ISAHP 2020 WEB CONFERENCE

ANPSORT II METHOD: AN EXPERIMENTATION TO ASSESS THE RESILIENCE OF A SOCIO-ECOLOGICAL SYSTEM.

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NEOMA BUSINESS SCHOOL

GOAL

The aim of this contribution is to employ a Multicriteria Decision Analysis approach (MCDA) developed through the Analytic Network Process Sorting II method (ANPSort II) to investigate the resilience of a Socio-Ecological Systems (SES) as a group of territorial clusters in the Grand-Est region, France. A set of indicators was defined to evaluate the resilience of territorial clusters, according to analyses performed through GIS and STEEP+SWOT Analysis. A survey was led to investigate the importance of the set of indicators and to assess the resilience performance of the case study under investigation.

Keywords: Resilience, Mcda, AnpSort II

OUTLINE

1 FRAMING THE PROBLEM

2 LITERATURE REVIEW

3 METHODOLOGY

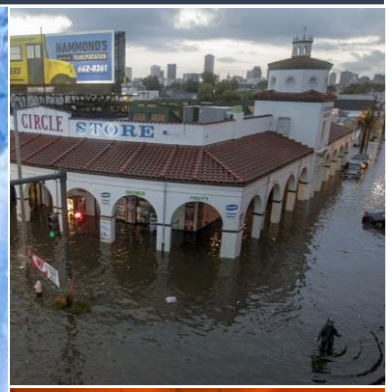
4 APPLICATION

5 RESULTS

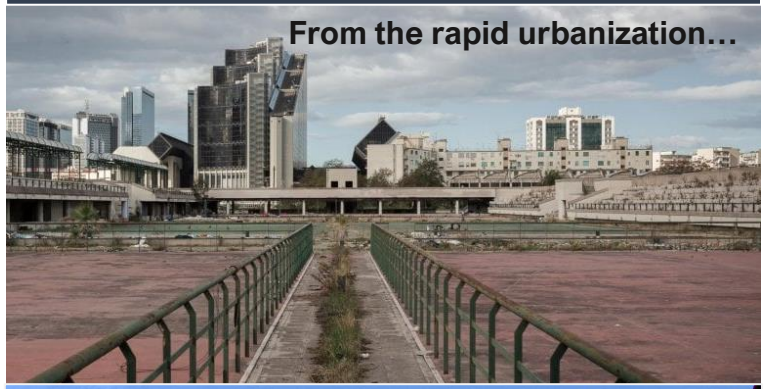
6 CONCLUSIONS AND NEXT STEPS

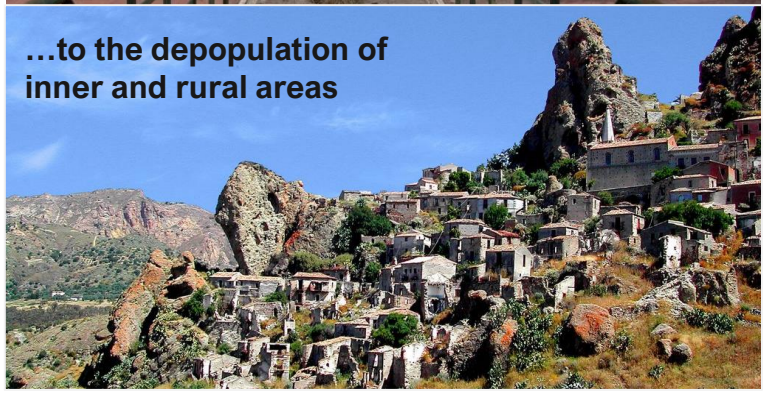
FRAMING THE PROBLEM

SHOCKS AND DISTURBANCES



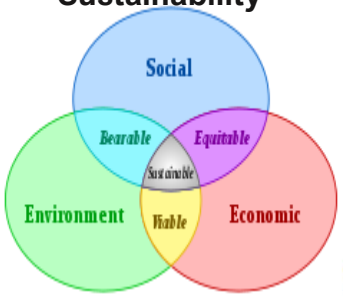
URBAN DYNAMICS



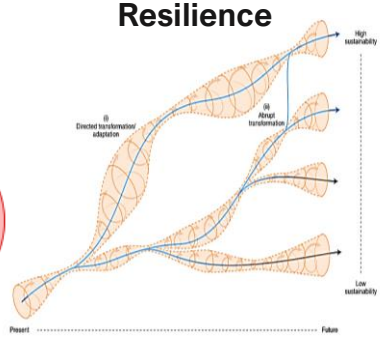


PLANNING CHALLENGES

Sustainability



Resilience

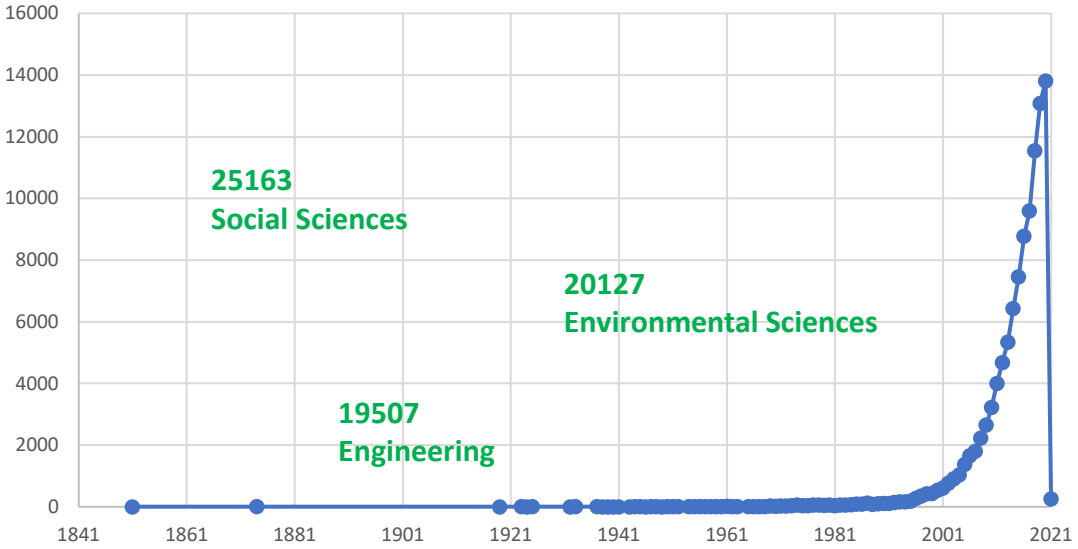


The design of policies and actions for increasing sustainability often may compromise resilience of an environmental system (Elmqvist et al. 2019)

Mismatches between government actions and environmental outcomes must be solved (Pillay & Buschke, 2020)

LITERATURE REVIEW

Papers including the keyword "resilience"



Resilire, "to bounce back" (Skeat, 1882)

Ecological resilience (Holling, 1973)

Engineering resilience (Holling, 1995; Berkes & Folke, 1998)

Social Resilience (AHPR, 1999)

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Economic Resilience (Pendall et al., 2010)

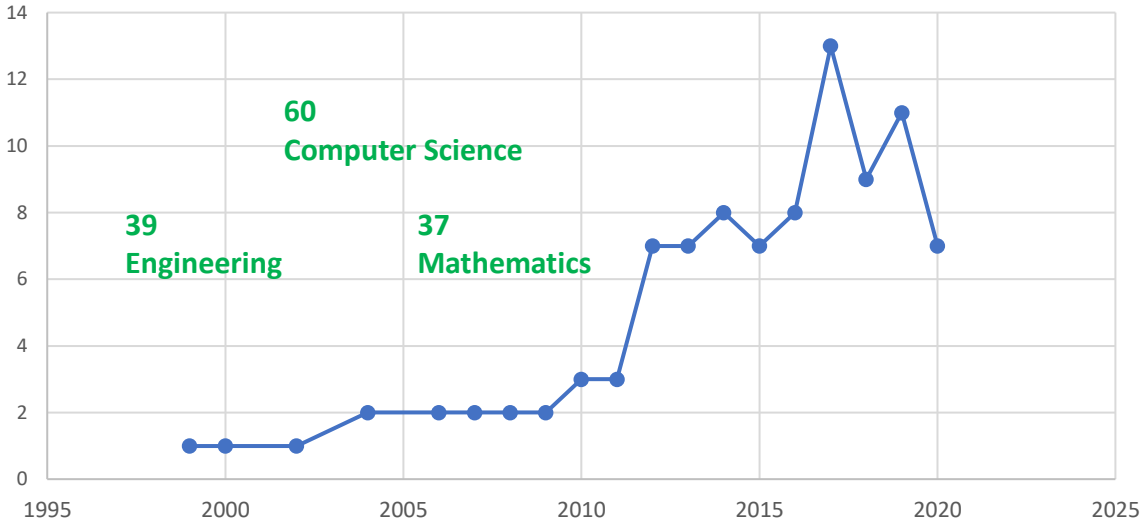
RESILIENCE, POLYSEMIC CONCEPT (Gunderson et al., 2010)
...across different spatial and temporal scales (Gunderson & Holling, 2002)

Urban Resilience (Meerow et al., 2016)

Sustainability, Resilience and Transformations (Elmqvist et al., 2019)

Territorial Resilience (Brunetta et al., 2019, Assumma et al., 2020)

Papers including "sorting method" AND "decision-making"



Author, Year	Description	Field
Ishizaka et al. (2012)	Development of the AHP Sort as new variant of the AHP process to support decision problems of large scale.	Decision-making
Miccoli and Ishizaka (2017)	AHPSort II for a risk classification of municipalities to wolf attack on livestock farms.	Risk Analysis
Ishizaka and Pereira (2020)	ANPSort method to provide a researcher classification in the ambit of high education academy.	Education

Elaborations from Scopus (Accessed on November 2020)

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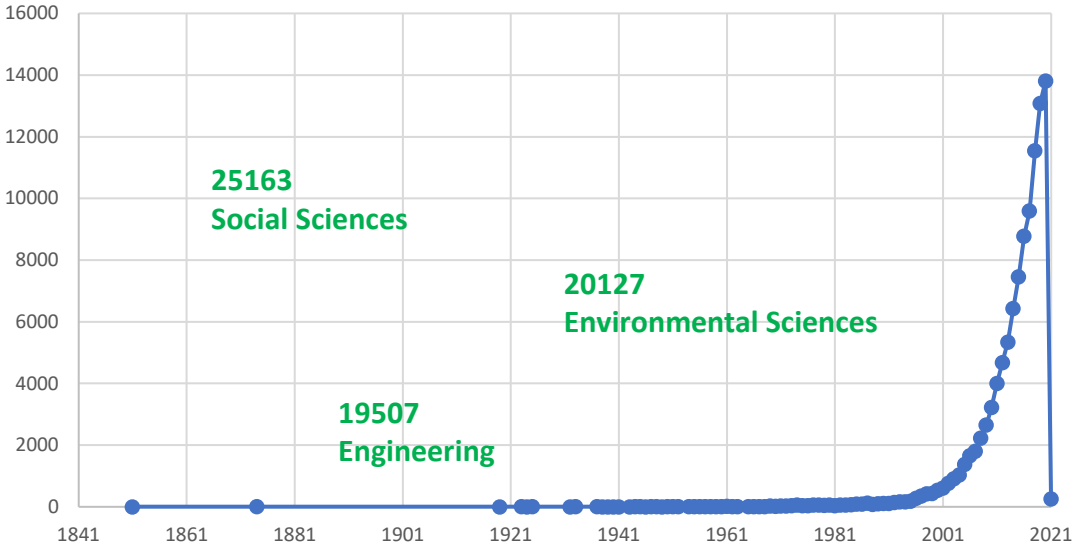

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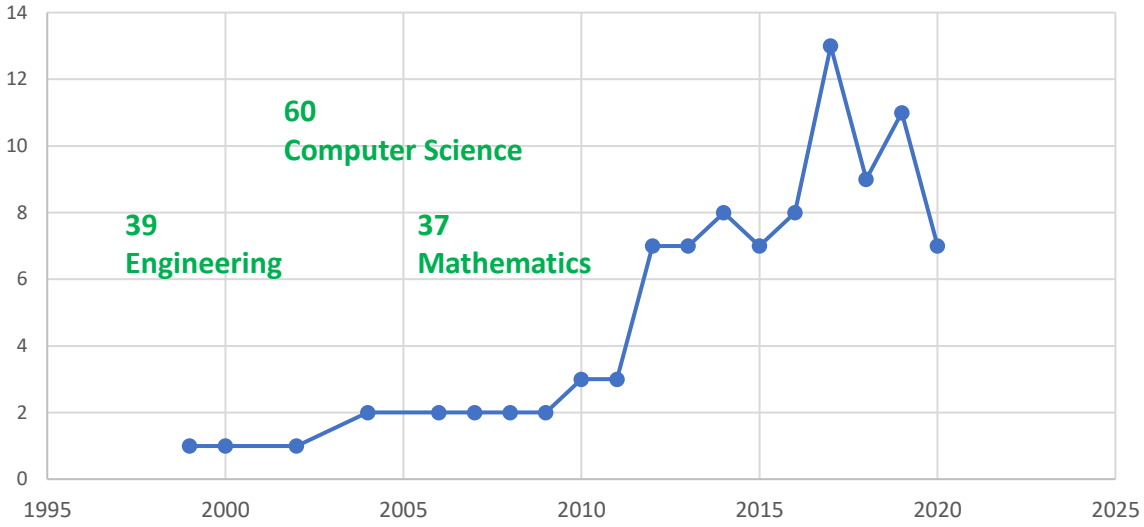
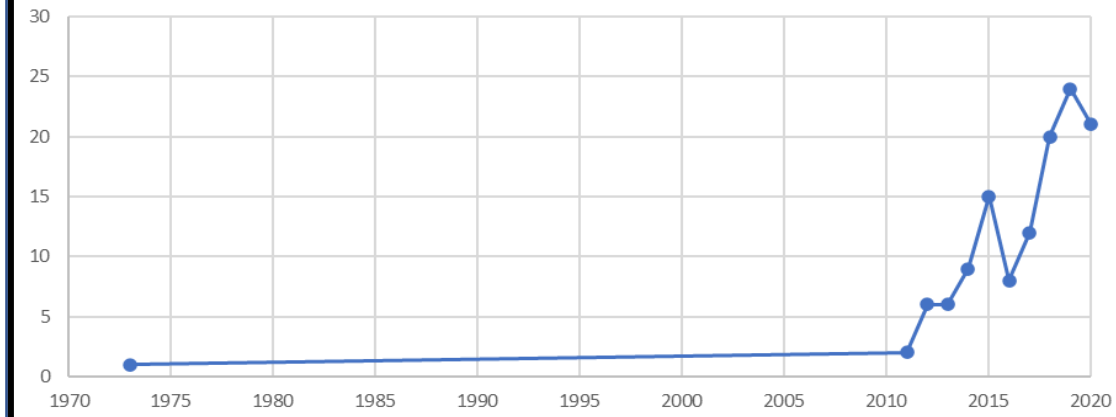


Papers including boh keywords
"sorting" AND "resilience"



ANPSORT II : METHODOLOGY

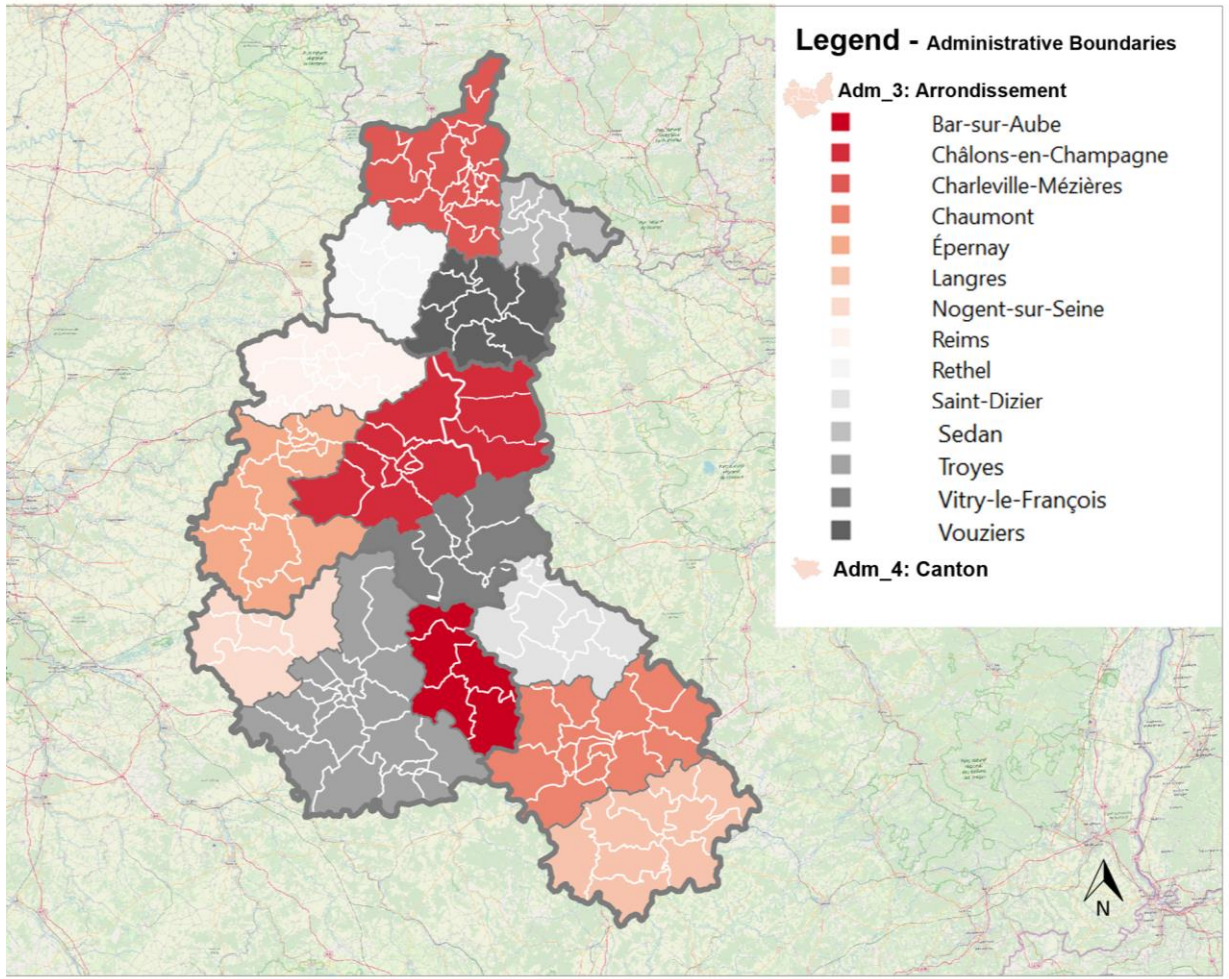
[Ishizaka et al., 2012; Miccoli & Ishizaka, 2017; Ishizaka & Pereira, 2020]

1. Definition of the decision problem as a network. Definition of a finite number of alternatives $a_k, k = 1, \dots, 14$, a set of classes of resilience $C_i, i = 1, \dots, 4$
2. Definition of local limiting profiles lp_{ij} or central profiles cp_{ij} with respect to the 4 classes;
3. Pairwise comparisons of the network's elements, at nodes and clusters levels by using the Saaty's Scale;
4. Selection of representative points $s_{oj}, o = 1, \dots, rp_j$ of each indicator;
5. Pairwise comparisons between the lp_{ij} and s_{oj} to obtain the priorities p_{ij} and p_{oj};
6. Calculation of p_k and l_{pi} (see Eq.2, 3 and 4, Miccoli & Ishizaka, 2017)
7. Elaboration of the supermatrices of the ANP model to obtain final limiting priorities w_j
8. Assignment of global priorities p_ks with lpis to a resilience class.
9. Steps from 5 to 9 are replicated for each alternative of evaluation;
10. Refinement of those alternatives just above and below the lpis with ANPSort. If both ANPSort and ANPSort II methods classifications are similar, the process is terminated. Otherwise, the alternatives must be further classified.
11. Elaboration of spatial maps to visualize the most resilient and the less resilient areas.

APPLICATION - CASE STUDY

FRANCE

GRAND-EST REGION



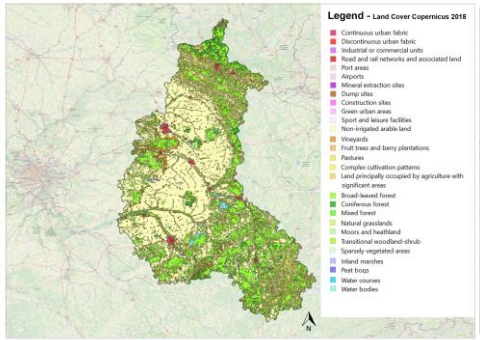
ARRONDISSEMENTS ORGANIZED INTO 14 TERRITORIAL CLUSTERS (CL)

2_Departments	3_Arrondissement 2019	CL	Area_ha
Ardennes	Charleville-Mézières	1	183.420
	Rethel	2	120.233
	Sedan	3	79.191
	Vouziers	4	141.448
Aube	Bar-sur-Aube	5	119.752
	Nogent-sur-Seine	6	128.407
	Troyes	7	354.535
Haute-Marne	Chaumont	8	249.401
	Langres	9	217.538
	Saint-Dizier	10	158.757
Marne	Châlons-en-Champagne	11	280.331
	Épernay	12	233.988
	Reims	13	152.902
	Vitry-le-François	14	151.886
	TOTAL		2.674.169

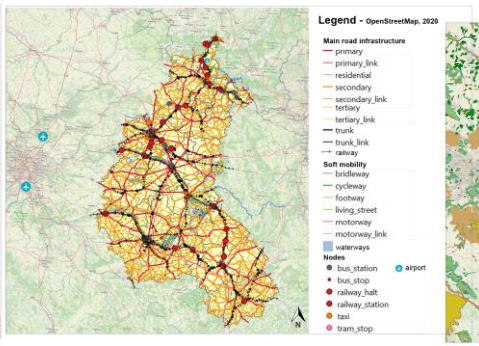
PRELIMINARY ANALYSES

QGIS analyses

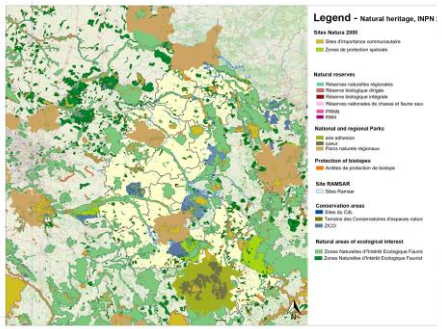
LAND COVER



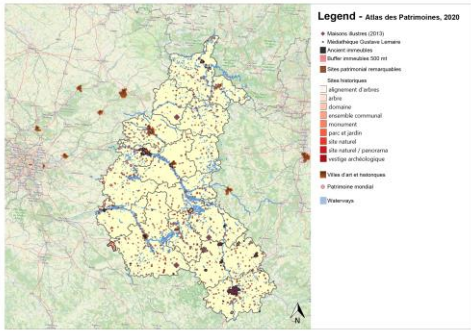
TRANSPORTS AND ACCESSIBILITY



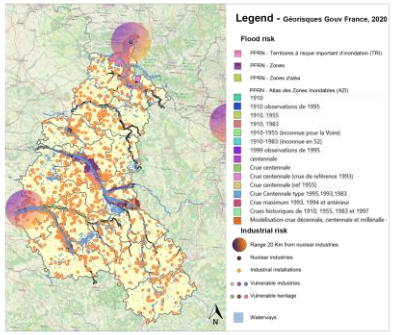
PROTECTED AREAS



CULTURAL HERITAGE



RISKS



STEEP+SWOT ANALYSIS

	Driving Factors	Strenghts	Weaknesses	Opportunities	Threats
SOCIETY	Population age	Attractive agglomerates favor an increase of population in some departments (i.e. Aube and Marne)	Increase of the aging trend of population	Increase the economic attractiveness through new services, job offer and social capital	Lack of generational change
	Education	The University of Champagne as the association of universities Presence of foreign population with high level of education			
	Associations	Presence of several historical associations and cooperatives, foundations and mutuals diffused in ahe territory			
	Population density	Low population density with respect to the other French regions, in part due to the concentration of industrial activities			
	Population flows		Flatting population growth due to the out-migration in other regions and abroad		
TECHNOLOGY	Industries		Global crisis (2008) and high international competitiveness have weakened the traditional industries		The aging of the industrial installations may increase the technological risk in the territory
	Dams				A potential falling of the dams could cause relevant social and economic losses.
	Energy	Presence of a regional renewable energy network (solar, eolic installations)	High energy consumption in the territory than the other French regions, due to the intense industrial activity.	Major sensibilization and incentives for using green energy	
	Transports	EU infrastructures cross the territory. Presence of the Vautry airport logistic platform. Presence of the transfrontalier railway LGV. Navigable rivers. Regional Plan 2015-2020 for renovating infrastructures	The transport and logistic sectors are in decline sine the 2008 crisis. High international competitiveness. Increase of the fuel costs	Definition of strategic policies for empowering the transport and logistic sectors. Periodic mantainance of the railway for avoiding the rapid aging. Empowering the network of logistic platforms	The lack of intervention could cause a further decrease of competitiveness and thus an economic loss for the territory.
ENVIRONMENT	Natural hazards	Strategies of risk management regulated by the normative in force (ZRDC)	The lytological characteristics of the soil (clay) cause landslides and floods events in the territory	Adoption of measures to secure slope stability. Major sensibilization of local communities to natural hazards	The increasing level of groundwaters could favor heavy flooding events
	Air quality	Drop of high greenhouse emissions.	High levels of greenhouse emissions caused by agriculture and breeding activities	Major sensibilization to production techniques at lower environmental impact.	The lack of intervention may cause a worsening of the local communities health
	Water quality	Good ecological state of water bodies in the basin head.	Deterioration of water quality in the valley, due to the pressures of agriculture and wine farms, industries and urban settlements	Adoption of measures for reducing the water pollution and protecting aquatic habitats and biodiversity	

ENVIRONMENT	Waste management	Falling trend of waste production with respect to the national trend. Programs, projects, activities for local communities		Encouraging enterpreneurships to adopt sustainable measures for waste production and management.	
	Land take	Laws (SRU, Grenelle 1 then 2, ALUR) and resource conservation have gradually brought a strengthened framework against land take	Progressive soil sealing, leading in particular to the fragmentation of natural areas and the loss of ecosystem services.	Creation of a strategy for adapting the urban space to theresidents and companies (standard quality, economic accessibility)	
	Climate Change		Increasing of temperatures and dry periods influence negatively on biodiversity and agriculture; Local forests suffer the dry period.	Adaptation of agriculture methods for limiting the effects of climate changes and for preserving water resource	The reduction of the precipitation days may reduce the infiltration and the outflow, thus stressing the water resource. The increase of dry periods may diffuse parasites in the forests, thus carrying relevant damages. The hot days may increase the air pollution, thus affecting the people health.
ECONOMICS	Real Estate	Social housing higher than the other French regions; Recovery of the rural buildings in peri-urban and rural areas with ANRU; Investment location system regulated by the French law.	Old real estate properties and expensive investments for the recovery. Difficulty to sale big properties, in favor of collective properties. Tendency to build new properties, due also to the low energetic building characteristics.	Recovery of vacant and abandoned properties, in order to re-launch them in the real-estate market; Building new properties according the demand of young families and with high energy performance.	
	Agriculture farms	Highly specialized agriculture farms. Regional plan (PRAD, 2015) for increasing the quality of the production systems.	Falling trend of breeding. Loss of grasslands. Quality production under the certified degrees. The biological agriculture is the less practised.	Major sensibilization of farmers to quality certifications and on the effects of climate change on cultivations;.	The lack of intervention may increase the greenhouse effect, water pollution, also solicited by climate change.
	Forest management	Wide extension of forestry surfaces	Forest production on hardwood, far from the demand of conifers; Loss of forestry companies and jobs	Adopting models of Payment for Ecosystem Services (PES) with the aim at obtaining environmental benefits by managing forests Introduction of new products and services.	The lack of forest management may increase the effects of floods and landslide events in the territory
	Green jobs	Increasing of green jobs that contribute to the life quality of local communities; Creation of competitiveness clusters R&D.		Creation of new job demand	
	Tourism	Presence of the Great Lakes, Regional Park and othe protected areas favor the green tourism. The Unesco site attracts eno-gastronomic tourism from all over the world. Tourism solutions to stay in the destination for more than 1 day; Tourism policies for accessibility for people with disabilities. Touristic routes by byke and motorbyke.		Increase the accessibility with more sustainable modal transports to visit tourism destinations. Increasing the networking between tourism and local productors; Increasing the education in tourism field. Catalyzing cultural events for increasing tourism attractivenss	An increase of attractiveness may increase the tourism pressure in the territory

POLICY	Actors and Stakeholders			Increase the relations for increasing the life quality with sustainable and resilient policies.	
	Climate Planning	Plan Climat Air Energie Territorial (PCAET) for urban communities with more than 20000 inhabitants		Major involvement of population and economic sectors in the activation of strategies for climate change	
	Rural development	LAGs' rural network favors the exchange, learning and aid in the realization of LEADER actions		New botto-up initiatives for local development through the cooperation of local actors and attraction of funds	
	Regional Planning	Regional Plan in force 2015-2020 for renovating the infrastructures in the territory			
	EU investments	Presence of investments from 3 EU funds (FEDER, FSE, CTE) according to the EU Strategy 2020			
LANDSCAPE	Unesco site	Presence of Champagne Hillsides, Houses and Cellars since 2015	Lack of measures to protect and restore biodiversity of the landscape. Lack of an Heritage Impact Assessment by windfarms	Strategies of economic growth, biodiversity protection and restoring of biodiversity	No biodiversity protection may influence negatively the state of conservation of the Unesco site
	Protected areas	Regional Park Montagne de Reims, natural and cultural sites. Cultural events and accommodation for rural tourism forms		Increasing the landscape quality and biodiversity; involvement in large scale business-park projects.	Invasive hydraulic interventions and other disturbances may compromise the state of the protected areas
	Cultural heritage	Military heritage, from the Gallic era until the First World War. Significant hydraulic and industrial heritage			
	Vernacular heritage	Presence of cross, calvaries, terminals, wash-houses, drinkers, fountains, walls) that contributes to the landscape identity		Preserving and valorizing cultural heritage by adapting a more sustainable tourism offer.	
	Landscape disturbances	Acoustic maps for regulating noise pollution. Development areas for wind turbines. Regional system of renewable energy (SSRE+R)	Highways and railways as source of noise pollution. Dense energy network that causes landscape fragmentation	Interventions to mitigate noise pollution in proximity of protected areas. New projects that relate landscape and eolic network	The lack of mitigation measures may impact negatively on the well-being of the inhabitants
ECOLOGY	Biodiversity	Presence of aquatic habitats and micro habitats in relation to Natura 2000. Adoption of programs for preserving and enhancing natural habitats.	Disturbances that compromise the life of habitats with high ecological quality		An increase of attractiveness may increase the tourism pressure in the territory and the impacts on the environment
	Ecological connectivity	Natural Plan (2016-2021) for preserving, enhancing and restoring the ecological connectivity. Program Trame verte et bleue.	River bodies are mainly artificial and the presence of obstacles compromise the ecological connectivity	Adoption of interventions to limit the erosion and recover the idromorphology and the ecological state of habitat and micro-habitat.	
	Green areas	Presence of wide forests with good ecological quality	Presence of isolated grasses, rock habitats. Humid areas in decline		Invasive hydraulic interventions may compromise the ecological state of the humid areas
	Urban areas and impermeable barriers		Progressive soil sealing, leading in particular to the fragmentation of natural areas as well as to the overall landscape	Planning green interventions for favouring the ecological connectivity, especially in proximity of forests and protected areas	Soil sealing may imply the planning of new infrastructures that may obstacle the ecological connectivity

Definition of a set of 40 indicators aiming at measuring the resilience of SES. (This set was synthetized to be employed in the network model.)

Definition of a dataset for the 14 CLs according to the main international, national and regional data sources (e.g. COPERNICUS, INSEE, DREAL Grand-Est)

Facilitation in the definition of the network model by identifying dependency and retroactive relationships between the elements of the network.

APPLICATION NETWORK MODEL

SOCIETY

- Population density (ab/km2)
- Inactive population with less than14 y.o. and more than 65 y.o. (no.)
- Population with high education (%)

REGIONAL DEVELOPMENT

- Active establishments (no.)
- Unemployment rate (%)
- Deal flows of green projects (€/y)

TECHNOLOGY

- Accessibility from Paris (minutes)
- CO2 emissions (kg/year)
- Strategic buildings and works (no.)

ECONOMY

- Active establishments (no.)
- Unemployment rate (%)
- Deal flows of green projects (€/y)

ENVIRONMENT

- Green areas of high ecological quality (Mcal/m2 per year)
- Contaminated sites (no.)
- Environmental associations (no.)

CLASSES

- C1 Poor Resilience
- C2 Medium Resilience
- C3 Good Resilience
- C4 Strong Resilience

Elaboration through SUPER DECISIONS CDF

14 Territorial clusters (alternatives k):

- CL1 Charleville-Mézières
- CL2 Rethel
- CL3 Sedan
- CL4 Vouziers
- CL5 Bar-sur-Aube
- CL6 Nogent-sur-Seine
- CL7 Troyes
- CL8 Chaumont
- CL9 Langres
- CL10 Saint-Dizier
- CL11 Châlons-en-Champagne
- CL12 Épernay
- CL13 Reims
- CL14 Vitry-le-François

What is the meaning of the classes of resilience performance?

POOR Resilience C_1

The SES is characterized by poor conditions in all considered dimensions. It is highly exposed to vulnerabilities and risks.

lp_{ij}

MEDIUM Resilience C_2

The SES under investigation is intermediate between poor and good resilience performances. It could improve its conditions through a high effort.

lp_{ij}

GOOD Resilience C_3

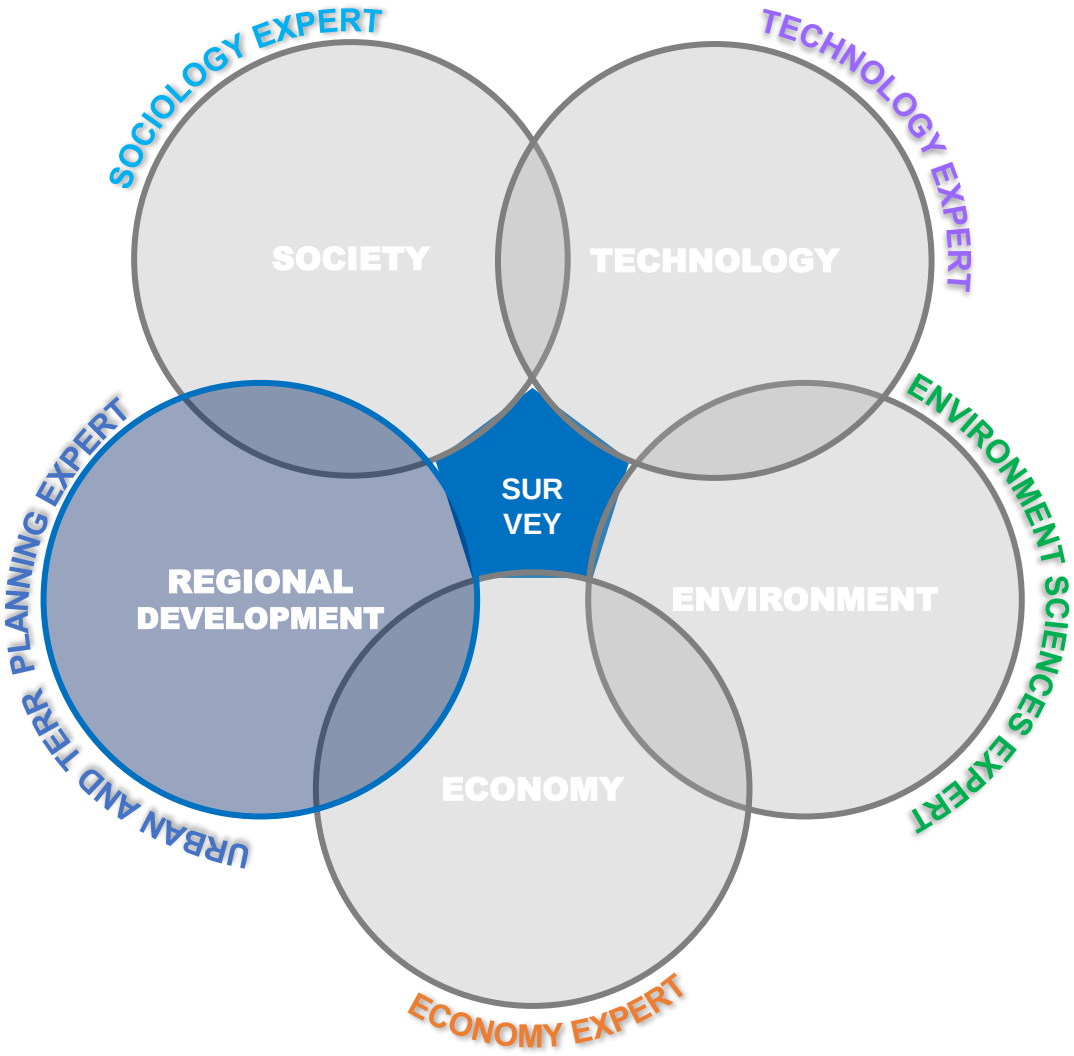
The SES is characterized by a good robustness and it can easily reach a new positive equilibrium.

lp_{ij}

STRONG Resilience C_4

The SES under investigation has a high robustness in all considered dimensions and it is able to cope with changes through the minimum effort.

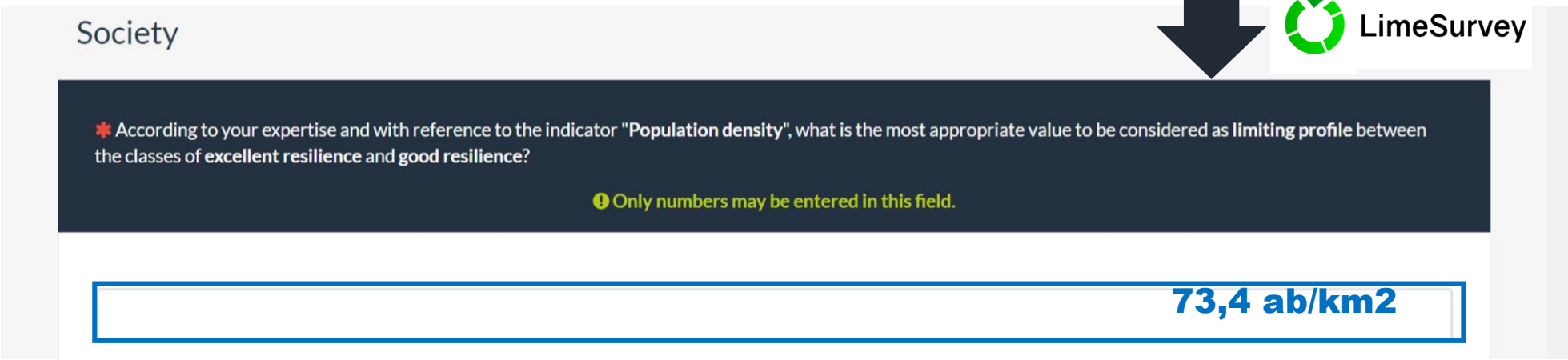
APPLICATION – SURVEY



- This application is focused on the opinion on one single expert.
- The engaged expert has expertise in the field of urban and territorial planning.
- Other experts have been engaged and the survey is still in course.

APPLICATION – SURVEY

		SOCIETY			TECHNOLOGY			ENVIRONMENT			ECONOMY			REGIONAL DEVELOPMENT		
Clusters		Population density (ab/km2)	Inactive population (<15 yo and >65 yo) (no.)	Population with high education (%)	Accessibility from Paris (minutes)	CO2 emissions (kg per year)*	Number of strategic buildings	Green areas of high ecological quality (m2)	Contaminated sites (no.)	Environmental associations	Active establishments (no.)	Unemployment rate (%)	Deal flow for green projects (2014-2020)	Groups of Local action	Land take index 1990-2018	EIA and SEA procedures 2018
CL1	Charleville-Mézières	86,6	43.112	19,4	148	322854724,9	123	85.442	58	2	11.856	17,8	4.219.476 €	2	0,21	8
CL2	Rethel	[illegible]	11.103	20,3	112	4137493525	36	8.203	3	1	3.331	9,6	602.753 €	1	0,10	4
CL3	Sedan	73,4	15.912	16,6	159	322854724,9	63	26.870	20	0	4.175	19,2	1.042.000 €	0	0,24	1
…	…						…								…	…
CL14	Vitry-le-François	32,8	12.954	16,1	123	1108018013	66	30.867	2	2	3.789	15,2	1.486.464 €	1	0,29	3



1. DEFINITION OF LOCAL LIMITING PROFILE

SOCIETY	POOR	*l_ipj*	MEDIUM	*l_ipj*	GOOD	*l_ipj*	EXCELLENT
Population density (ab/km2)		20,3		42,1		73,4	
Inactive population (no.)		63261		15912		8169	
Population with high edu (%)		16,2		20,3		22,3	

EXPERT OF URBAN AND REGIONAL PLANNING

SUPPLEMENTARY MATERIAL

- List of indicators
- Dossier Champagne-Ardennes
- STEEP+SWOT Analysis

zoom

APPLICATION – PAIRWISE COMPARISONS

With reference to the class ''Good resilience'', in Regional Development cluster, what is the most important indicator? And how much?

PAIRWISE COMPARISONS AT NODES LEVEL

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
EIA AND SEA PROCEDURES					**5**													LAND TAKE
EIA AND SEA PROCEDURES							**3**											LOCAL ACTION GROUPS
LAND TAKE						**4**												LOCAL ACTION GROUPS

Priorities

EIA AND SEA PROCEDURES	**0.62670**
LAND TAKE	**0.09362**
LOCAL ACTION GROUPS	**0.27969**

CR ratio: 0.08247

Saaty's scale

Intensity	Definition
1	Equal importance
3	Moderately of major importance
5	High importance
7	Very high importance
9	Extreme importance
2,4,6,8	Intermediate values

EXPERT OF URBAN AND REGIONAL PLANNING

SUPER DECISIONS CDF

zoom

APPLICATION – PAIRWISE COMPARISONS

With reference to the class ''Poor resilience'', what is the most important dimension? And how much?

PAIRWISE COMPARISONS AT CLUSTERS LEVEL

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
ALTERNATIVES													**5**					ECONOMY
ALTERNATIVES														**6**				ENVIRONMENT
ALTERNATIVES															**7**			REG. DEVELOP.
ALTERNATIVES												**4**						SOCIETY
ALTERNATIVES											**3**							TECHNOLOGY
ECONOMY							**3**											ENVIRONMENT
ECONOMY											**3**							REG. DEVELOP.
ECONOMY							**3**											SOCIETY
ECONOMY								**2**										TECHNOLOGY
ENVIRONMENT											**3**							REG. DEVELOP.
ENVIRONMENT							**3**											SOCIETY
ENVIRONMENT							**3**											TECHNOLOGY
REG. DEVELOP.							**3**											TECHNOLOGY
REG. DEVELOP.						**4**												SOCIETY
SOCIETY							**3**											TECHNOLOGY

Priorities

ALTERNATIVES	**0.03327**
ECONOMY	**0.22794**
ENVIRONMENT	**0.17331**
REG. DEVELOP.	**0.37970**
SOCIETY	**0.07757**
TECHNOLOGY	**0.10822**

CR ratio: 0.08584

Saaty's scale

Intensity	Definition
1	Equal importance
3	Moderately of major importance
5	High importance
7	Very high importance
9	Extreme importance
2,4,6,8	Intermediate values

EXPERT OF URBAN AND REGIONAL PLANNING

SUPER DECISIONS CDF

zoom

APPLICATION – REPRESENTATIVE POINTS

Indicators “Land Take 1990-2018” and “EIA and SEA assessments” of the Cluster “Regional Development”

	MAX						MIN
so_{ij}	0.39		0.25		0.13		0.02
lp_{ij}		0.30		0.17		0.10	

	MIN	Cluster 1			Cluster 2		MAX
so_{ij}	1		3		5		10
lp_{ij}		2		4		8	

Joining point

EXPERT OF URBAN AND REGIONAL PLANNING

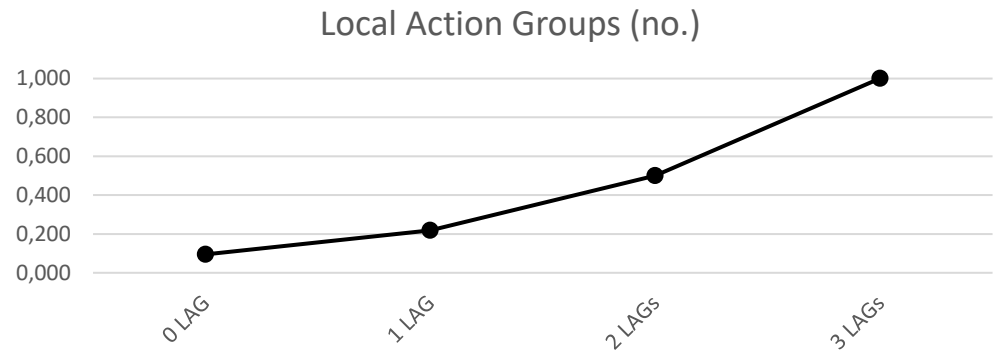
APPLICATION – REPRESENTATIVE POINTS

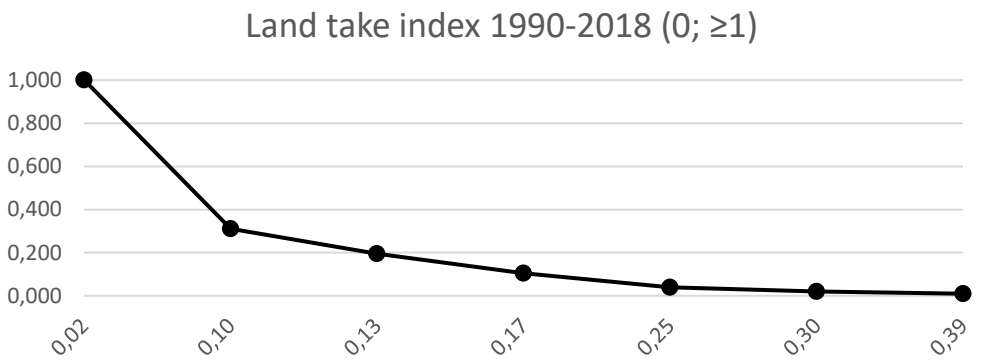
Indicators of the cluster “Regional Development”

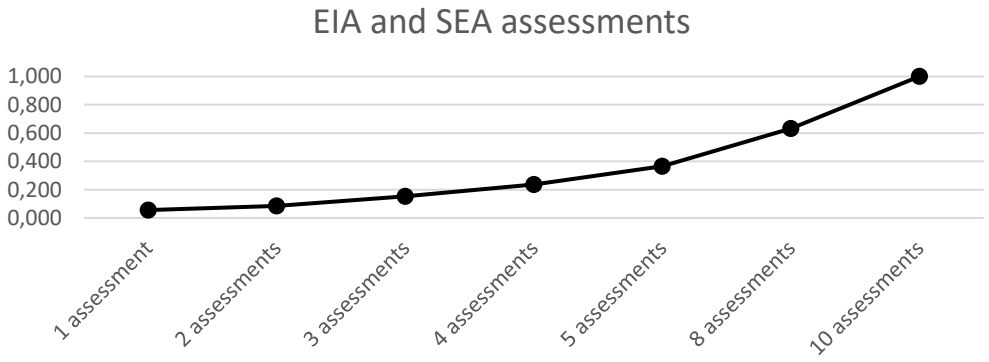
Local Action Groups (no.)	Local priorities	Joining Point	Linkage Cluster 1 and Cluster 2	Normalized priorities
0 LAG	0,117			0,095
1 LAG	0,268			0,218
2 LAGs	0,614			
		1,84		
2 LAGs	0,333		0,61441	0,500
3 LAGs	0,667		1,22884	1,000

Land Take (0; ≤1)	Local priorities	Joining Point	Linkage Cluster 1 and Cluster 2	Normalized priorities
0,39	0,057			0,010
0,30	0,116			0,020
0,25	0,229			0,040
0,17	0,598			
		9,153		
0,17	0,065		0,598	0,105
0,13	0,122		1,112	0,196
0,10	0,193		1,766	0,311
0,02	0,620		5,677	1,000

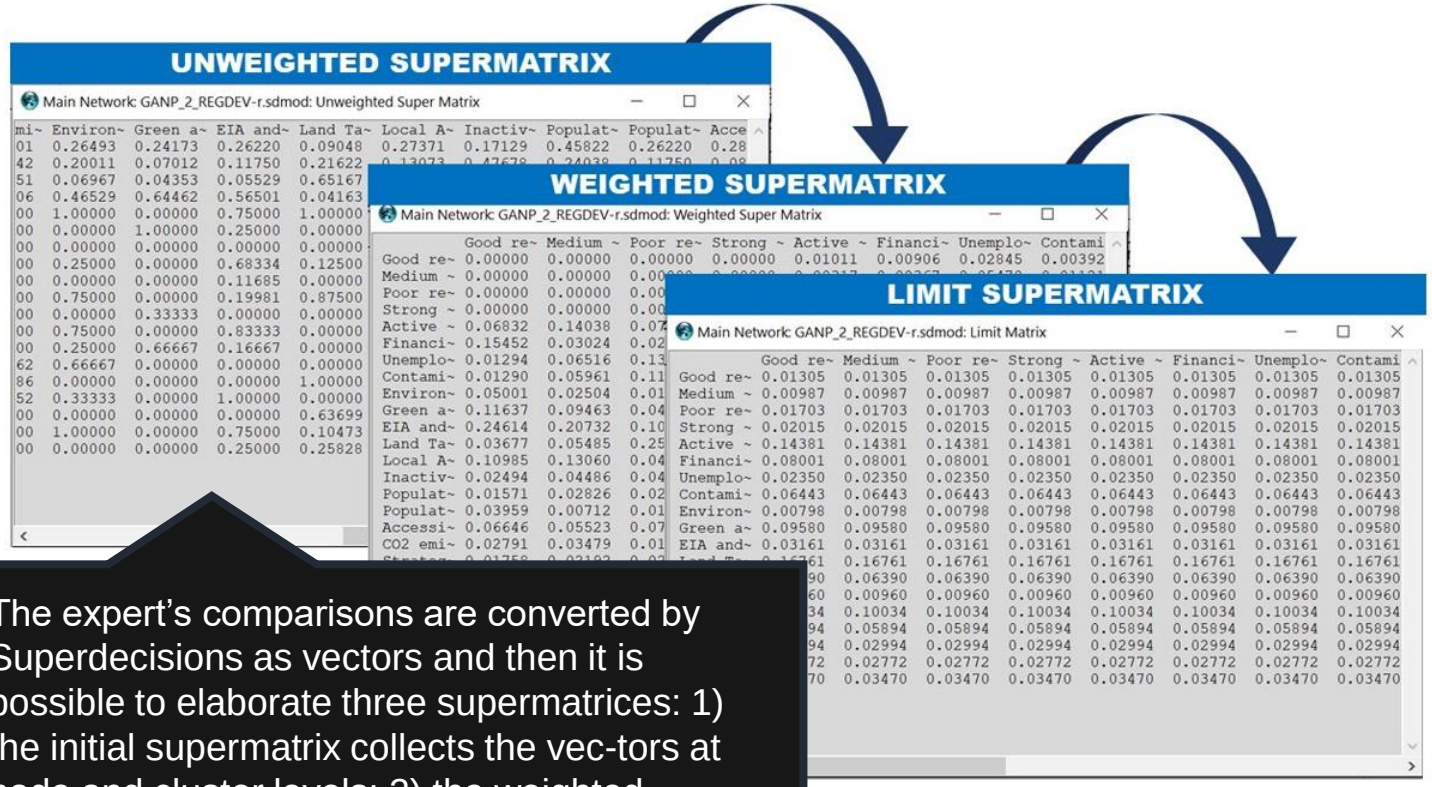
EIA and SEA procedures (no.)	Local priorities	Joining Point	Linkage Cluster 1 and Cluster 2	Normalized priorities
1 assessment	0,106			0,056
2 assessments	0,164			0,087
3 assessments	0,288			0,152
4 assessments	0,448			
		4,225		
4 assessments	0,106		0,448	0,237
5 assessments	0,164		0,691	0,366
8 assessments	0,283		1,195	0,632
10 assessments	0,448		1,891	1,000







APPLICATION – PAIRWISE COMPARISONS



The expert's comparisons are converted by Superdecisions as vectors and then it is possible to elaborate three supermatrices: 1) the initial supermatrix collects the vec-tors at node and cluster levels; 2) the weighted supermatrix aggregates both vectors of nodes and clusters; 3) the limit supermatrix multiplies these vectors for themselves until when the vectors became stable. In this way, it is possible to obtain the ranking of final priorities and a ranking of the alternative scenarios.

Elaboration through SUPER DECISIONS CDF

LEVEL OF CLUSTERS - PRIORITIES

Dimensions	Priorities
Society	0,073
Technology	0,115
Environment	0,210
Economy	0,201
Regional Development	0,401
CR RATIO	0,059

LEVEL OF NODES - PRIORITIES

Nodes	Norm by Cluster	Limiting	Limiting normalized without alternatives w_j
Good resilience	0.21708	0,013049	
Medium resilience	0.16426	0,009874	
Poor resilience	0.28337	0,017034	
Strong resilience	0.33529	0,020155	
Active establishments	0.58149	0,143813	**0,153**
Deal flows for green projects	0.32351	0,08001	**0,085**
Unemployment rate	0.09501	0,023497	**0,025**
Contaminated sites	0.38302	0,064429	**0,069**
Environmental associations	0.04746	0,007984	**0,008**
Green areas of high ecologica	0.56951	0,095799	**0,102**
EIA and SEA procedures	0.12014	0,031611	**0,034**
Land Take	0.63700	0,167609	**0,178**
Local Action Groups	0.24286	0,063902	**0,068**
Inactive population	0.05686	0,009603	**0,010**
Population density	0.59414	0,100336	**0,107**
Population with high educatic	0.34899	0,058936	**0,063**
Accessibility from Paris	0.32414	0,029937	**0,032**
CO2 emissions	0.30018	0,027724	**0,029**
Strategic buildings	0.37567	0,034696	**0,037**
		1	1

APPLICATION
DATA ELABORATION

5. CALCULATION OF GLOBAL PRIORITIES

P_k FOR EACH INDICATOR AND ALTERNATIVE K

Alternatives k	Population density (ab/km2)	Inactive population (no.)	Population with high edu (%)	Accessibility from Paris (minutes)	CO2 emissions (kg/year)	Strategic buildings and works (no.)	Green areas of high eco quality (m2)	Contaminated sites (no.)	Environmental associations (no.)	Active establishments (no.)	Unemployment rate (%)	Deal flow for green projects (	Local Action Groups (no.)	Land take 1990-2018 (0;	EIA and SEA procedures	Total P_k
Charleville-Mézières	0,575	0,058	0,049	0,069	**1,000**	0,134	0,464	0,012	0,427	0,100	0,042	**1,000**	0,609	0,075	0,746	**0,287**
Rethel	0,114	0,319	0,098	0,188	0,025	0,013	0,006	0,860	0,223	0,008	**1,000**	0,035	0,218	0,387	0,259	**0,152**
Sedan	0,581	0,147	0,018	0,019	**1,000**	0,047	0,042	0,083	0,050	0,014	0,026	0,068	0,095	0,046	0,056	**0,122**
Vouziers	0,066	**1,000**	0,013	0,011	**1,000**	0,011	0,049	**1,000**	0,050	0,433	0,342	0,024	0,218	**1**	0,056	**0,324**
Bar-sur-Aube	0,069	0,694	0,007	0,082	0,396	0,034	0,093	0,204	0,050	0,009	0,147	0,044	0,095	0,010	0,162	**0,053**
Nogent-sur-Seine	0,182	0,091	0,021	0,785	0,740	0,121	0,008	0,334	0,050	0,016	0,046	0,088	0,095	0,219	0,162	**0,135**
Troyes	0,417	0,02	0,204	0,253	0,396	**1,000**	0,690	0,019	**1,000**	0,554	0,095	0,457	1,000	0,052	0,746	**0,351**
Chaumont	0,073	0,088	0,049	0,038	0,904	0,064	**1,000**	0,334	**1,000**	0,023	0,647	0,099	0,218	0,056	0,336	**0,117**
Langres	0,041	0,145	0,019	0,029	0,714	0,311	0,312	**1,000**	0,050	0,013	0,626	0,009	0,218	0,145	0,104	**0,106**
Saint-Dizier	0,185	0,083	0,010	0,054	0,831	0,013	0,312	0,227	0,223	0,023	0,045	0,482	0,218	0,030	0,056	**0,118**
Châlons-en-Champagne	0,162	0,025	0,189	0,240	0,256	0,114	0,094	0,227	0,698	0,118	0,356	0,018	1,000	0,146	0,056	**0,179**
Épernay	0,182	0,022	0,059	0,373	0,167	0,175	0,149	0,334	0,050	0,281	0,668	0,034	0,218	0,159	0,104	**0,157**
Reims	**1,000**	0,008	**1,000**	**1**	0,167	0,134	0,042	0,284	0,427	**1,000**	0,176	0,267	0,095	0,012	**1,000**	**0,438**
Vitry-le-François	0,092	0,138	0,013	0,116	0,236	0,052	0,049	**1,000**	0,427	0,011	0,176	0,291	0,218	0,032	0,162	**0,085**

Minimized

$$p_{kj} = 0{,}105 - \frac{0{,}105 - 0{,}040}{0{,}25 - 0{,}17} \cdot (0{,}21 - 0{,}17) = 0{,}075$$

Maximized

$$p_{kj} = 0{,}366 + \frac{1 - 0{,}366}{10 - 5} \cdot (8 - 5) = 0{,}746$$

$$p_k = \sum p_{kj} w_j$$

LP_i FOR EACH INDICATOR AND CLASS

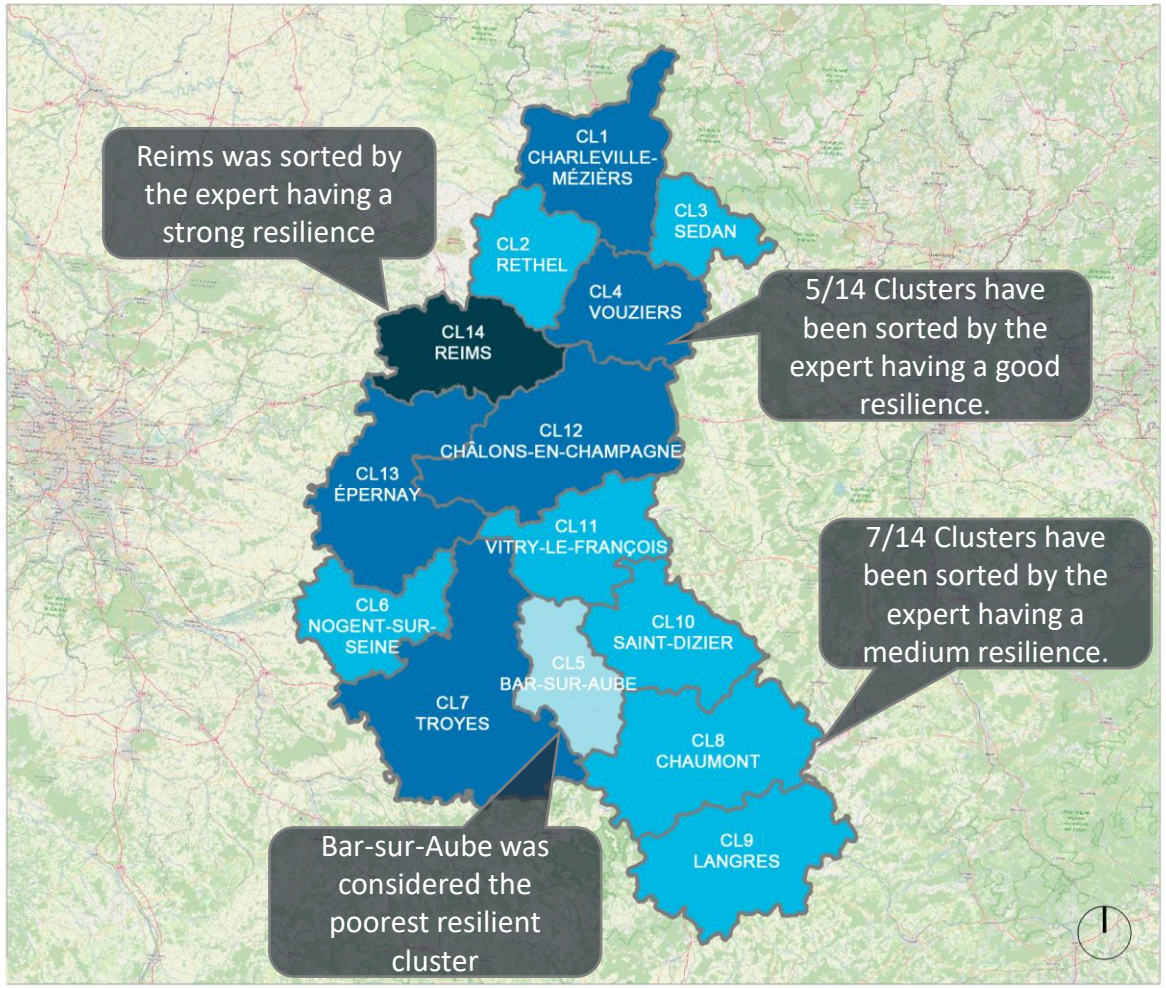
Limiting profiles's performances	Population density (ab/km2)	Inactive population (no.)	Population with high edu (%)	Accessibility from Paris (minutes)	CO2 emissions (kg/year)	Strategic buildings and works (no.)	Green areas of high eco quality (m2)	Contaminated sites (no.)	Environmental associations (no.)	Active establishments (no.)	Unemployment rate (%)	Deal flow for green projects (	Local Action Groups (no.)	Land take 1990-2018 (0;	EIA and SEA procedures	Total LP_i
LP_1	0,007	0,000	0,001	0,001	0,006	0,000	0,003	0,007	0,002	0,002	0,001	0,002	0,015	0,004	0,003	0,054
LP_2	0,017	0,001	0,005	0,006	0,009	0,002	0,010	0,011	0,003	0,014	0,004	0,009	0,034	0,019	0,008	0,151
LP_3	0,056	0,005	0,012	0,018	0,023	0,008	0,047	0,043	0,005	0,066	0,012	0,065	0,068	0,055	0,021	0,505

Legend
LP_1 is between the classes Poor and Medium Resilience
LP_2 is between the classes Medium and Good Resilience
LP_3 is between the classes Good and Strong Resilience

$$lp_i = \sum p_{ij} w_j$$

RESULTS

QGIS



5. ASSIGNMENT TO CLASSES

Alternatives k	CLASSIFICATION
Charleville-Mézières	GOOD
Rethel	GOOD
Sedan	MEDIUM
Vouziers	GOOD
Bar-sur-Aube	POOR
Nogent-sur-Seine	MEDIUM
Troyes	GOOD
Chaumont	MEDIUM
Langres	MEDIUM
Saint-Dizier	MEDIUM
Châlons-en-Champagne	GOOD
Épernay	GOOD
Reims	GOOD
Vitry-le-François	MEDIUM

6. FINAL TUNING

Alternatives k	ANP SORT	ANP SORT II
Bar-sur-Aube	POOR	POOR
Rethel	GOOD	MEDIUM
Épernay	GOOD	MEDIUM
Reims	GOOD	STRONG

CONCLUSIONS AND NEXT STEPS OF THE RESEARCH

PROS

- ✓ The ANPSort II has demonstrated its potentialities to sort the resilience performance of a SES.
- ✓ The ANPSort II able to support planners and decision-makers in the planning of scenarios of transformation.
- ✓ This application focused on the opinion on only one expert. Therefore other experts have been engaged into the sorting process.

CONS

- χ The engaged expert experienced some difficulties in setting the limiting profiles and was sometimes hesitant to simply provide a number. The introduction of an interval or a fuzzy limiting profile could help reduce this type of difficulties.

The application to a real case study raised some future perspectives.

- A threshold values will be considered to aid the experts in the identification of limiting or central profiles.
- The ANPSort II obtained by the experts' evaluations will be grouped together. Into a GANPSort II.
- The model will be replicated by involving real local actors and stakeholders to define a protocol of actions to increase the resilience of the case study under investigation.

ISAHP 2020 WEB CONFERENCE

Thanks very much for your kind attention!

ANPSORT II METHOD: AN EXPERIMENTATION TO ASSESS THE RESILIENCE OF A SOCIO-ECOLOGICAL SYSTEM.

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