A representation of ecosystem services provided by mangroves in French Guiana using Fuzzy Cognitive Maps

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MSEAS, 2024

Introduction

Mangrove in good ecological state

Compared to other French territories (Tregarot et al., 2021)

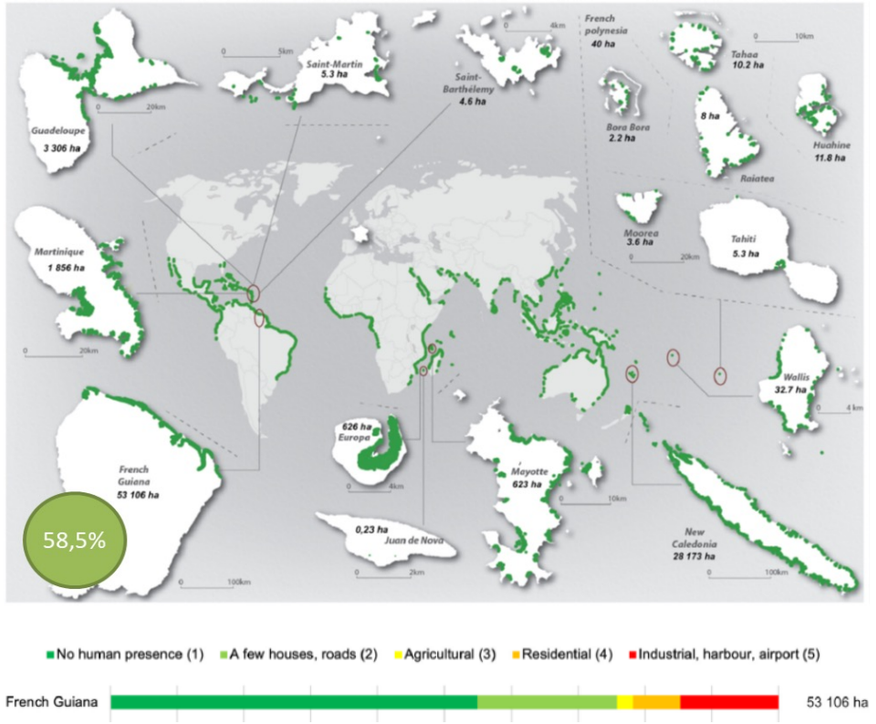
Compared to neighboring countries (Anthony and Gratiot, 2012)

An original littoral dynamic

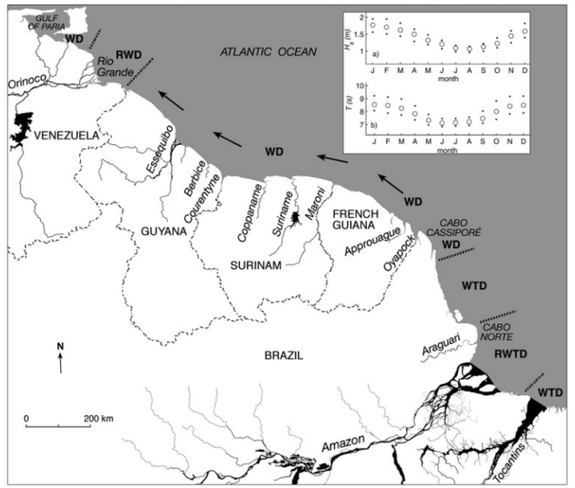
Migrating mudbanks

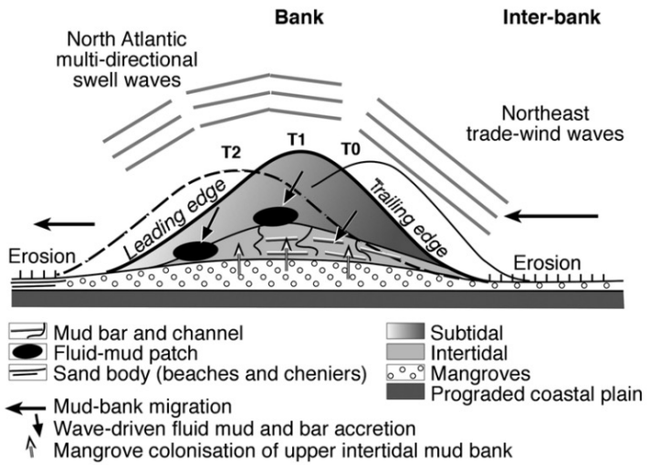
Target of an ambitious protection program

55,000 ha of mangroves to be protected (*Loi pour la reconquête de la biodiversité, 2016*).



Tregarot et al., 2021

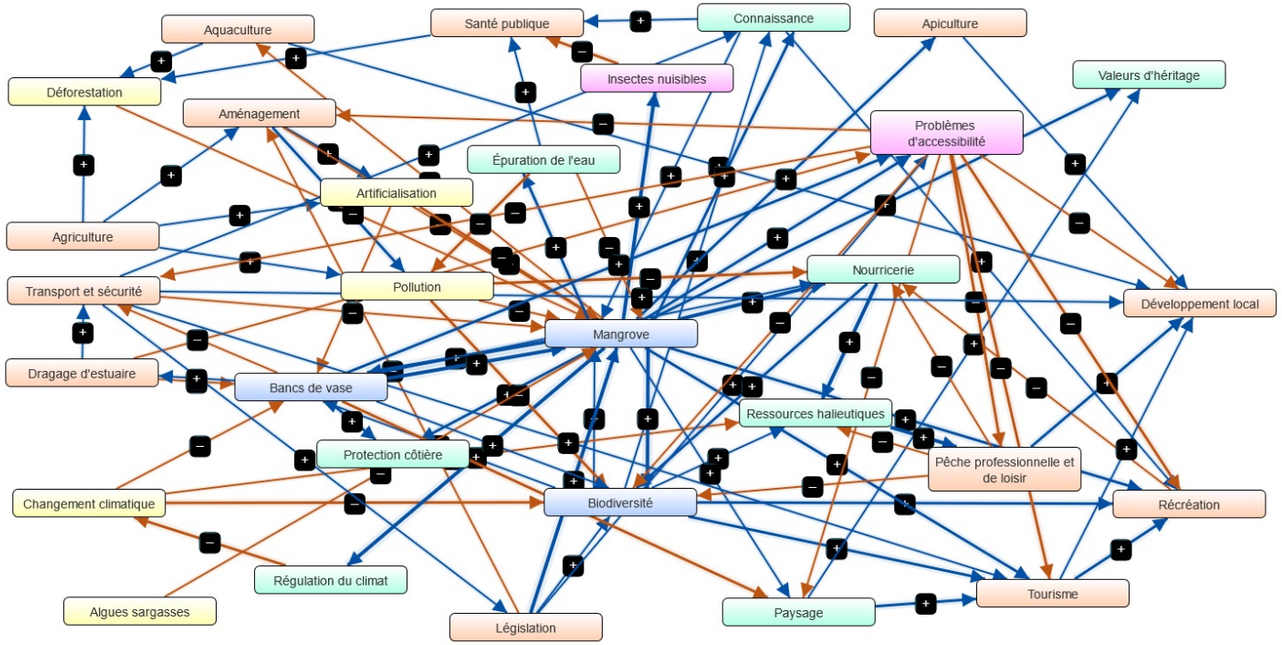




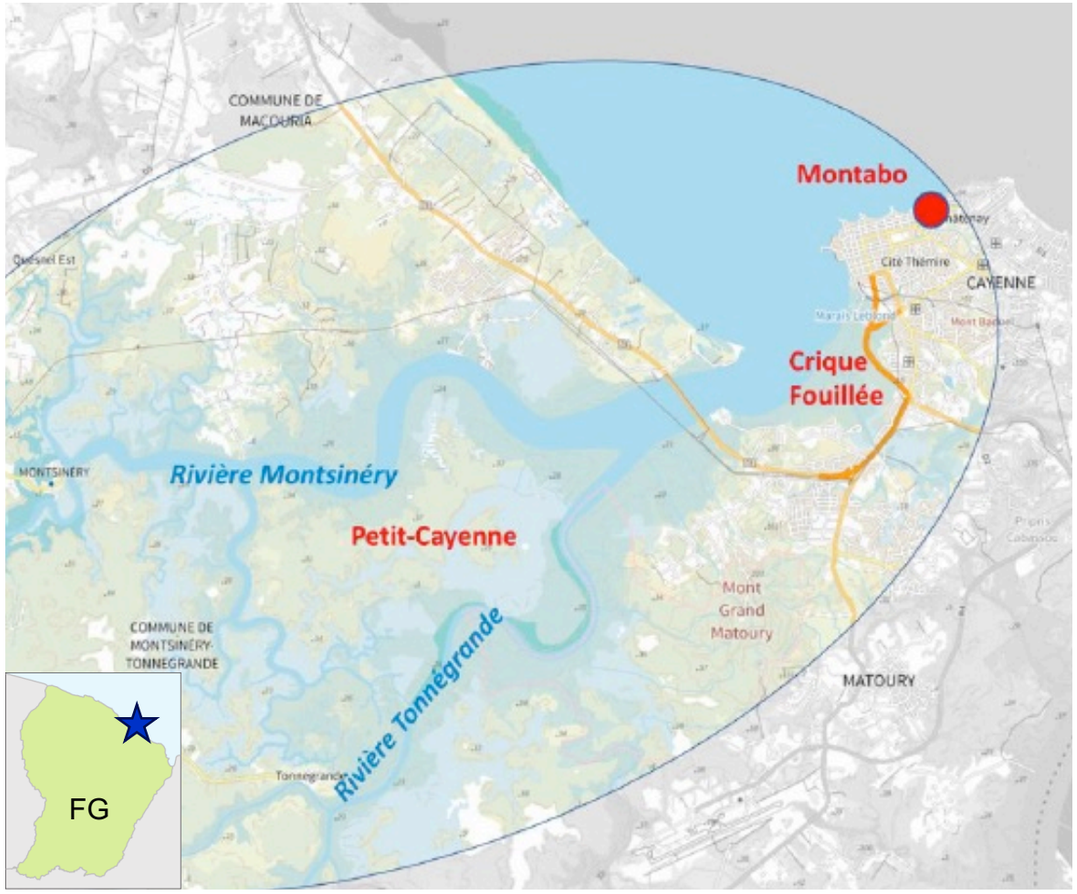
Anthony et al., 2014

Introduction

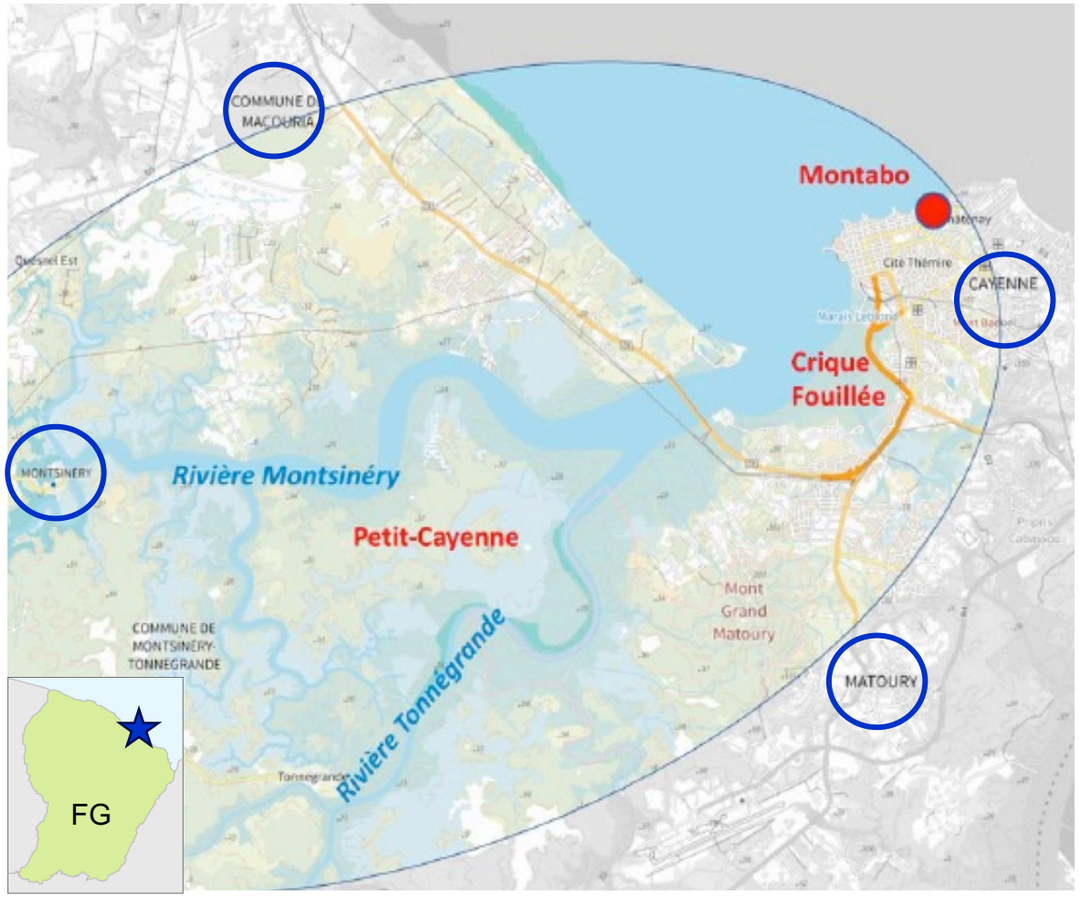
Ecosystem Services Assessment for the Conservation of Mangroves in French Guiana Using Fuzzy Cognitive Mapping



Scemama et al., 2022



Introduction



The estuary of the river of Cayenne

- Cayenne (pop. 57,000), Matoury (pop. 35,000), Macouria (pop. 19,000) and Montsinéry (pop. 3,500).

Introduction

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- Many resources
- Cultural aspects

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The estuary of the river of Cayenne

- Cayenne (pop. 57,000), Matoury (pop. 35,000), Macouria (pop. 19,000) and Montsinéry (pop. 3,500).
- Many resources
- Cultural activities
- And urban development

A need to better understand the entire system

Fuzzy Cognitive Mapping

Cognitive maps

“qualitative model(s) of how a given system operates" (Özesmi and Özesmi, 2004)

Drawing maps

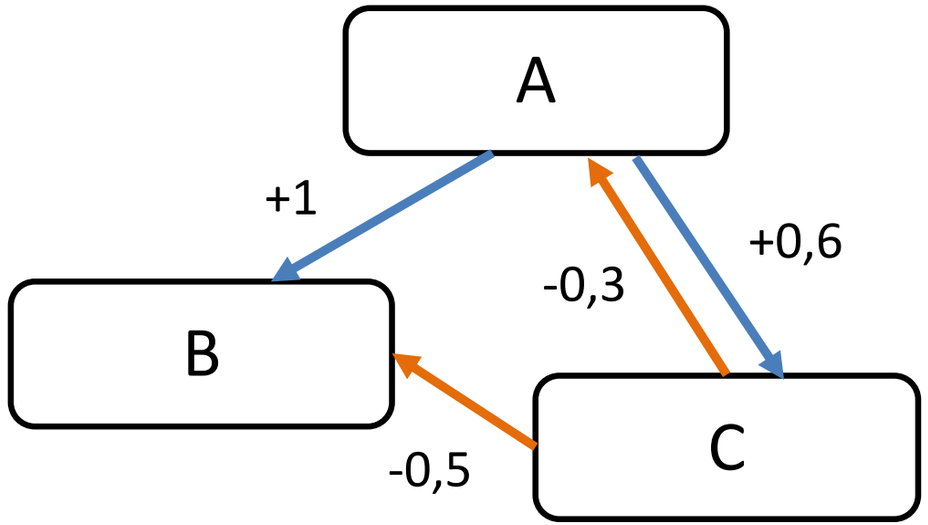
Based on variables and the causal relations between them

Variables can be tangible or more abstract concepts

Relations are measured on a $[-1; 1]$ scale.

Analyzing maps

Maps can be coded into adjacency matrix that allow analysis based on graph theory



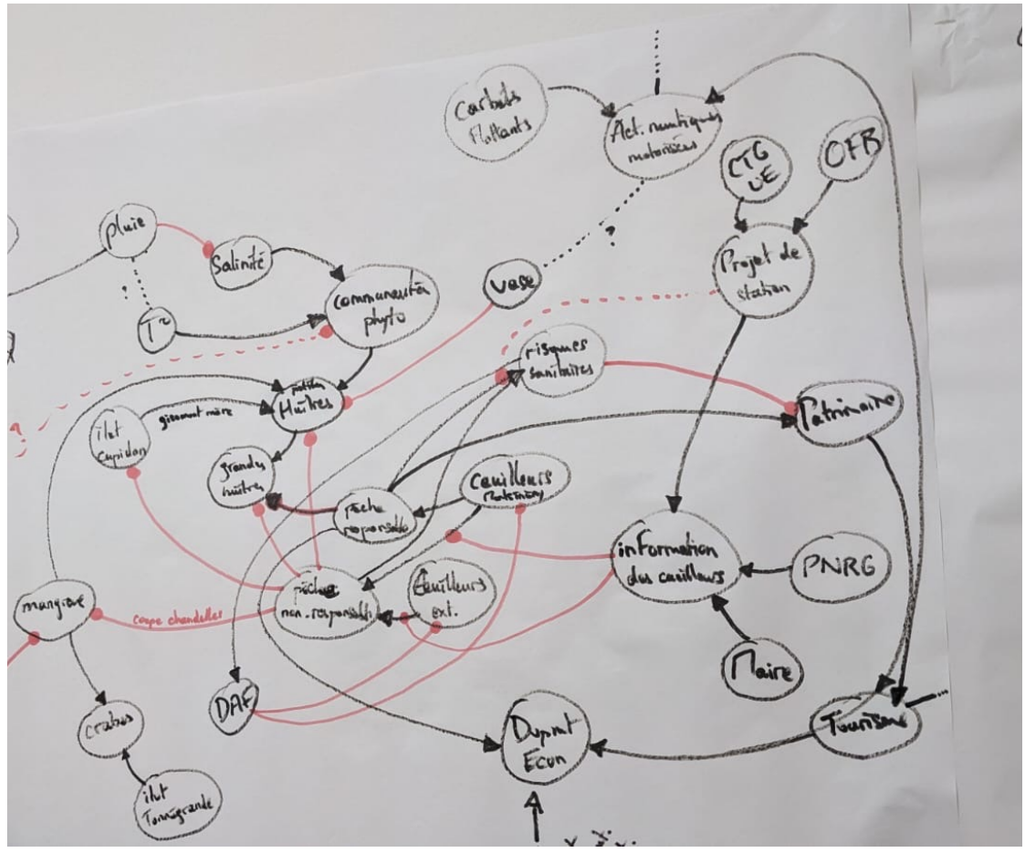
	A	B	C
A	0	1	0,6
B	0	0	0
C	-0,3	-0,5	0

Construction of individual maps

Face to face interviews with 39 experts

1. Post-it brainstorming
2. Drawing the map

Type of stakeholder	Number
Nature management and conservation	12
Professional and recreational users	11
Scientists	16

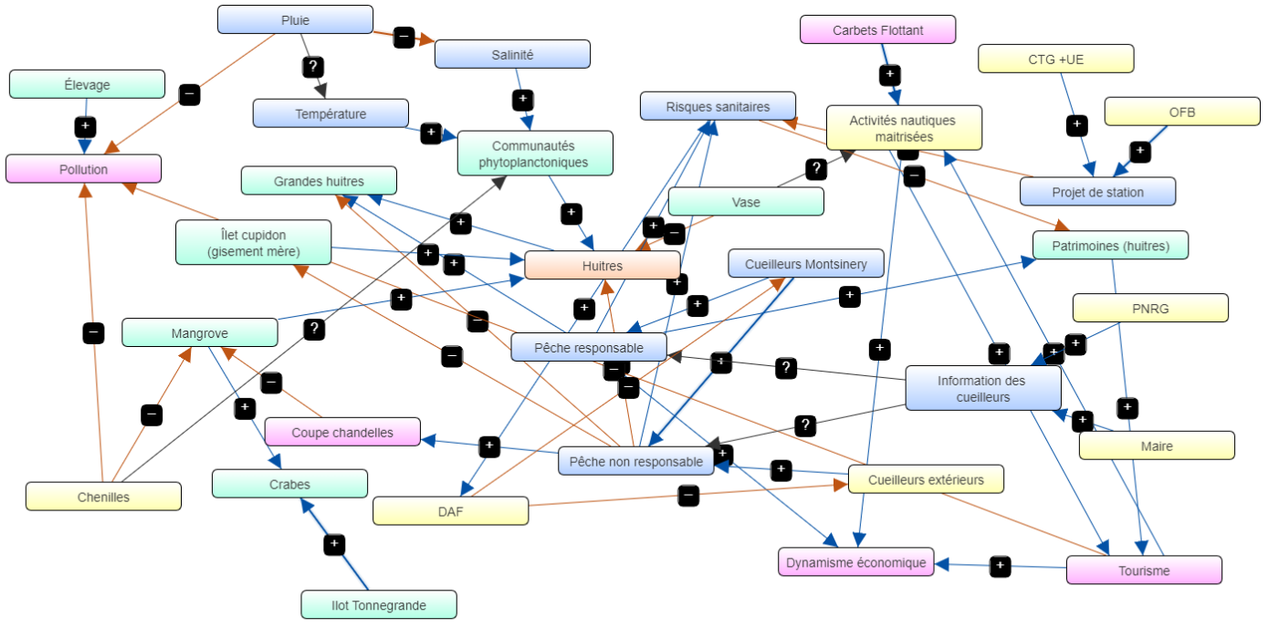


Step by step homogenization

Reduction of the number of variables

1. Obvious grouping (nurseries and *nourriceries*)
2. Negative formulations
3. Gathering under superior concepts

Step	Variables	Type of analysis
Interviews	612	
Homogenization	152	Individual analysis
Condensation 1	93	Group analysis
Condensation 2	57	
Condensation 3	32	Social maps



Data visualization using mentalmodeler

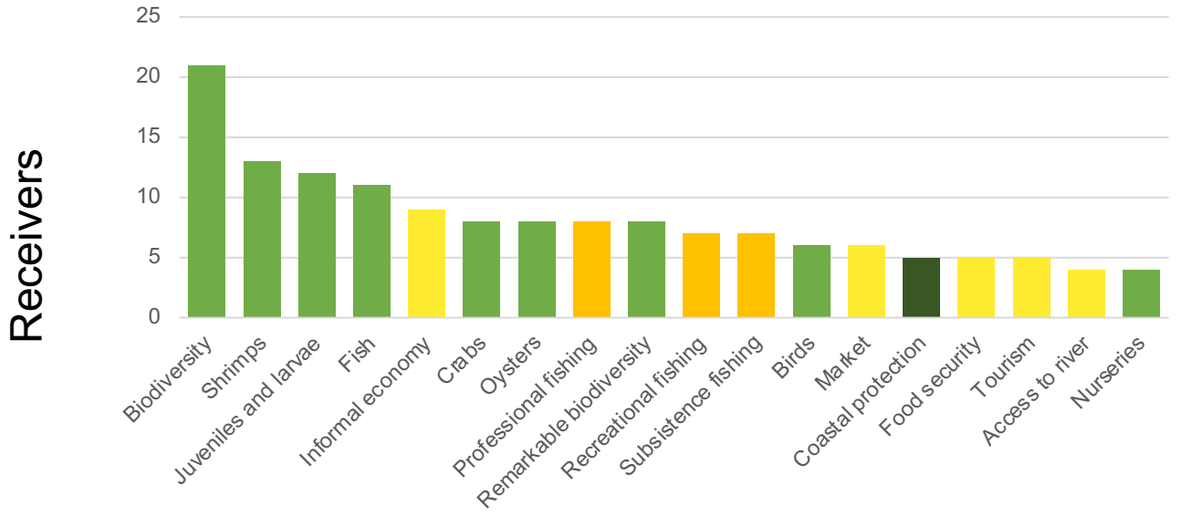
Analysis of individual maps

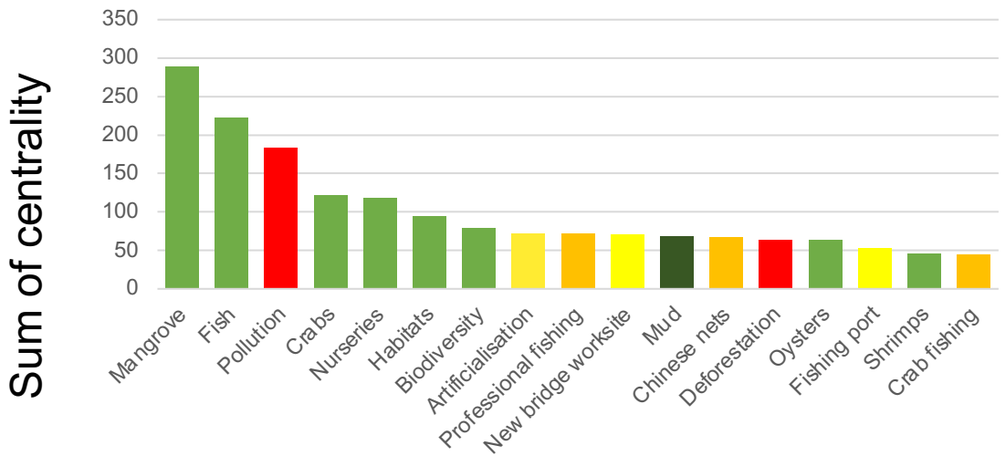
Using graph metrics

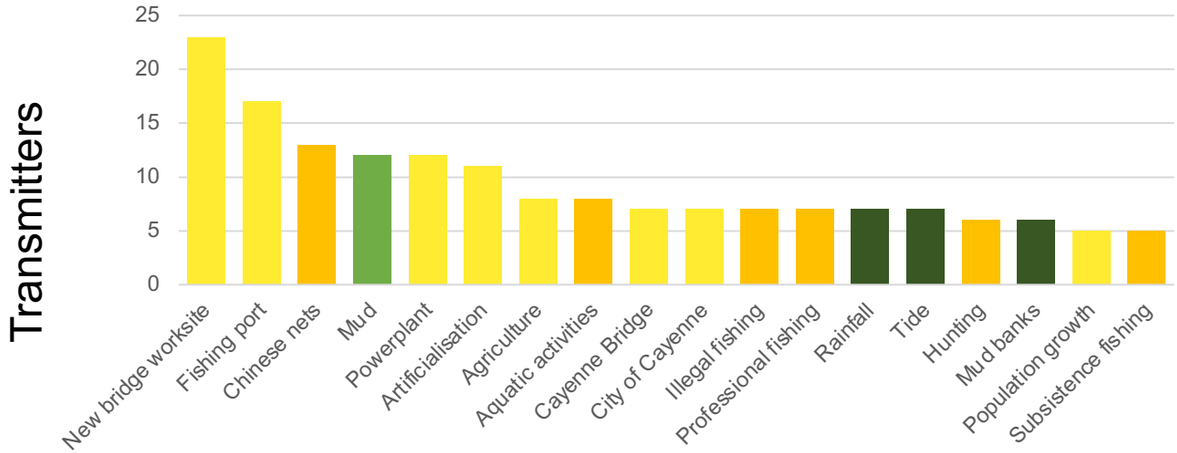
Centrality: contribution of a variable in a map

Transmitters: Forcing functions

Receivers: Output of the systems







Ecological compartments

Socio-economic factors

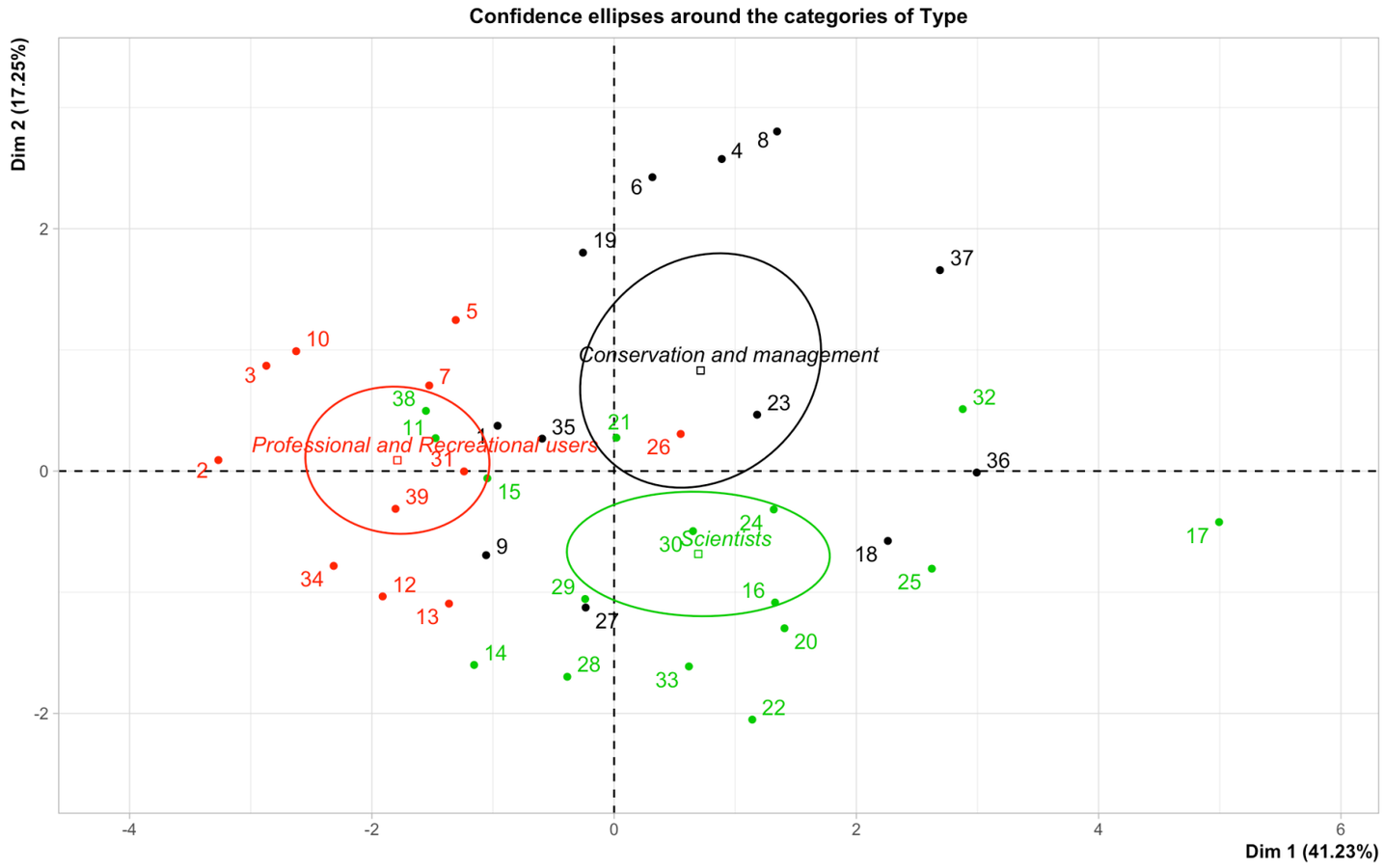
Pressure

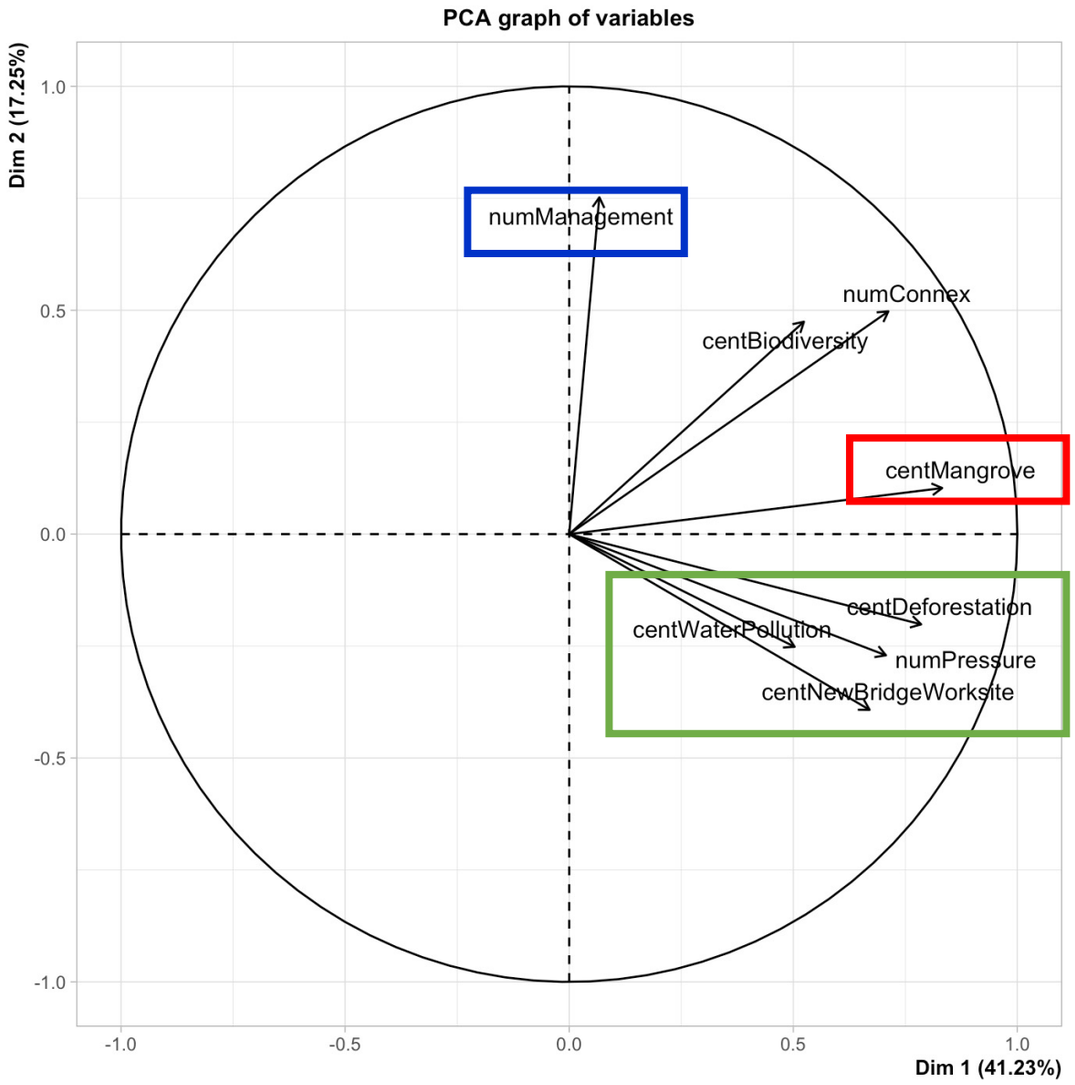
Ecological factor

Human activities

Management

Group analysis





Social map

- **Final condensation: 32 variables**

All individual matrix are coded into a 32x32 matrix

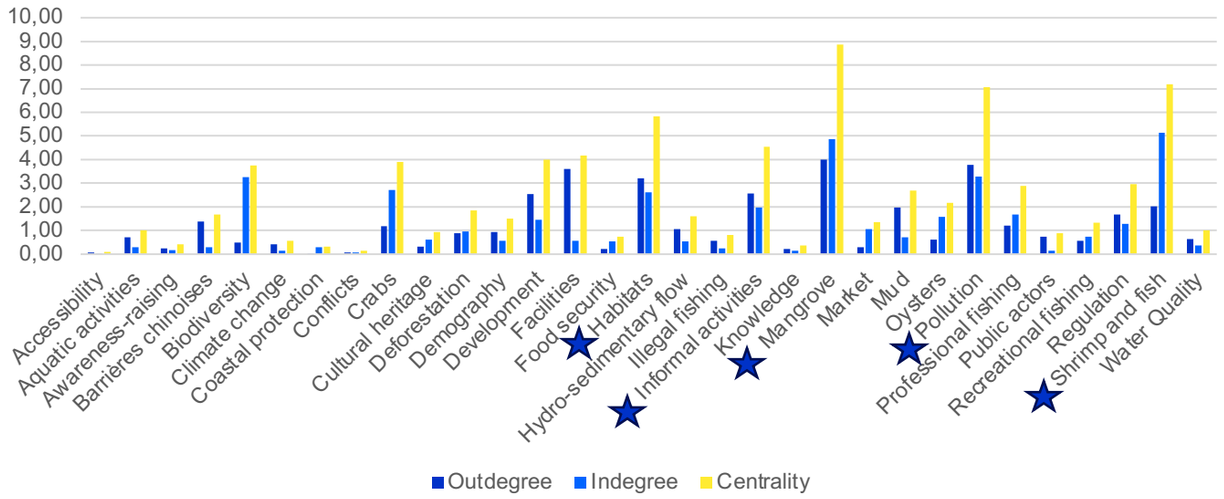
Sum of all matrix

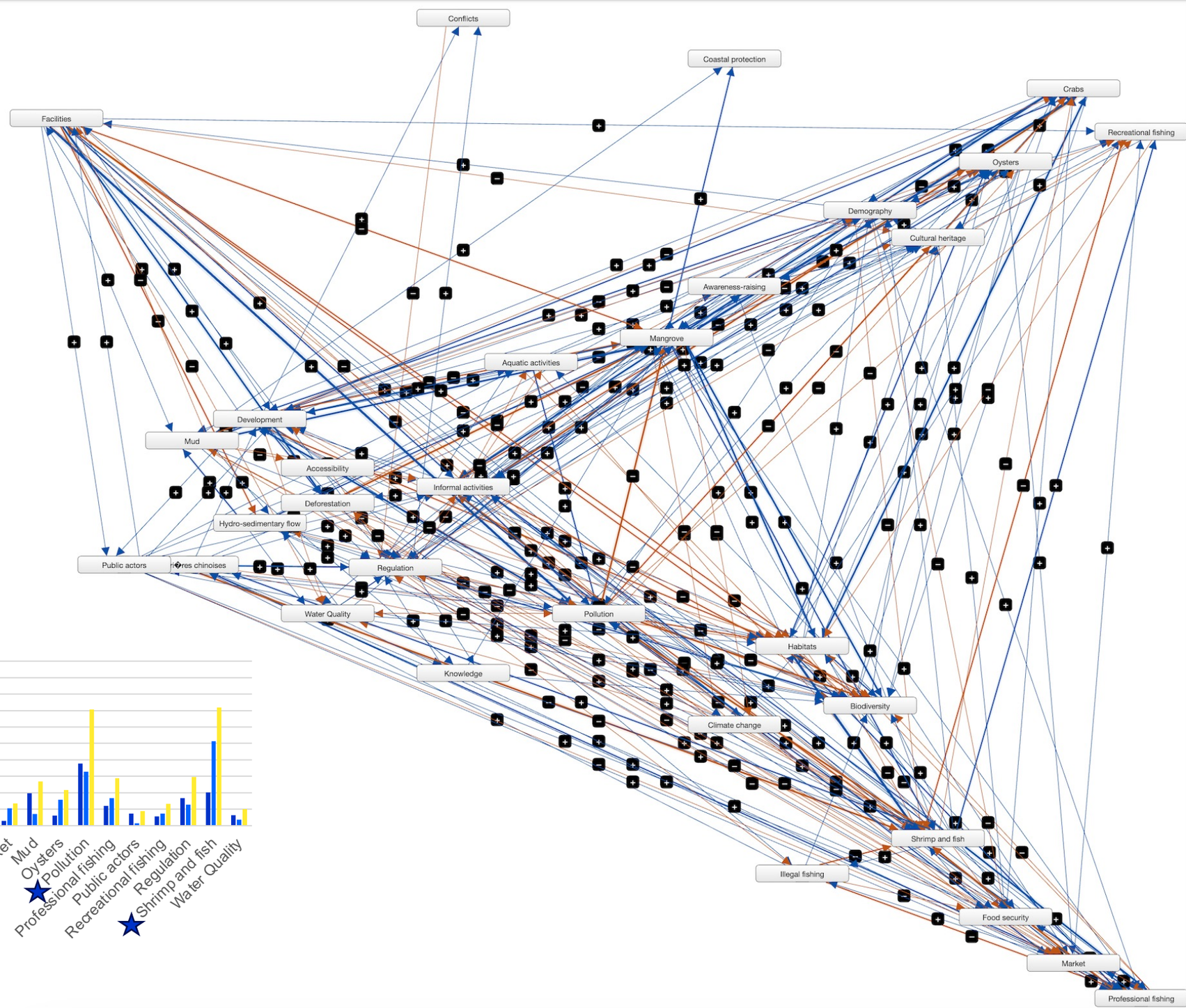
- **Set rules for connexions strength**

Normalization

Connection strength	Number of connection	%	Cumulated %
0	728		
1	143	48%	48%
2	54	18%	67%
3	23	8%	74%
4	11	4%	78%
5	12	4%	82%
6	6	2%	84%
7	9	3%	87%
8	4	1%	89%
9	3	1%	90%
10	3	1%	91%
11	4	1%	92%
12	2	1%	93%
13	3	1%	94%
14	3	1%	95%
15	1	0%	95%
16	3	1%	96%
17	3	1%	97%
18	1	0%	97%
19	1	0%	98%
20	1	0%	98%
21	2	1%	99%
22	1	0%	99%
23	0	0%	99%
24	1	0%	99%
25	0	0%	99%
26	1	0%	100%
27	1	0%	100%
28	0	0%	100%

Social map


10,00
9,00
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
Accessibility
Aquatic activities
Awareness-raising
Barrières chinoises
Biodiversity
Climate change
Coastal protection
Conflicts
Crabs
Cultural heritage
Deforestation
Demography
Development
Facilities
Food security
Habitats
Hydro-sedimentary flow
Illegal fishing
Informal activities
Knowledge
Mangrove
Market
Mud
Oysters
Pollution
Professional fishing
Public actors
Recreational fishing
Regulation
Shrimp and fish
Water Quality
Outdegree
Indegree
Centrality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Other rule?

	Connection strength	Number of connection	%	Cumulated %	
	0	728			
	1	143	48%	48%	
74%	2	54	18%	67%	Rejected
	3	23	8%	74%	
	4	11	4%	78%	
10%	5	12	4%	82%	Low (0.33)
	6	6	2%	84%	
	7	9	3%	87%	
	8	4	1%	89%	
8%	9	3	1%	90%	Medium (0.66)
	10	3	1%	91%	
	11	4	1%	92%	
	12	2	1%	93%	
	13	3	1%	94%	
8%	14	3	1%	95%	Strong (1)
	15	1	0%	95%	
	16	3	1%	96%	
	17	3	1%	97%	
	18	1	0%	97%	
	19	1	0%	98%	
	20	1	0%	98%	
	21	2	1%	99%	
	22	1	0%	99%	
	23	0	0%	99%	
	24	1	0%	99%	
	25	0	0%	99%	
	26	1	0%	100%	
	27	1	0%	100%	
	28	0	0%	100%	

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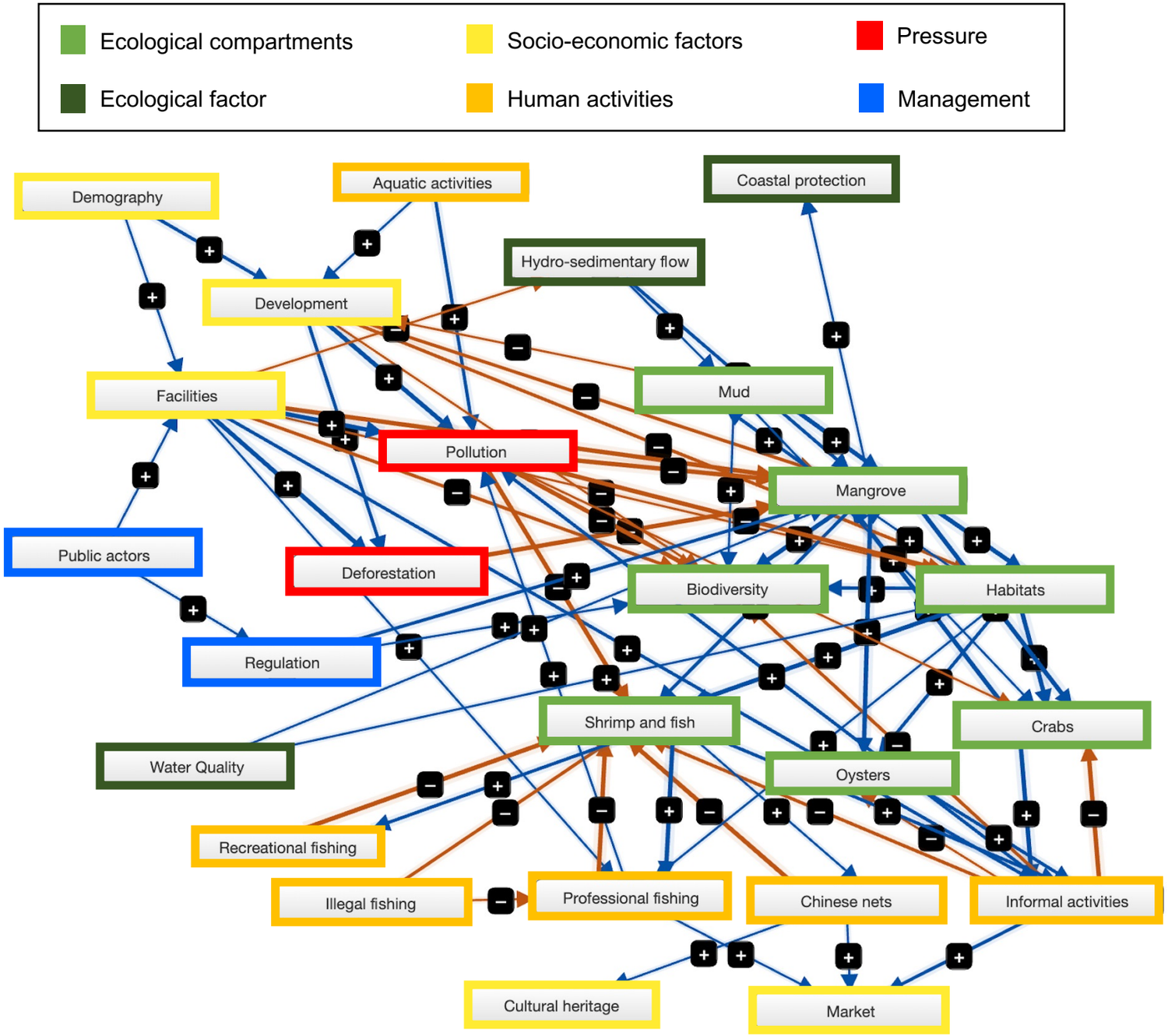

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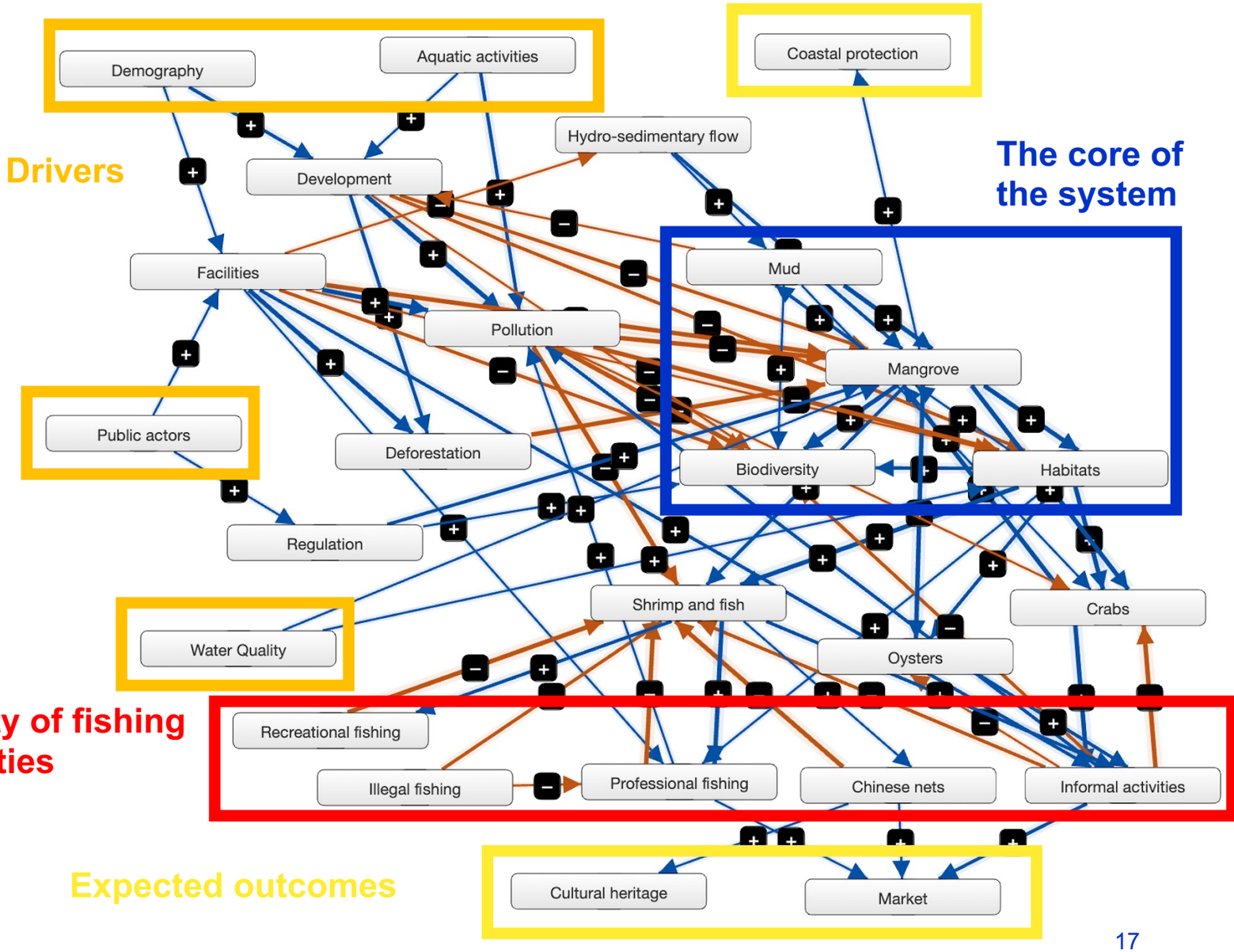


Scenario exploration

- **Scenario 1**

Increase of climate change

Doubling population

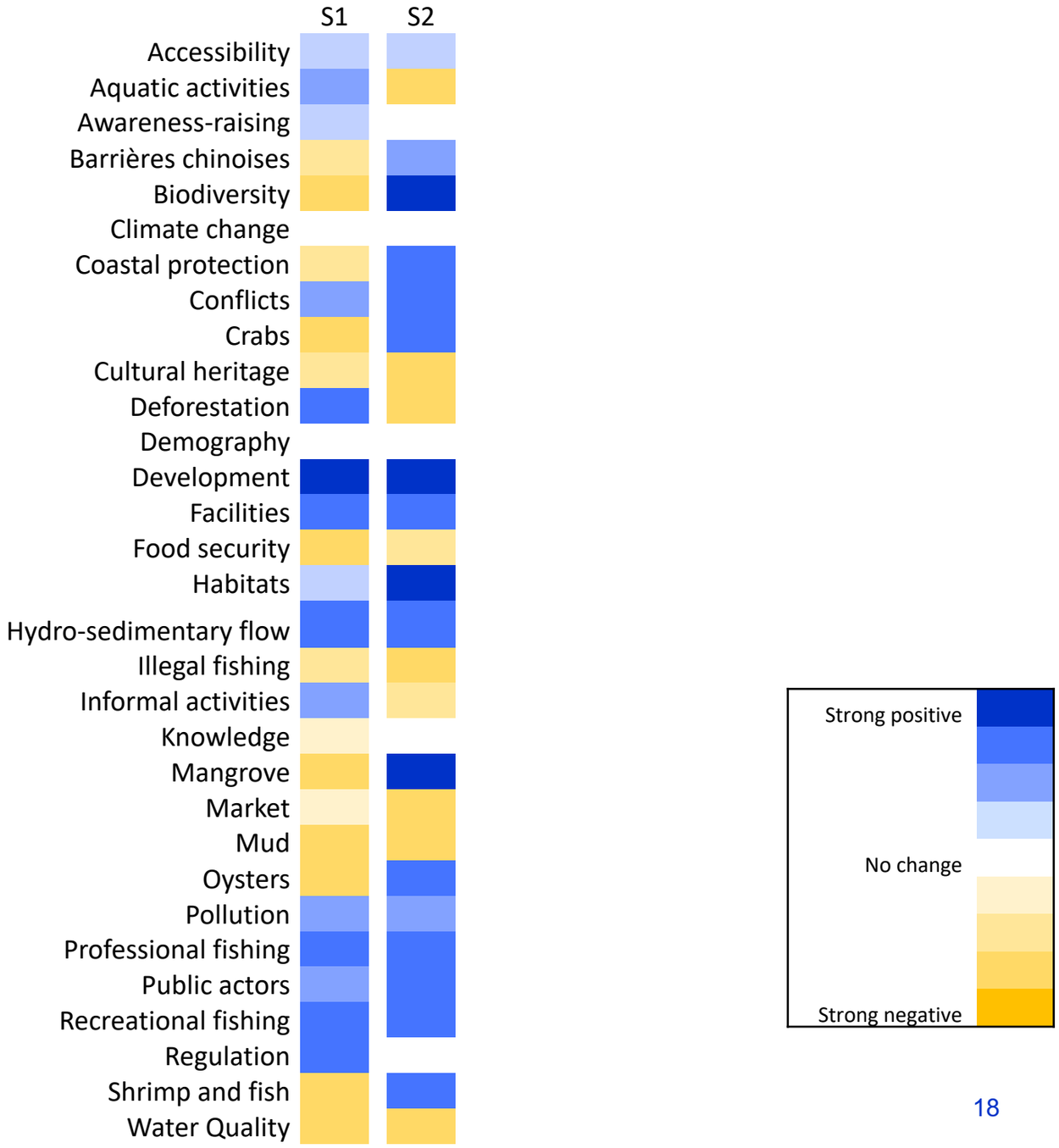
- **Scenario 2**

Scenario 1 + Conservation action

Awareness raising

Regulation

Knowledge production

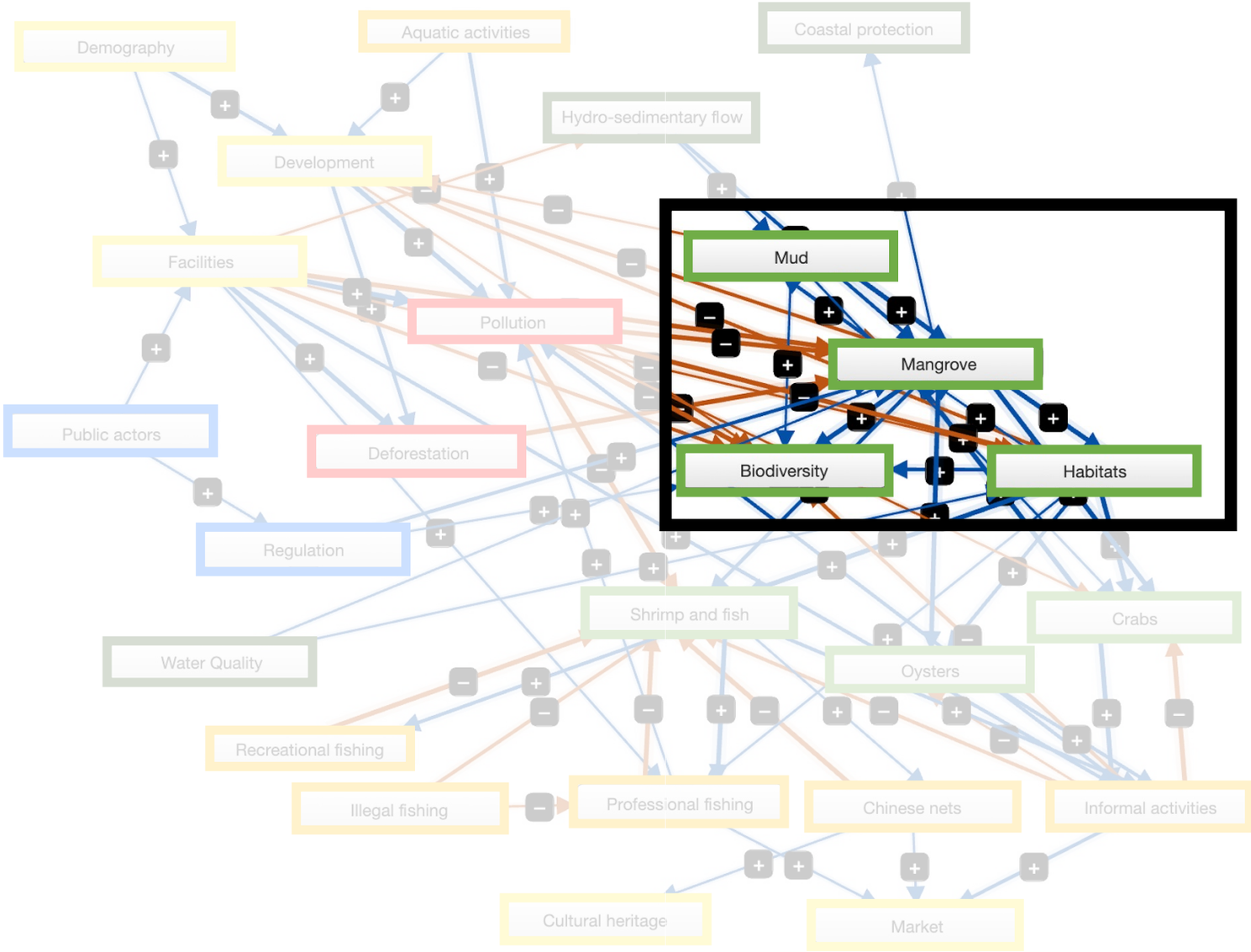


Conclusion

Mangroves are important but they are embedded into a complex system that is not enough considered in this very dynamic ecosystem

FCM an interesting tool to study socio-ecosystem in data poor context

Next step: a feedback from local experts!!!!



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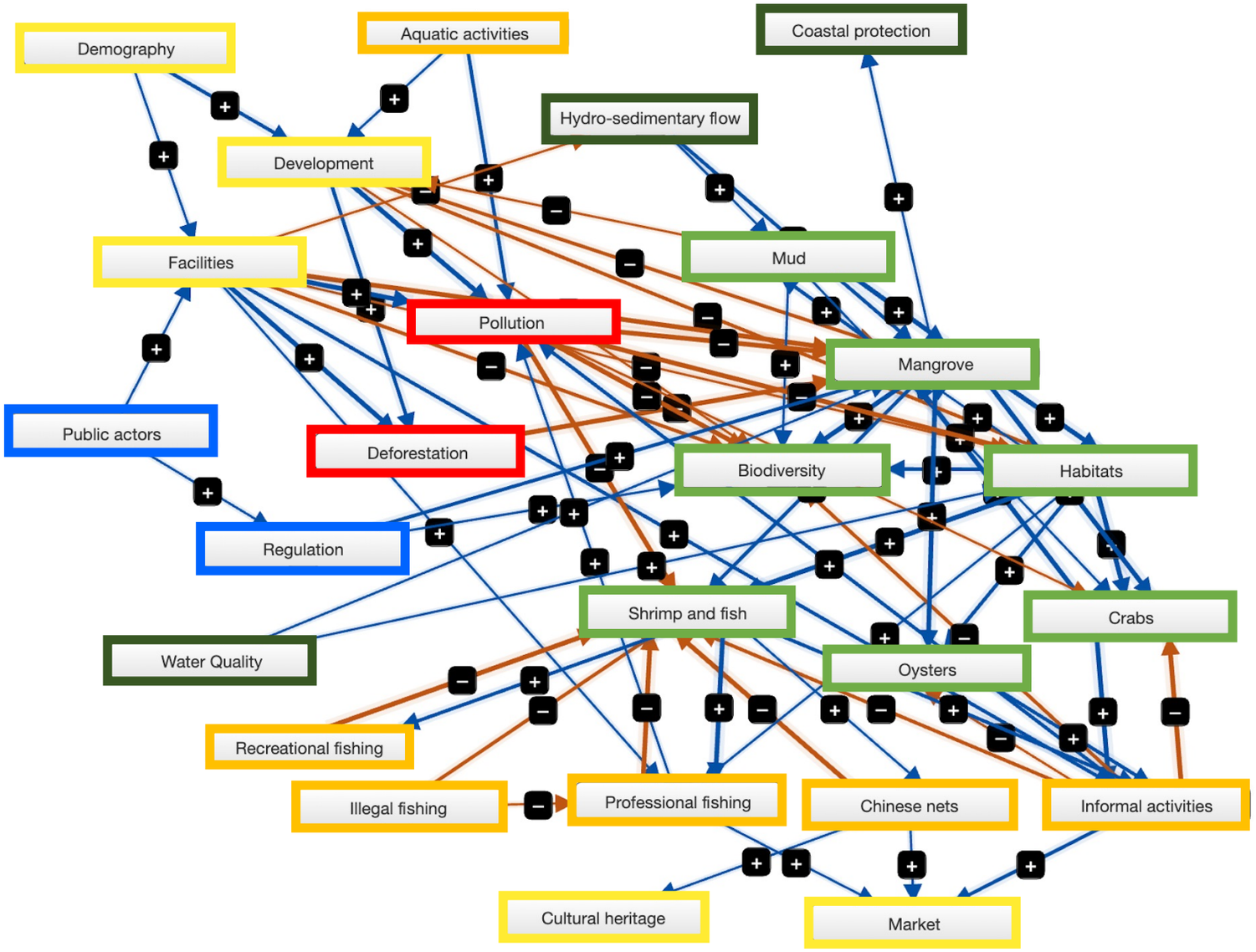

Thank you for your attention!!

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Number of new variable per new interview