_1, X_2, X_3, X_4, X_5) = P(X_1)\, P(X_2|X_1)\, P(X_3|X_1)\, P(X_4|X_2, X_3)\, P(X_5|X_4)$$

…and more importantly, it can inform us of causality within the ecosystem

Value

Trajectories* C

Trajectories* B

Trajectories* A

Interactions

Trajectories* this concept is analogous to the idea of *utility* in Economics

$$P(H|e) = \frac{P(e|H)\,P(H)}{P(e)}$$

(Bayes's theorem)

Climate Service A

X_1

Climate Service B

X_3

X_4

X_2

X_5

$$P(X_1, X_2, X_3, X_4, X_5) = P(X_1)\, P(X_2|X_1)\, P(X_3|X_1)\, P(X_4|X_2, X_3)\, P(X_5|X_2)$$

Implications and remarks of climate services ecosystems

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Climate services ecosystems in a nutshell…

- Following the demand-driven approach of climate services, the value of ecosystems is defined by the demand (or objective) of the ecosystem itself.

- Climate services ecosystems approach aims to increase the resilience of the network of interests by understanding how the interactions between the services and users impact the value of the ecosystem and the distribution of resources.

- Climate services ecosystems approach infer causality through Bayes theorem and the storyline approach- but also diagnosis through network analysis.

- There is a *potential* to identify patterns on the relationship between value and interactions within the ecosystems following an Hertzsprung-Russell-like diagram.

- Standardization of climate services and the continuous feedback between users and providers of climate services are essential for the self-regulation of climate services ecosystems.
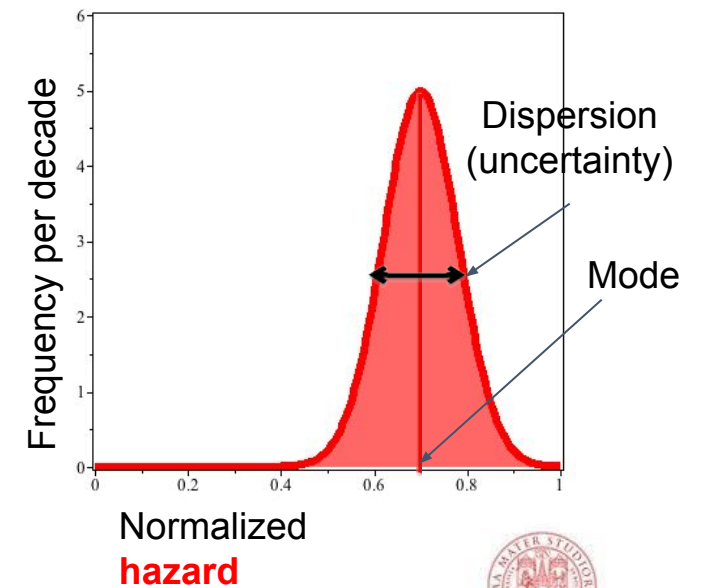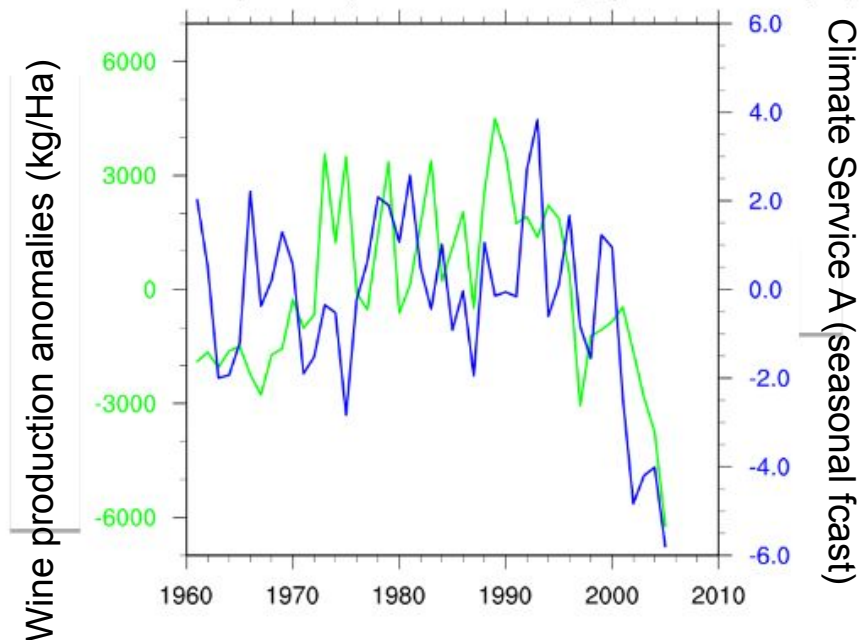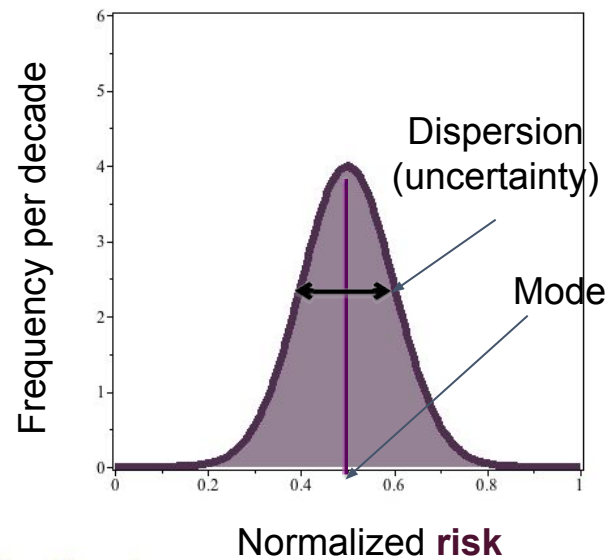
Thank you for your attention
For any questions, comments or concerns,
please contact:

Carmen.gonzalezromero@bsc.es

How do we value resilience?

Utilitarian approach ⟹ Capacity to satisfy users' needs ⟹ Increases resilience

Time and objective bounded
Resilience = f (Risk optimization) => risk monetization

Dummy data. Graphs used for explanatory purposes, extracted from an unpublished work at IRI led by Angel G. Muñoz

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

How do we define value?

Risk = Hazard x Vulnerability => Risk = Hazard x (Exposure X Sensitivity X Capacity to Adapt)

P (Risk) = f (Hazard x Vulnerability)

Current situation → Desired situation
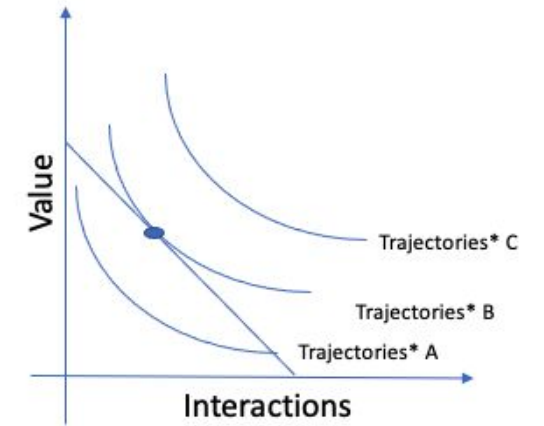
Trajectories* this concept is analogous to the idea of *utility* in Economics

BUT
Vulnerability uncertainties arent usually communicated

Vulnerability and hazard arent independent!

Vulnerability is very difficult to estimate, and not necessarily consistent with the observed risk (crop loss, number of deaths, budget loss, etc.)

Can we quantify and manage it?