2nd World BOSAI Forum/International Disaster Risk Conference 2019
spin disaster knowledge to wave BOSAI wisdom

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A social-ecological approach to disaster risk management applied to the case study of the Marche Region, Italy

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CRITICAL ISSUES

- **THEORETICAL ISSUES:**
  - need to consider complex human-natural systems
  - need to merge disaster resilience and environmental sustainability agendas

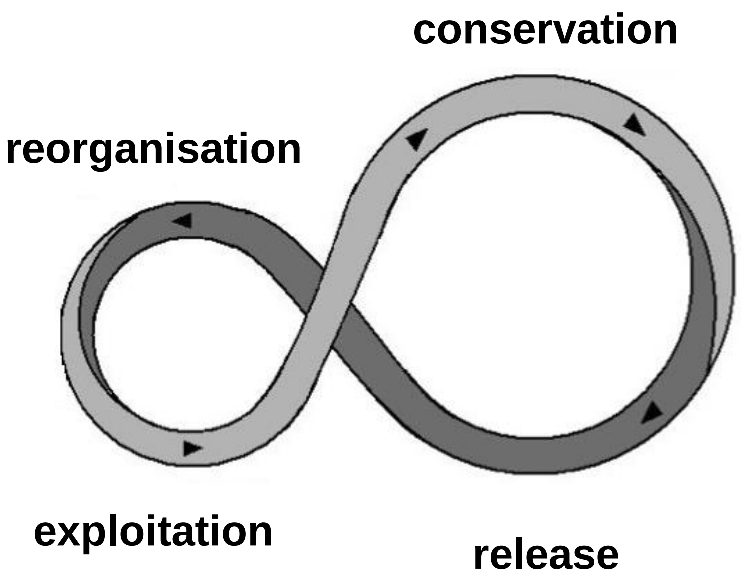
- **ASSESSMENT ISSUES:**
  - no commonly accepted tool
  - disaster metrics not included

→ HOW CAN THIS INFORM LOCAL POLICIES?

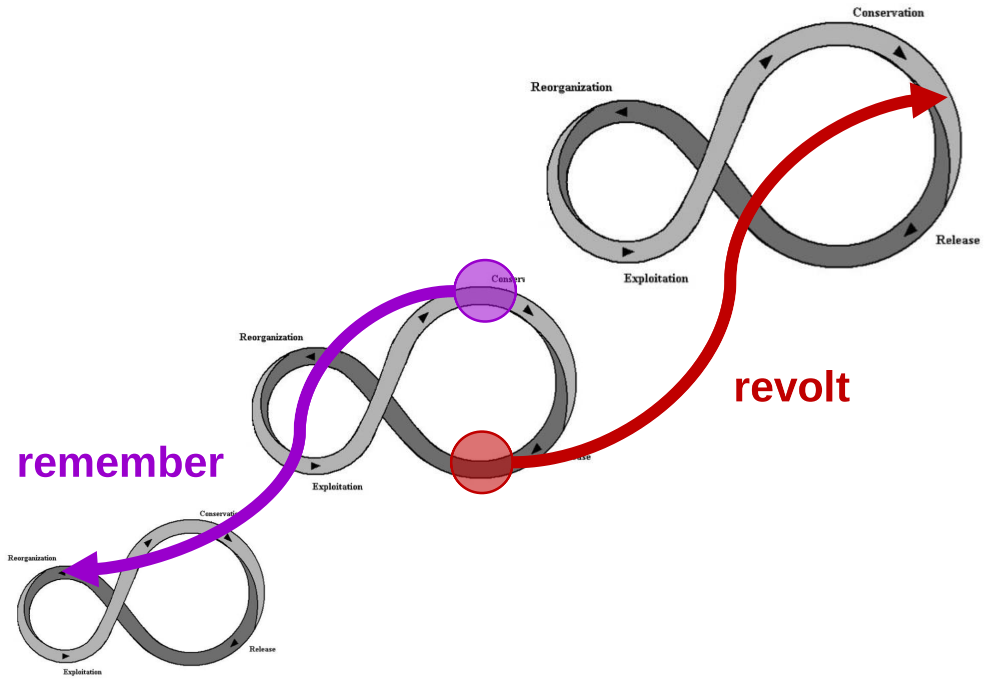
THEORETICAL BACKGROUND

PANARCHY MODEL – prof. C. S. Holling

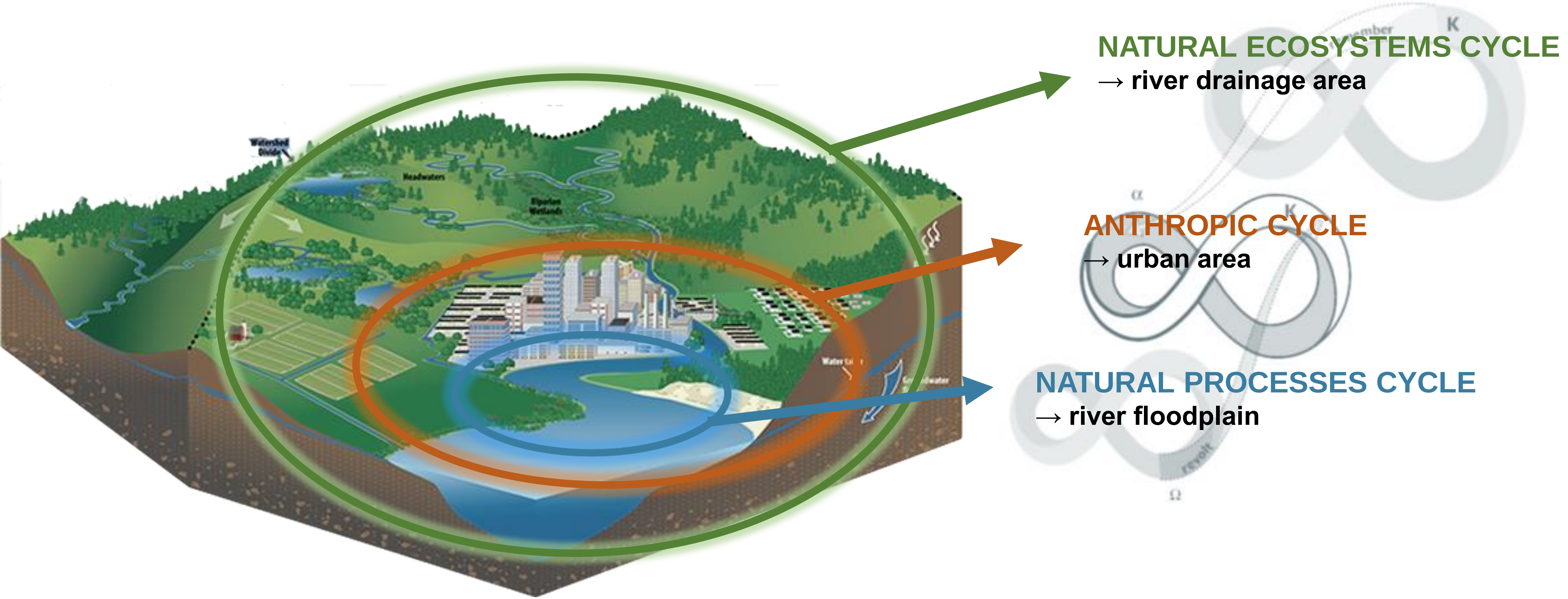
ADAPTIVE CYCLE



INTERACTIONS

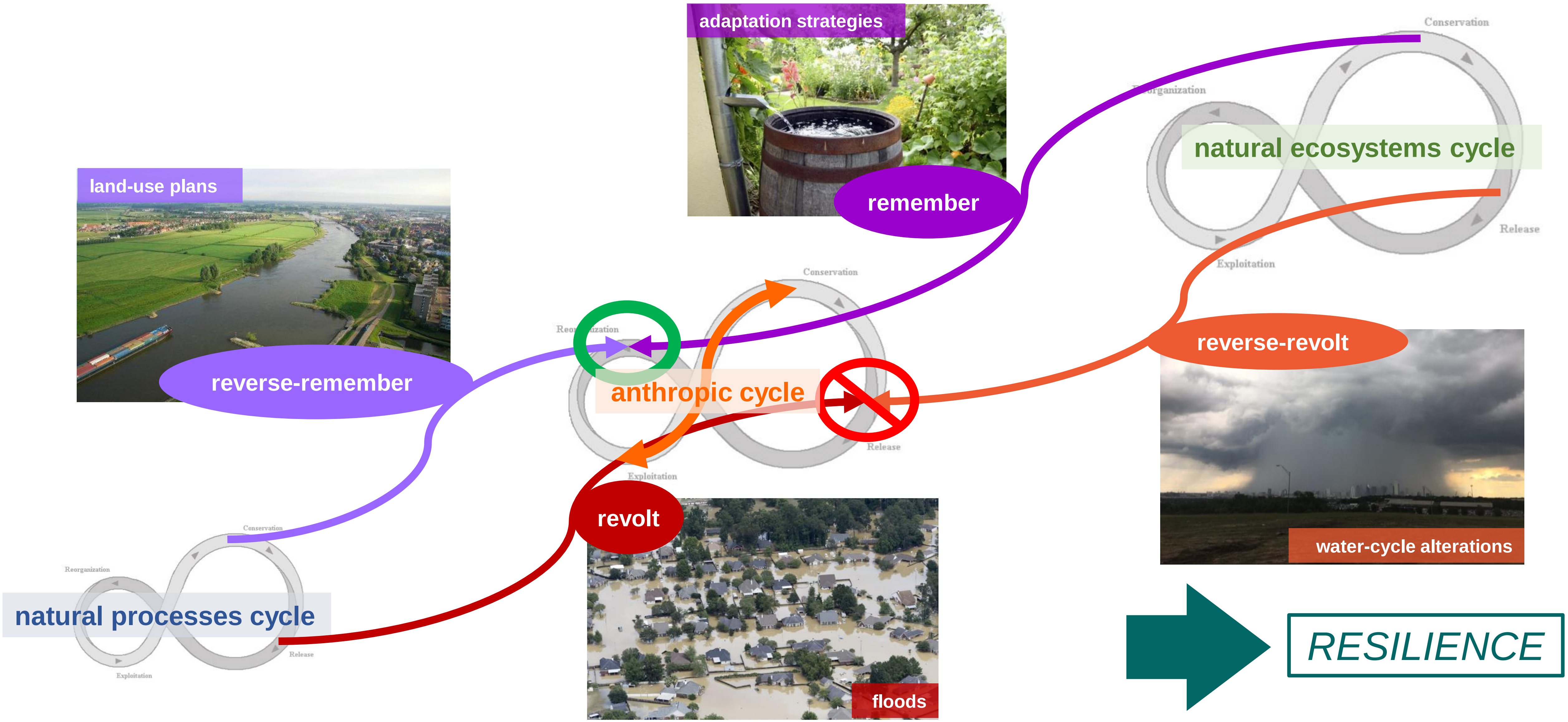


MODELLING SOCIAL-ECOLOGICAL SYSTEMS



Source: http://www.journey2050.com/what-is-a-watershed/

INTERACTIONS IMPACTING
ON THE ANTHROPIC CYCLE



INTERACTIONS IMPACTING
ON THE NATURAL CYCLES

ASSESSMENT FRAMEWORK

METHODOLOGY

- 1st PHASE

  indicators related to flood disaster

- 2nd PHASE

  general significant indicators (from literature)

quantitative analysis

cluster analysis → ***discriminant analysis***

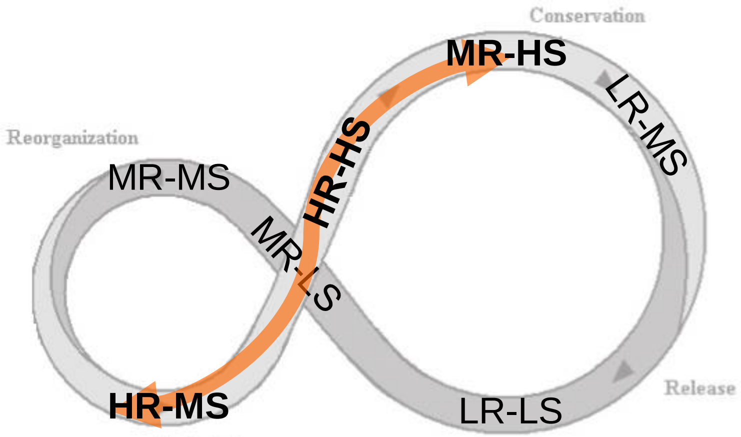
- 3rd PHASE

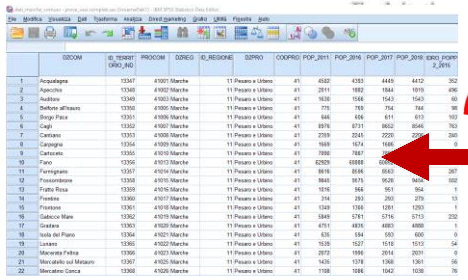
  questionnaires delivered to local communities

- 4th PHASE

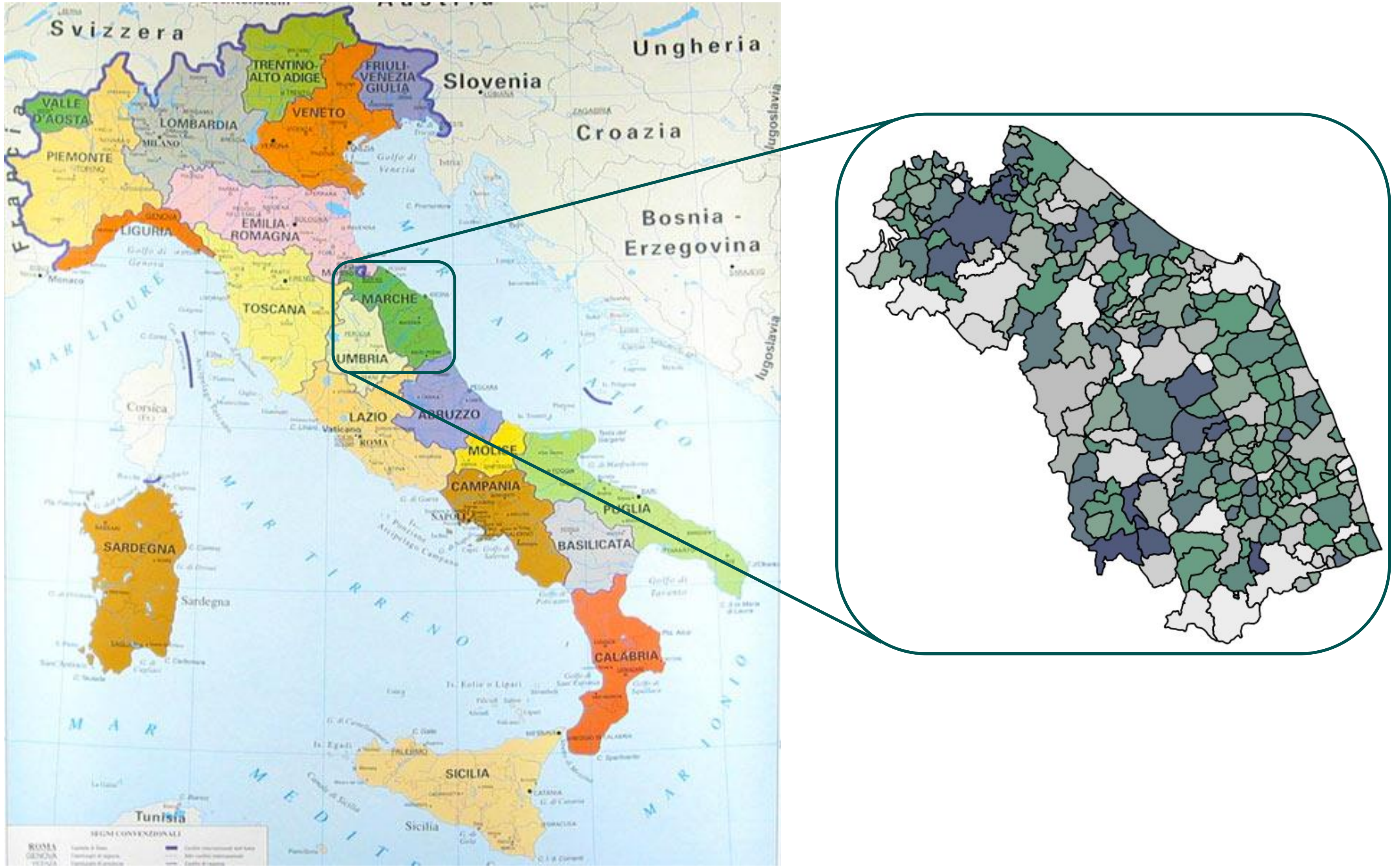
  comparison between quantitative and qualitative data

qualitative





CASE STUDY – Marche Region, Italy



- **Marche Region**
  - 1˙522˙608 residents
  - 9˙401 km² area
  - 229 municipalities
- **Time interval**:
  - 2008-2018
- **Flood events**:
  - 2011 ⟶ 2015

1st phase
classification

1st PHASE – *cluster analysis*

	attribute	indicator
RESILIENCE	*LEARN*	variation of population exposed to flood hazard
		POP_FLOOD
	ABSORB	grants for extraordinary and emergency interventions
		EMERG_GRANT
	RECOVER	ratio of tax revenue after 2 years and on last flood's year
		IRPEF_VAR

	attribute	indicator
SUSTAINABILITY	*FUNCTIONS*	variation of land take per total municipality area
		LAND_TAKE
	SERVICES	variation of clean water input
		CLEAN_WATER
	INTEGRITY	number of species in inadequate or bad state
		SPECIES_INADBAD

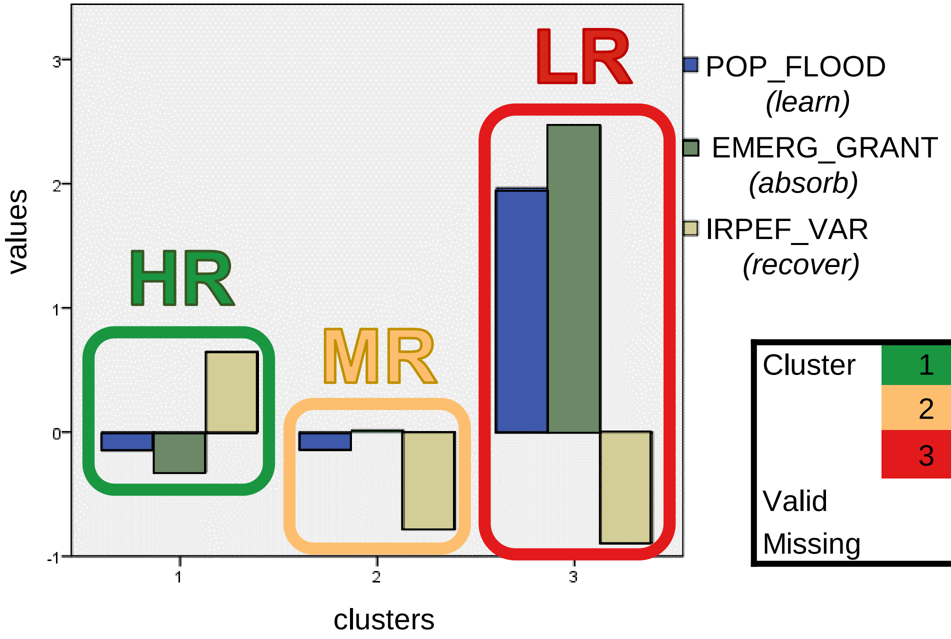
1st PHASE – *cluster analysis*

- *mixed clustering procedure*: hierarchical (**Ward's**) method + non-hierarchical (**k-means**) method
- 3 clusters:

  - high resilience (**HR**)
  - medium resilience (**MR**)
  - low resilience (**LR**)

  - high sustainability (**HS**)
  - medium sustainability (**MS**)
  - low sustainability (**LS**)

centroids of final clusters

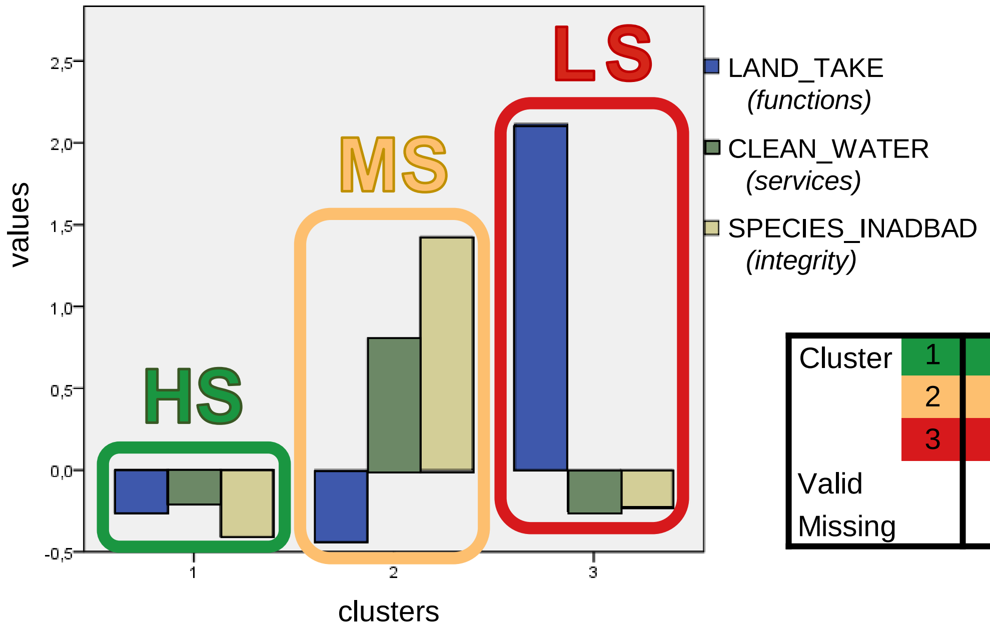


Cluster		
Cluster	1	127
	2	86
	3	16
Valid		229
Missing		0

ANOVA

	F	Sig.
Z-score: POP_FLOOD	46,567	,000
Z-score: EMERG_GRANT	106,185	,000
Z-score: IRPEF_VAR	122,460	,000

centroids of final clusters



Cluster		
Cluster	1	152
	2	48
	3	29
Valid		229
Missing		0

ANOVA

	F	Sig.
Z-score: LAND_TAKE	216,286	,000
Z-score: CLEAN_WATER	23,691	,000
Z-score: SPECIES_INADBAD	135,584	,000

1st PHASE – *cluster analysis*

➢ *RESILIENCE*

Number of cases per cluster

Cluster	1	127
	2	86
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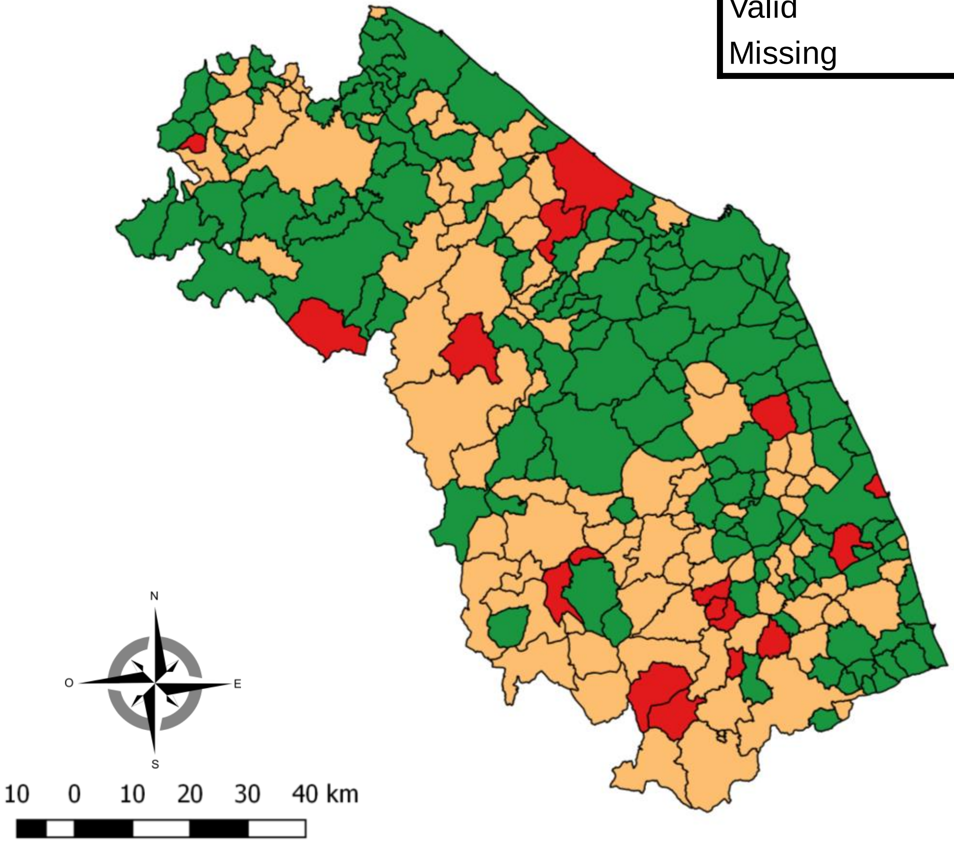
Missing		0



➢ *SUSTAINABILITY*

Number of cases per cluster

Cluster	1	152
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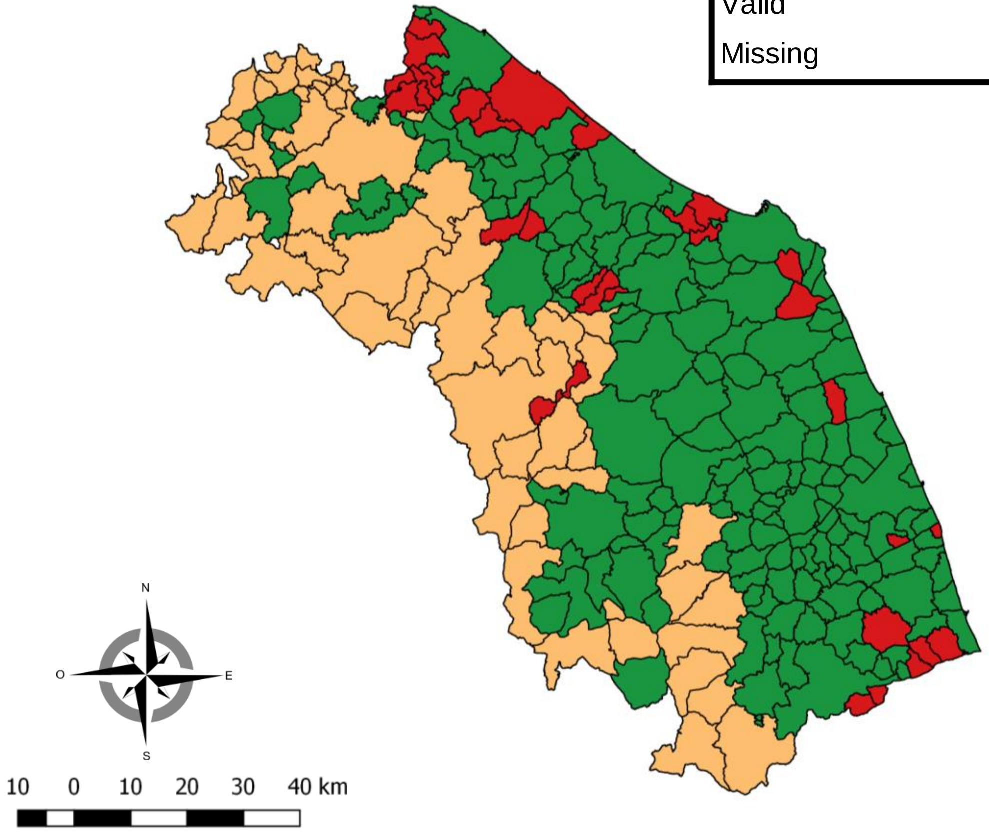
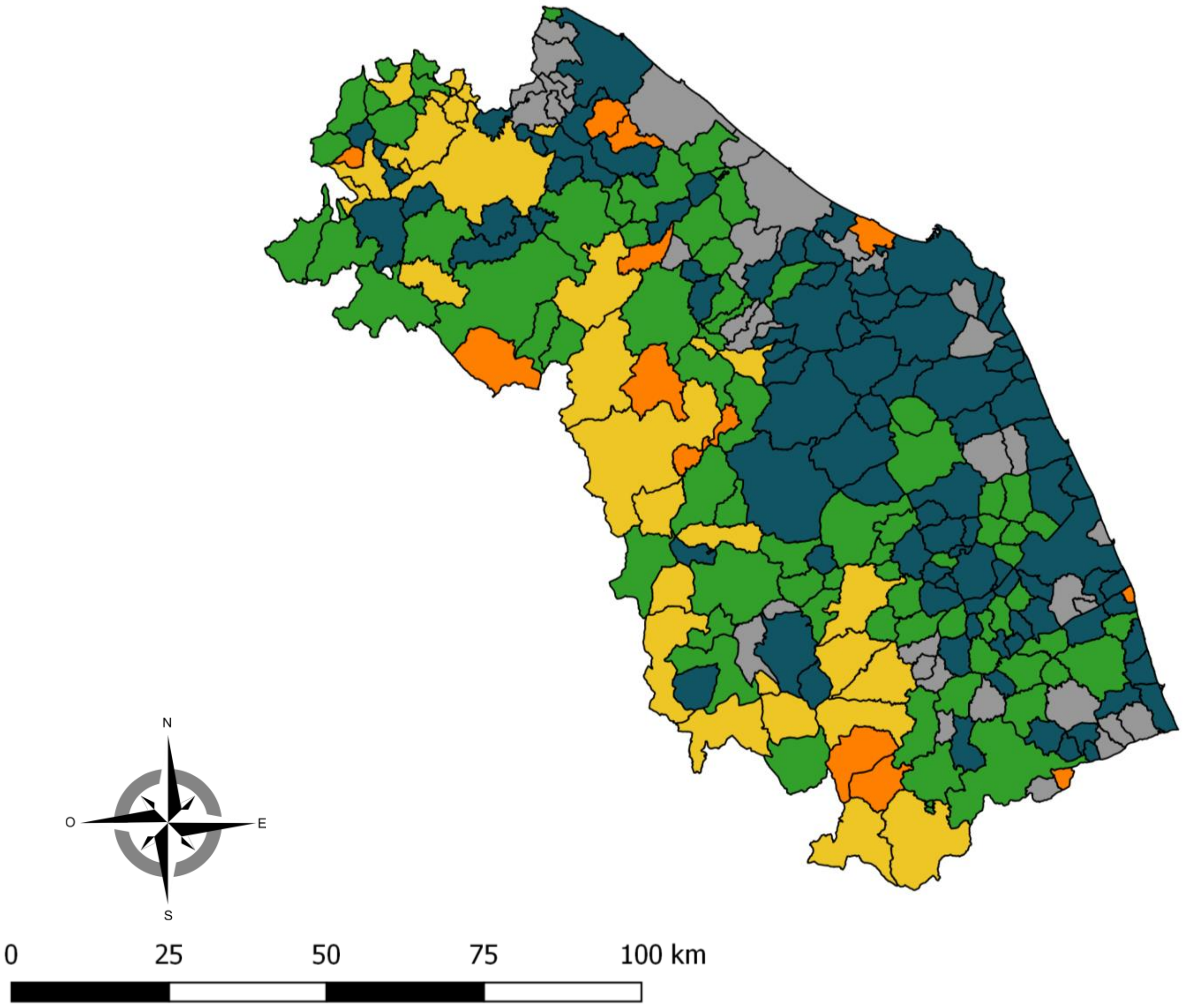
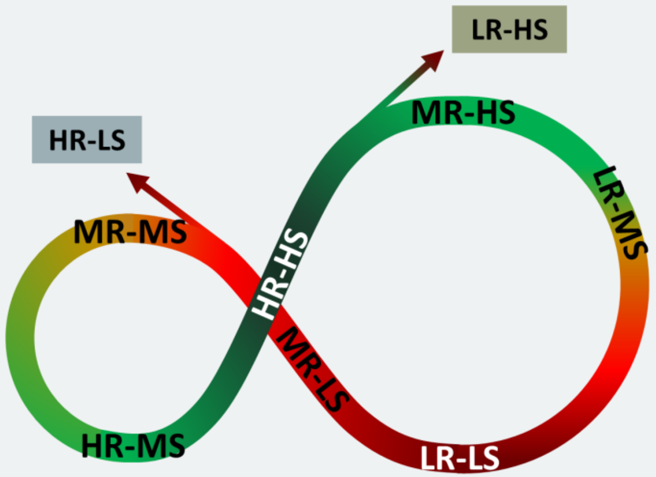


1st PHASE – *output*
RESILIENCE & SUSTAINABILITY

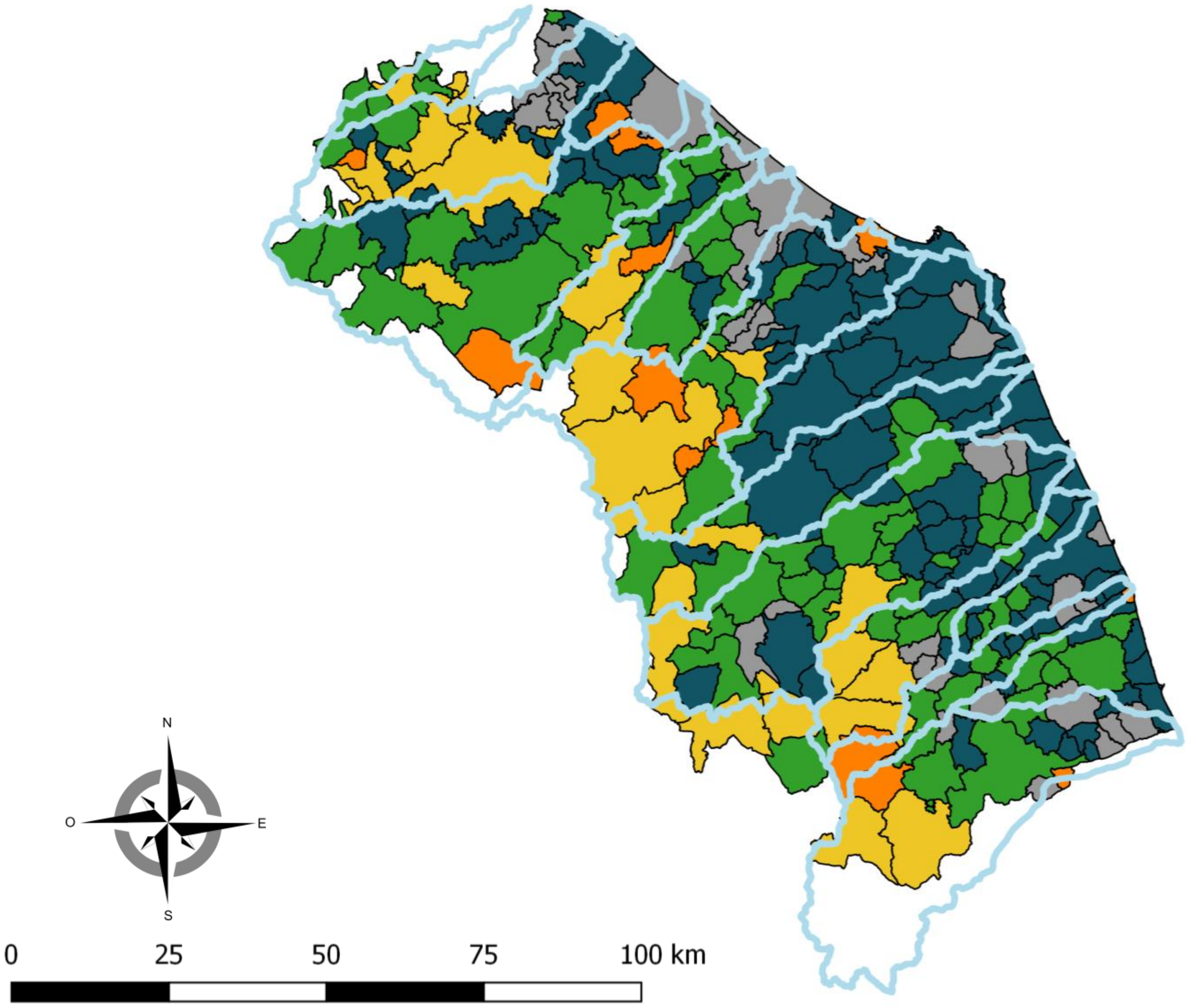


#	cluster	%
88	**HR-HS**	38,43%
18	**HR-MS**	7,86%
53	**MR-HS**	23,14%
159	***foreloop***	69,43%
25	**MR-MS**	10,92%
8	MR-LS	3,49%
5	LR-MR	2,18%
0	**LR-LS**	0,00%
11	LR-HS	4,80%
21	HR-LS	9,17%



HOW CAN THIS INFORM LOCAL POLICIES?

→ Identify criticalities and excellences within the territory (e.g. river basins)



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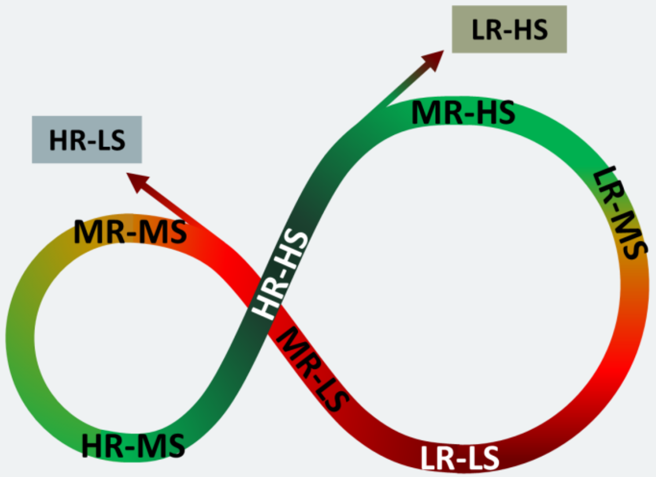

2nd phase characterisation

2nd PHASE – RESILIENCE
discriminant analysis

	dimension	variable	source
RESILIENCE	*DEMOGRAPHIC*	immigrants	Italian National Institute of Statistics, Ministry of Interior, Italian National Firefighters Corps, Regional Agency for Health
		population over 65 years old	
		female population	
		population density	
	SOCIAL	population with higher education or more	
		territory with UWB internet access	
		population involved in civic organisations	
		public revenues of civil protection organisations	
		volunteers expenditure of civil protection organisations	
	ECONOMIC	employment rate	
		per-capita income	
		social expenditure for poverty, social assistance, …	
		(present – resident population) / resident population	
	HEALTH	mental health discharges	
		residence and non-residence structures for elderly people	
		hospital staff	
		hospital beds	
		average time of arrival on place over the past 5 years	
	INFRASTRUCTURAL	local expenditure for flood mitigation	
		extension of municipal roads	
		wasted drinking water / produced drinking water	
		mean building construction year	

2nd PHASE – RESILIENCE
discriminant analysis

EIGENVALUES				
function	eigenvalue	%variance	%cumulative	canon. correlation
1	0,281	73,5	73,5	0,469
~~2~~	~~0,102~~	~~26,5~~	~~100,0~~	~~0,304~~

WILKS LAMBDA				
function	Wilks Lambda	Chi-square	df	sig.
1	0,708	73,266	44	0,004
~~2~~	~~0,908~~	~~20,569~~	~~21~~	~~0,486~~

discriminant function $D = \sum_{i=1}^{n} c_i \cdot v_i$

where:
n = number of considered variables
c_i = standardised coefficient of the ith variable
v_i = value of the ith variable

In this case:

D = 0,551128*IMMIGR - 6,17363*POP_over65 + 7,57278*POP_FEM - 0,119824*DENSPOP - 0,597299*ISTR_SUP - 0,25919*UWB_ACCESS - 1,31271*VOLONT + 0,44112*ENTRATE_ENTIPUBB_ASSPC - 0,266433*USCITE_RIMB_VOLONT_ASSPC + 0,285924*TASSO_OCCUP_2011 + 0,680172*REDDITO_PROCAP + 0,0611737*SPESA_SERVSOC_POV + 0,277892*POP_PRE_RES_PERC - 0,595948*DIST_PSIC_DIM + 0,221489*STRUTT_NON_RES_NUM_COM + 0,942819*PL_TOT - 0,715504*PERS_COMP - 0,0548045*VVFF_TARR_MEDIO - 0,290362*INVEST_RIDRA - 0,324971*STRADE_COM + 0,061268*DISP_IDRO - 0,00811112*AVG_RESBUILD_AGE

HOW CAN THIS INFORM LOCAL POLICIES?

→ *Evaluate the effects of policies*

→ *Monitor the state of the municipalities*

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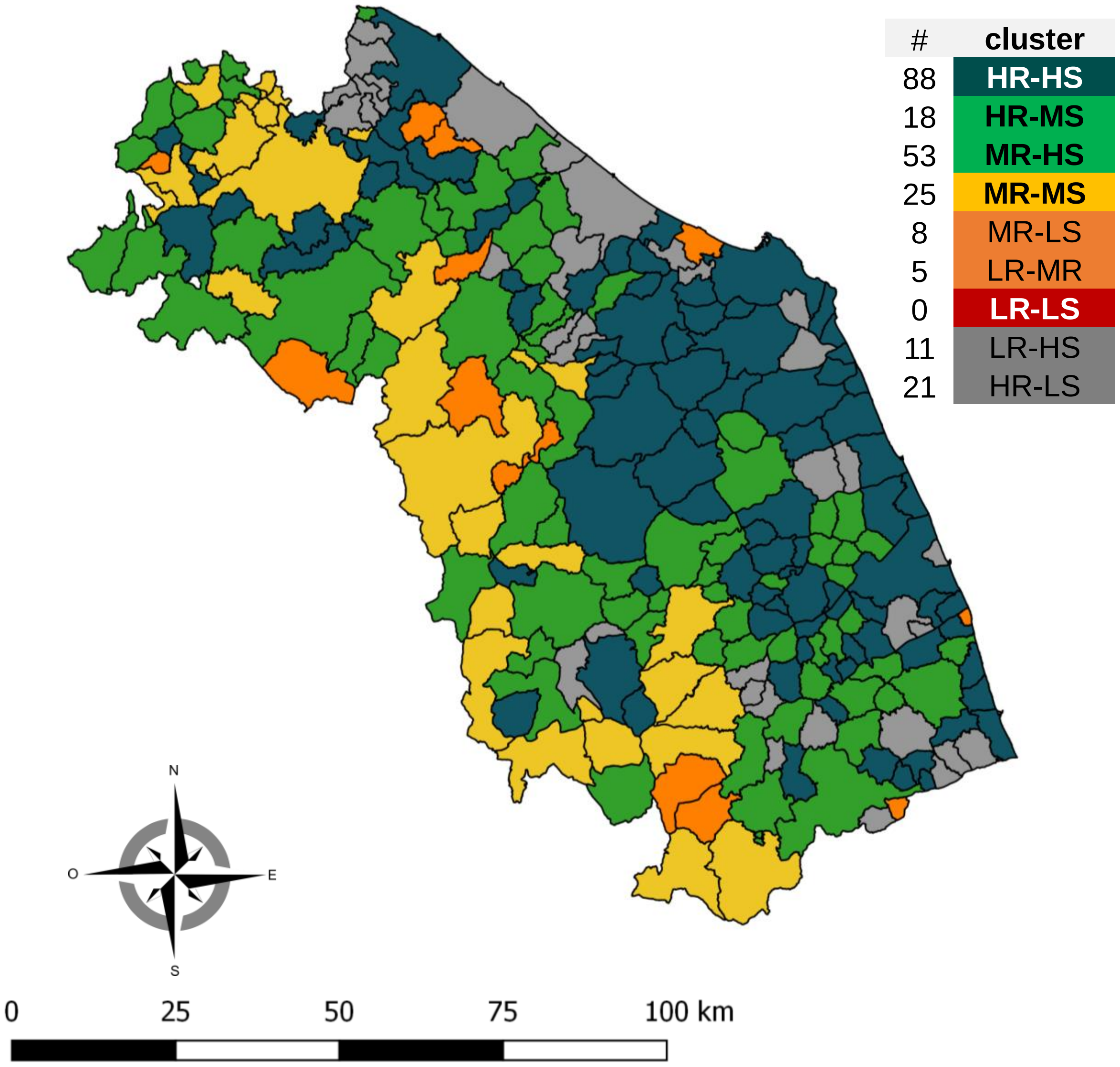
3rd phase

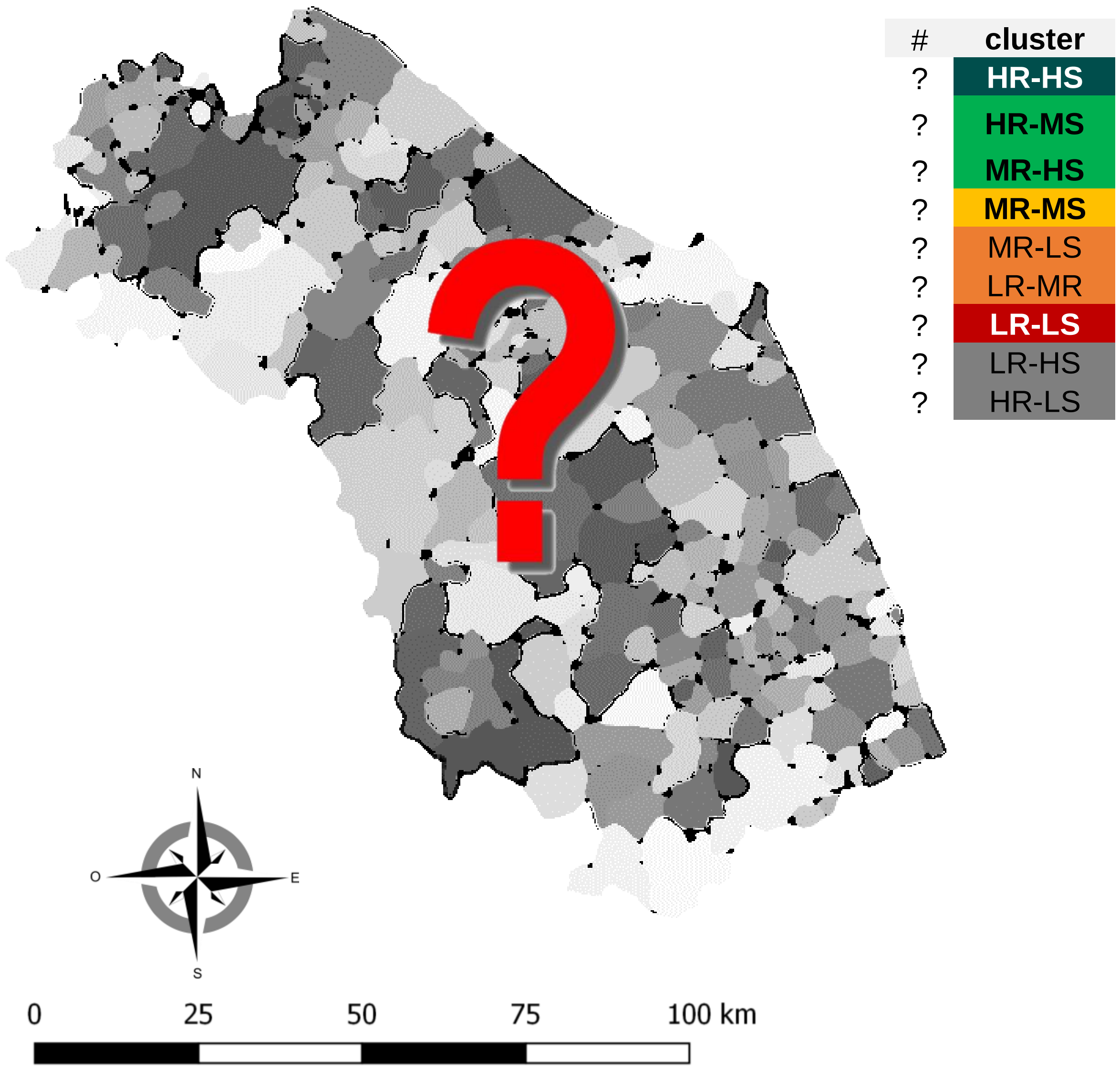
localisation

3rd PHASE – *questionnaires*

Topic	Theme	Sub-theme	Purpose	#	Question	Answers	*cluster*
RESILIENCE	*perception*	***learn***	Effect of last flood on development path → *reverse-remember interaction*				
				1	*Do you think that the last flood has influenced the economic, social and infrastructural development of your municipality?*	*a.* yes, it prompted initiatives to make it safer	**HR**
						b. yes, it compromised it	**LR**
						c. no	**MR**

HOW CAN THIS INFORM LOCAL POLICIES ?
→ Identify mismatches, raise awareness





thank you