

*EU Global System Dynamics and Policy and European Climate Forum's
Workshop on
System Dynamic Models of Coupled Natural-Social Systems
Bekkarvik, 22-26 June 2009
Bergen, Norway*

Participatory modelling for climate change adaptation at the interface between research and policy/decision making

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Euro-Mediterranean Centre for Climate Change



Doctoral School
ChangeS
Global Change Science and Policy



Preamble

- **Researchers** have their own networks, communication systems, languages, priorities, tools,...
- **Policy makers** have their own networks, communication systems, languages, priorities, time scales,...
- **Stakeholders** have their own networks, communication systems, languages, priorities, preferences,...
- *Research in support to policy/decision making should – at least attempt to – bridge the gaps between the different communities*
- *This is the case of planning for Climate Change Adaptation*



Objectives

- To explore approaches for bridging the gap between conceptual models adopted by policy makers and models developed by the research community
- To present the ongoing activities of the BrahmaTWinn Project in the field of participatory modelling
- To propose an operational approach for integrating multiple sources of knowledge within common interfaces and simple system dynamics modelling routines for scenario analysis

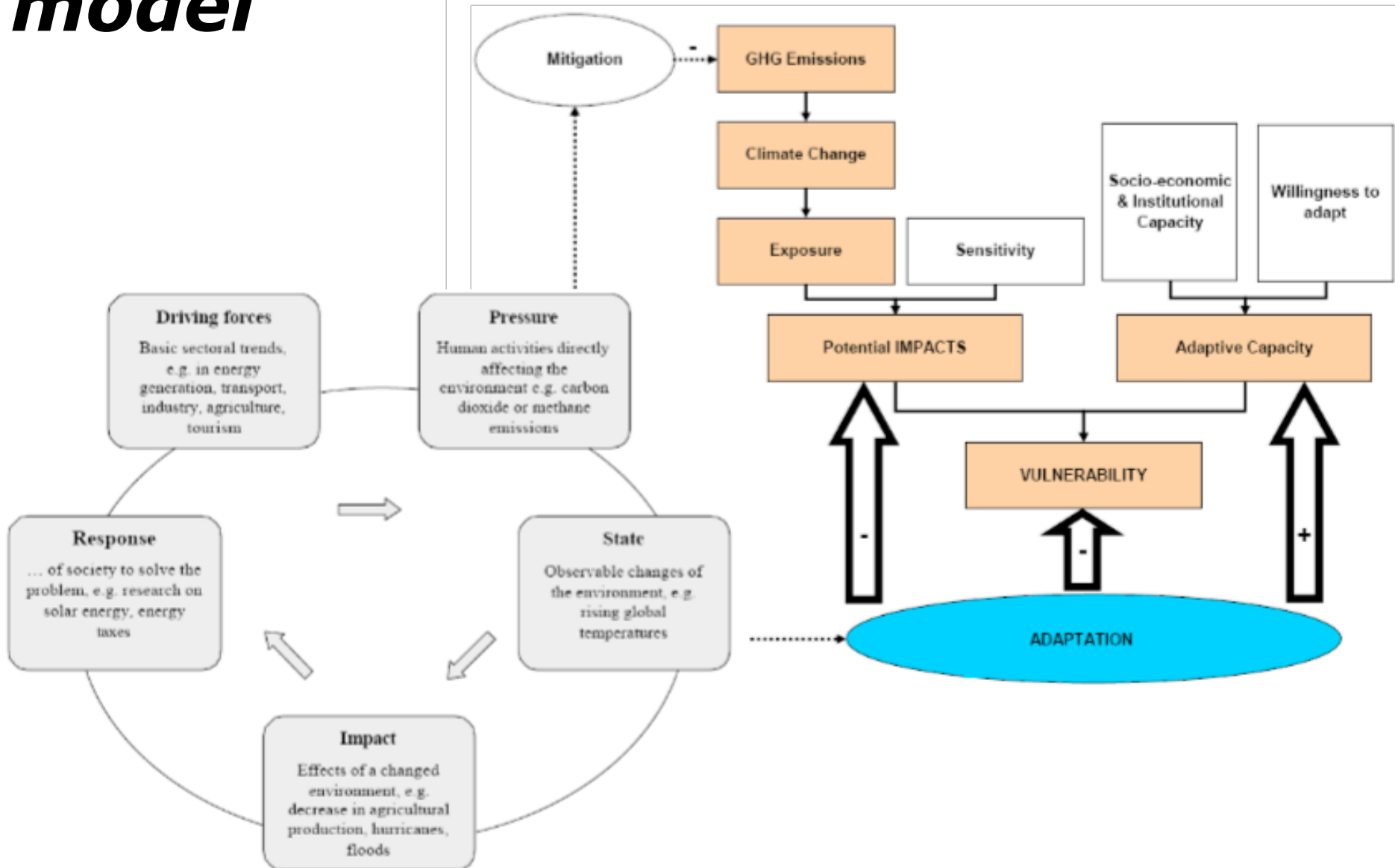


Policy making: conceptual model

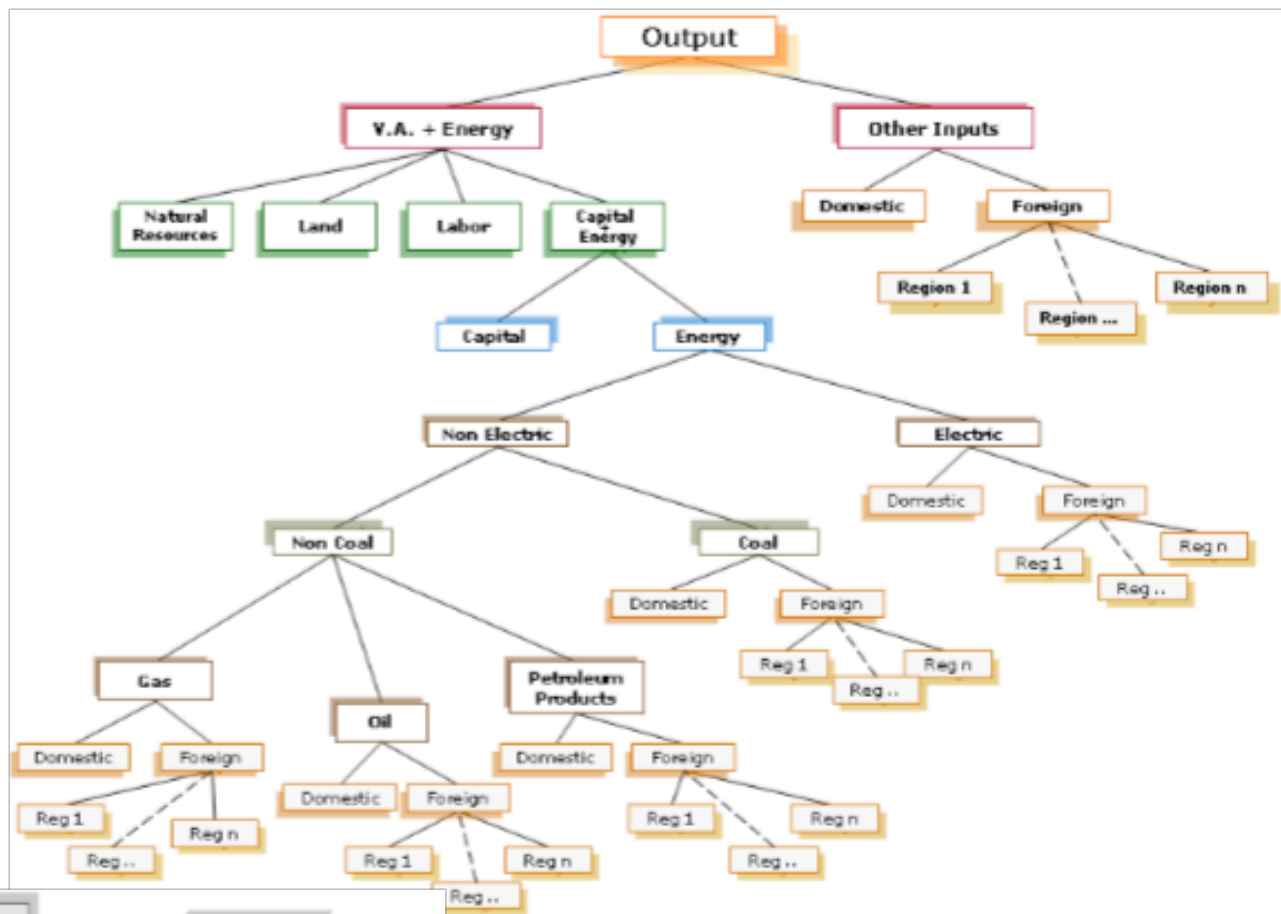


COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels,
SEC(2009) 387/2



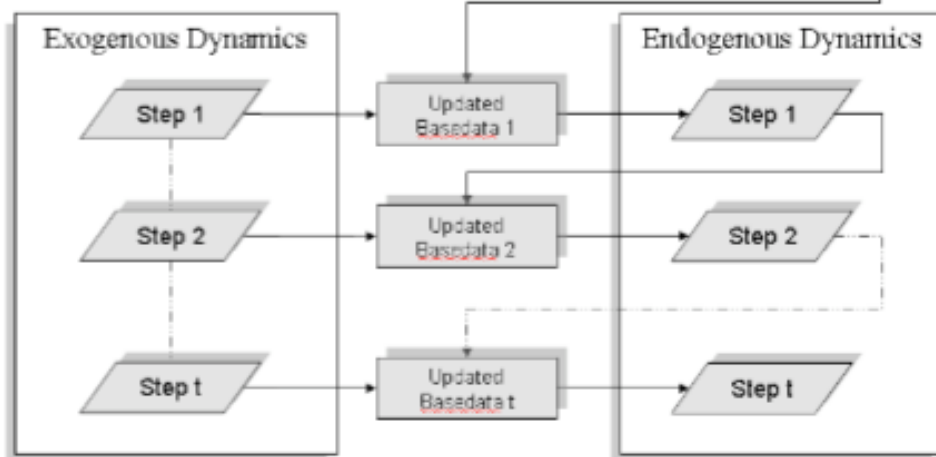
Research: e.g. CGE model



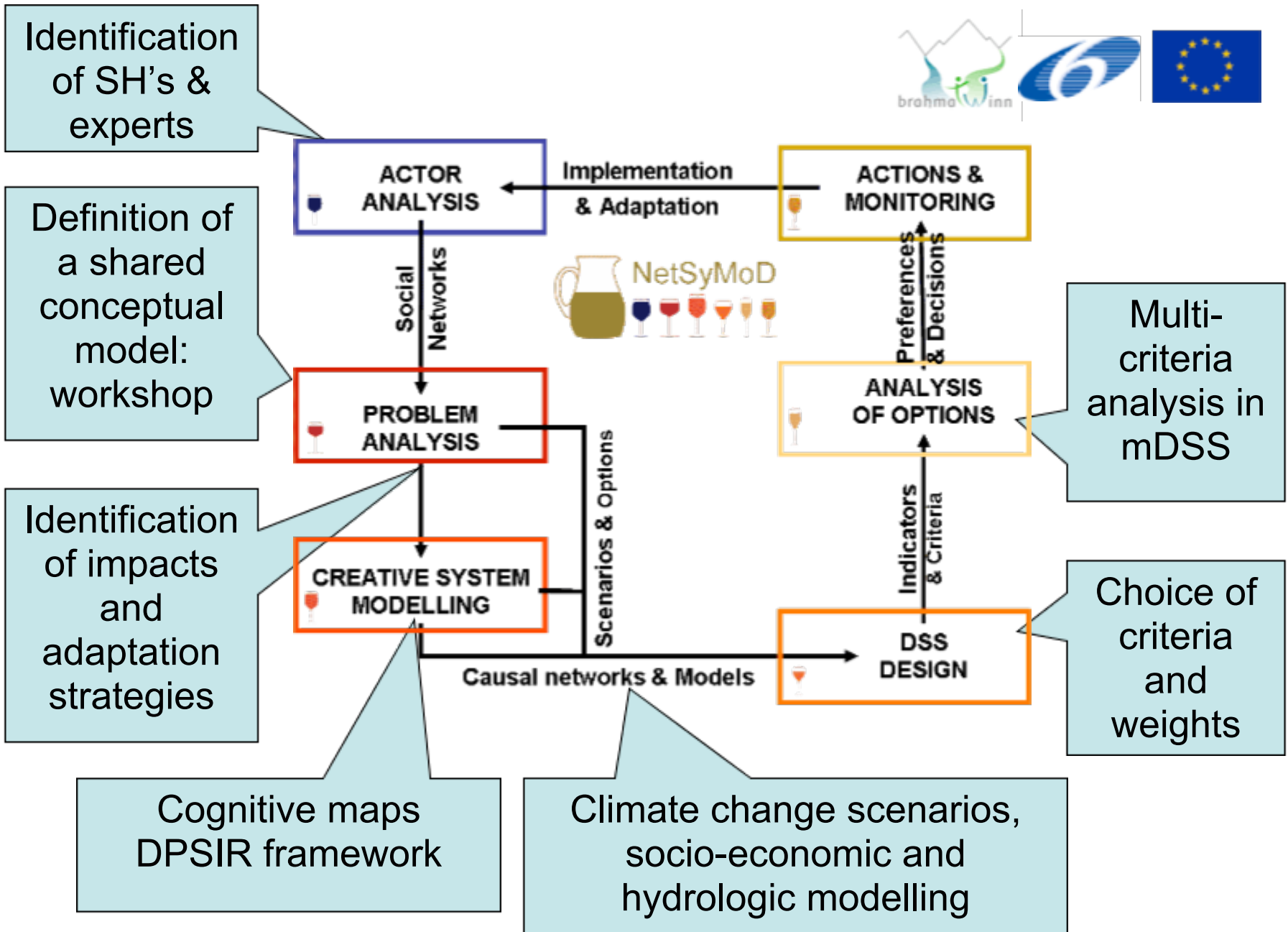
Preliminary Step



Recursive Simulation



Brahmatwinn Project: CC adaptation in upper river basins

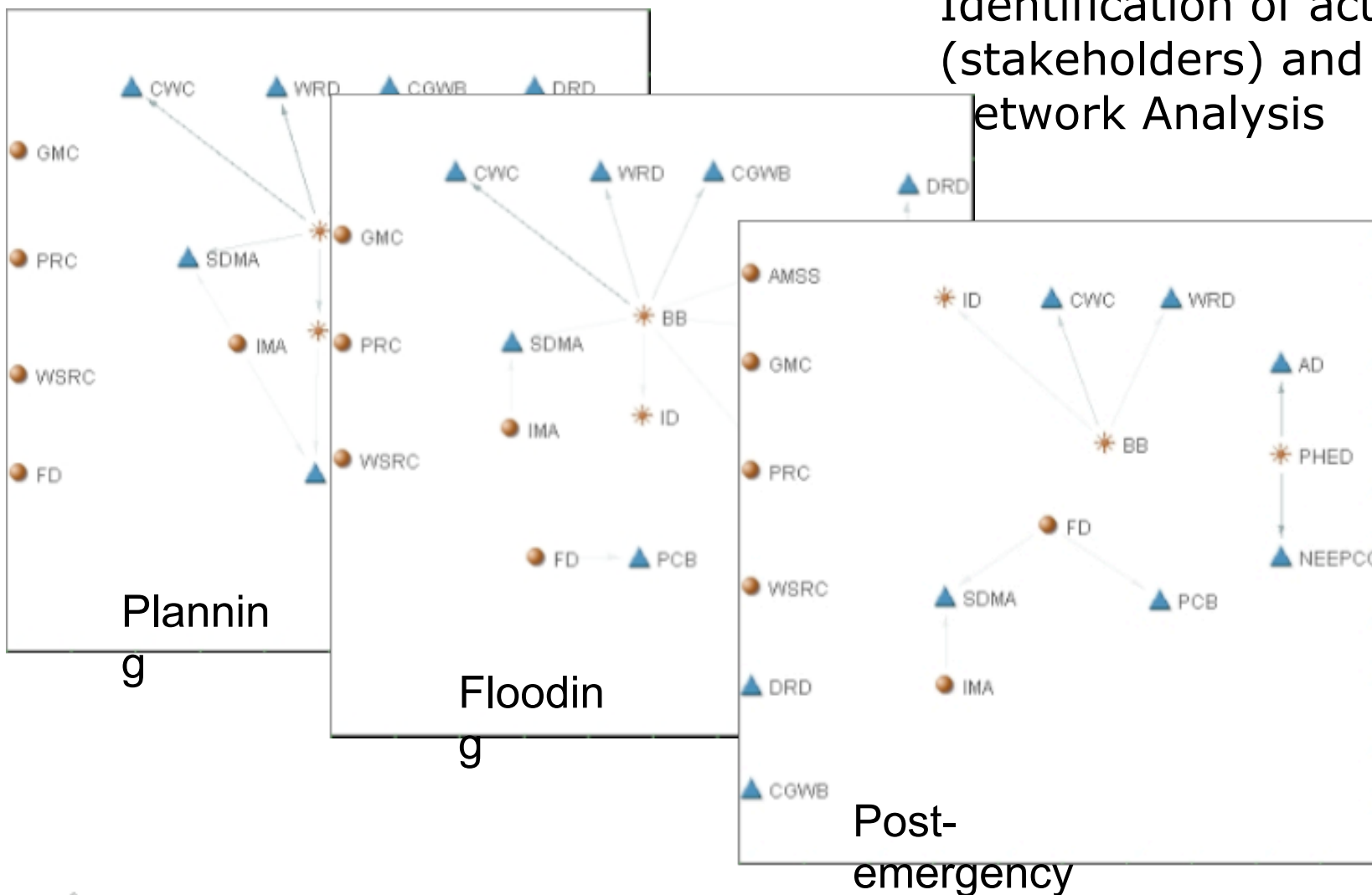


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Social Network analysis 1/2

Identification of actors (stakeholders) and Social network Analysis

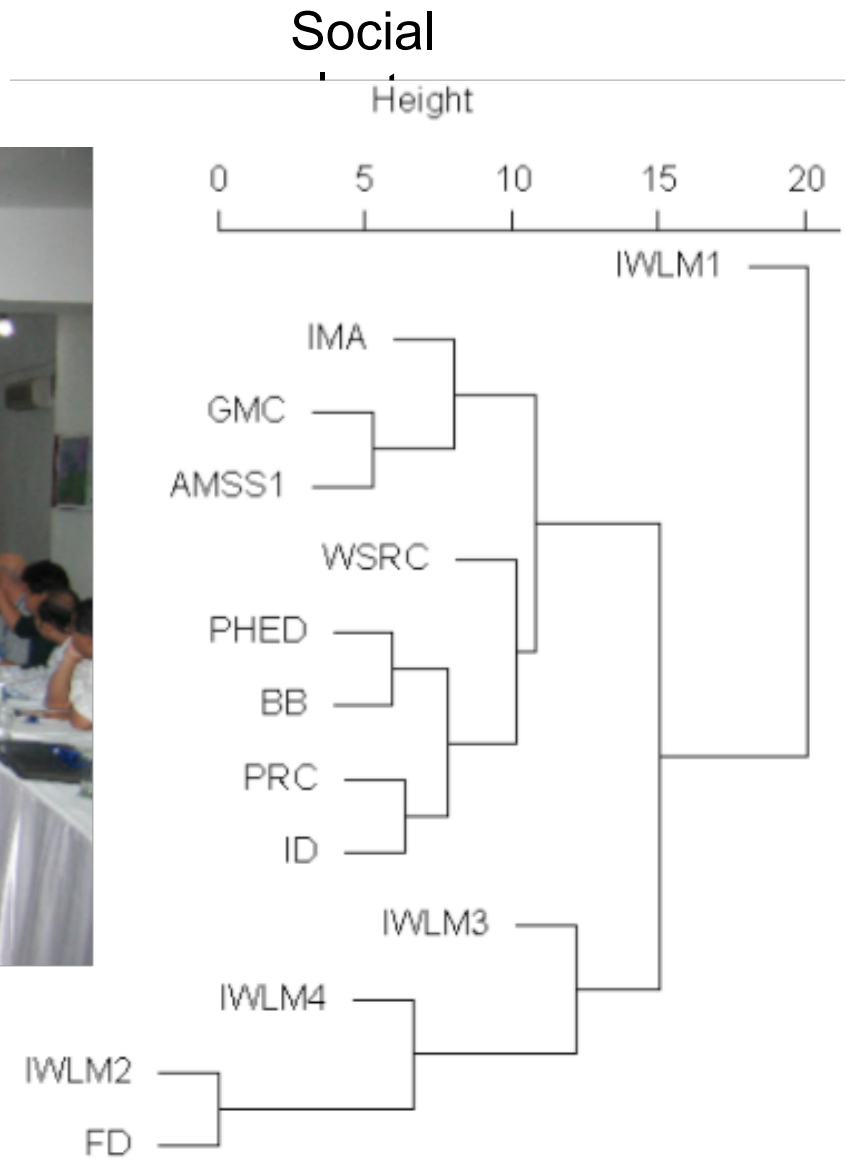


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Social Network analysis 2/2

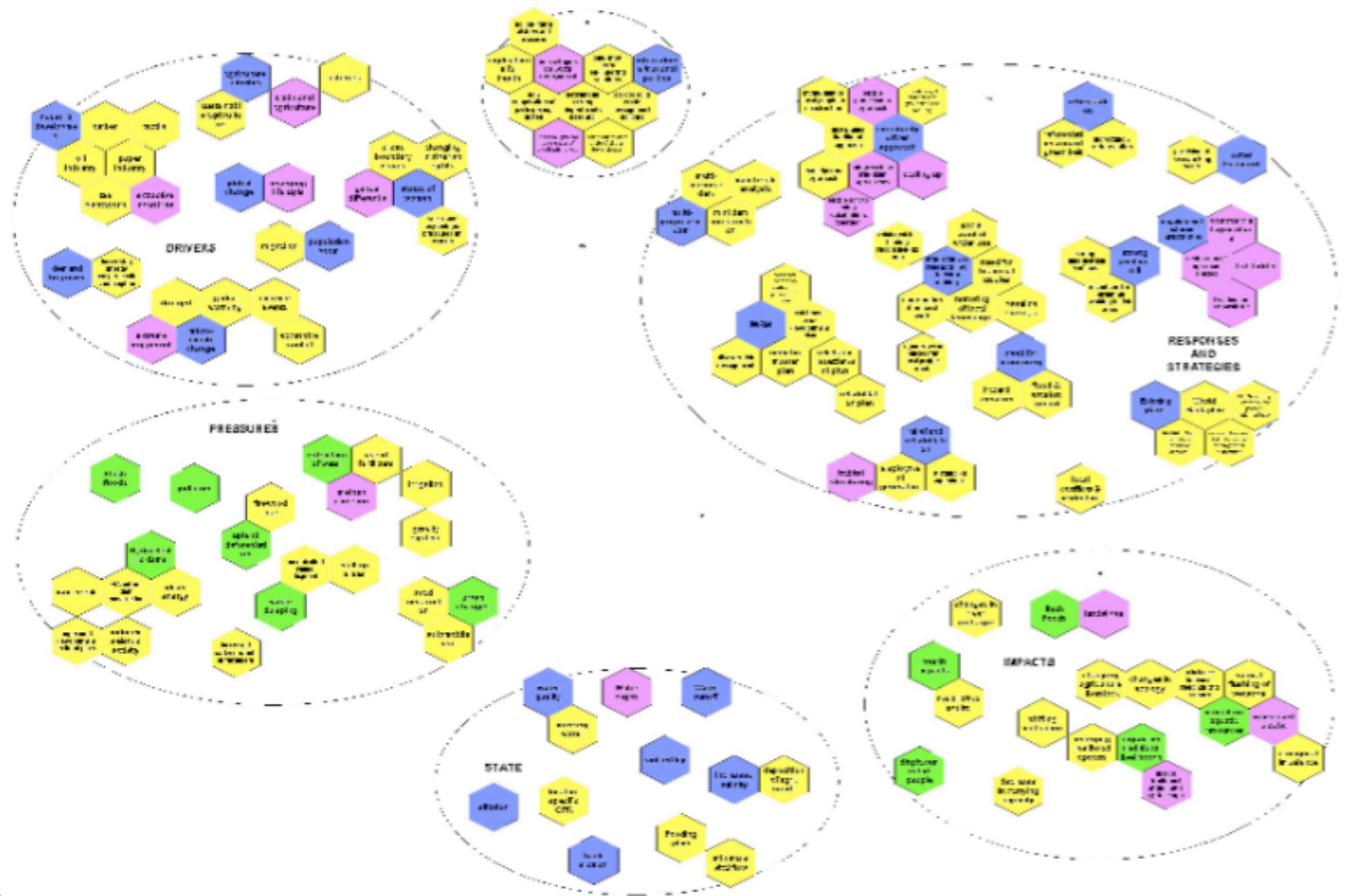
Stakeholders' workshops



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Creative System Modelling 1/9



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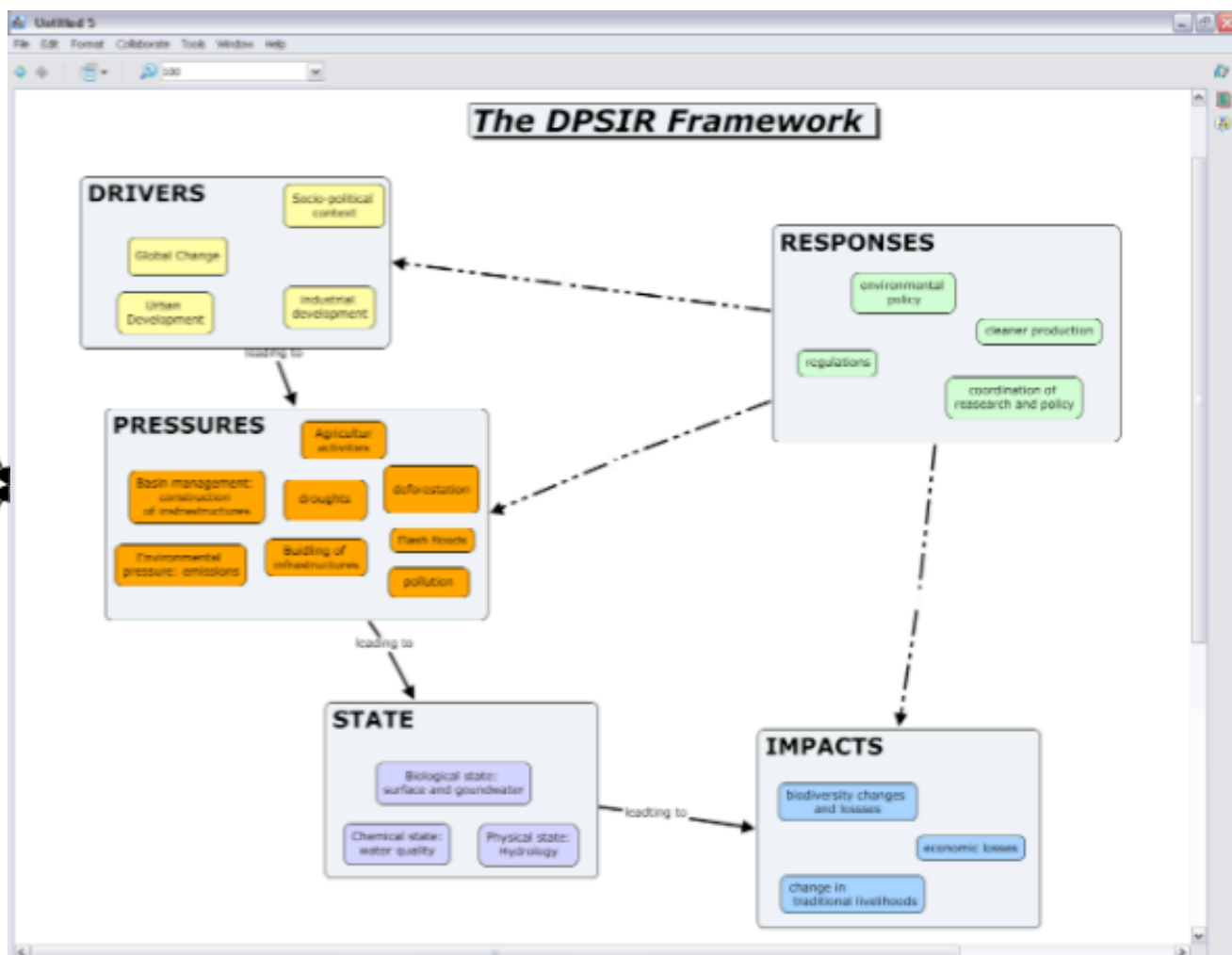
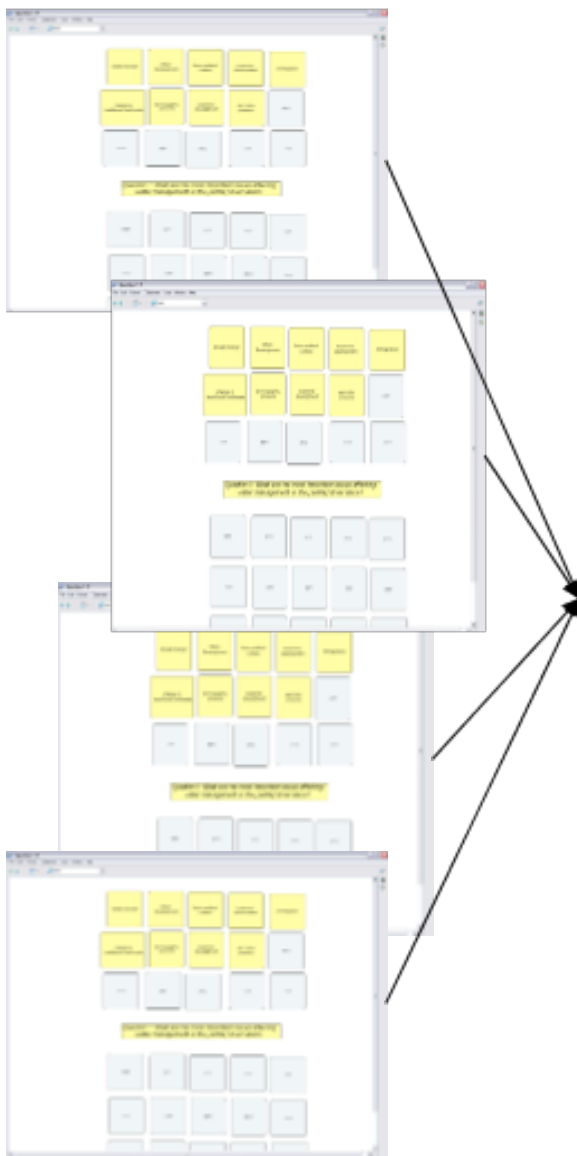


Brainstormin

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Creative System Modelling 2/9

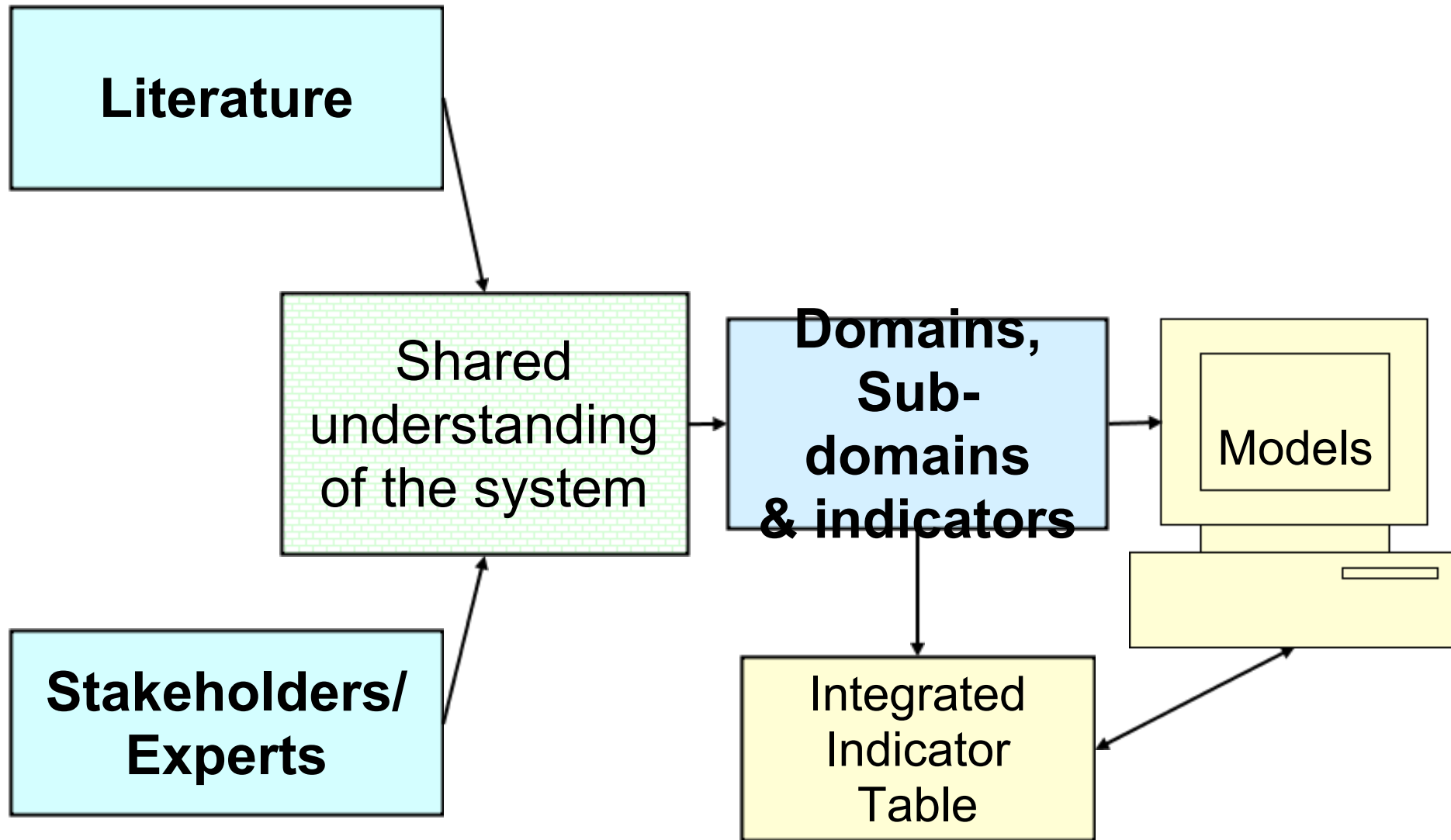
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Clustering in the DPSIR Framework



Creative System Modelling 3/9



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Framing and formalising conceptual models

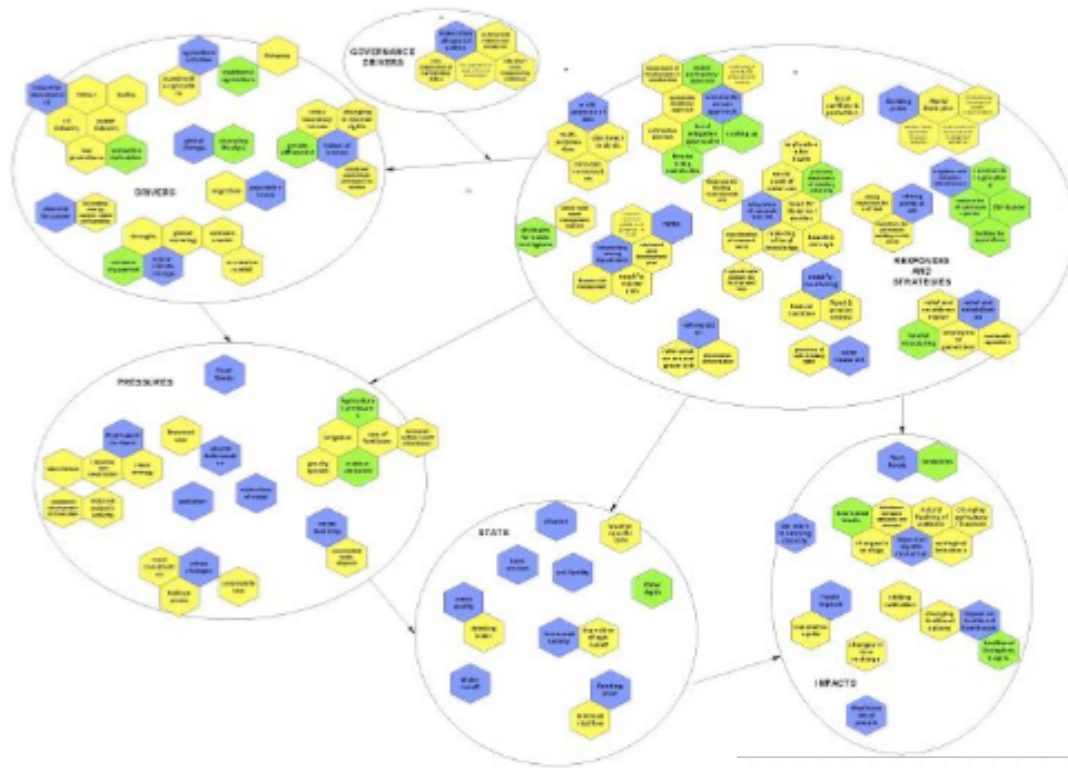
Creative System Modelling 4/9

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Area	Indicator	Description	Unit	Partner	U	L	R	W	V	Health-Domain	Stakeholders	U	V	W	Health-Domain				
Soil description	Soil depth	Vertical depth in the soil profile. This indicator can be calculated as the ratio of soil depth to the total soil depth.	m	FAO											Soil description				
	Soil depth (ratio of total soil)	Ratio of soil depth to the total soil depth.	%	FAO												Soil description			
	Soil depth (ratio of total soil)	Ratio of soil depth to the total soil depth.	%	FAO													Soil description		
	Soil depth (ratio of total soil)	Ratio of soil depth to the total soil depth.	%	FAO														Soil description	
	Soil depth (ratio of total soil)	Ratio of soil depth to the total soil depth.	%	FAO															Soil description
	Soil depth (ratio of total soil)	Ratio of soil depth to the total soil depth.	%	FAO															
Ecosystem diversity	Biodiversity	Vertical distribution of various components and species that characterizes the degree of vertical complexity and the degree of vertical change and effect the distribution of a broad range of fauna and flora (Shaw et al. 2001).	species/decade/m ²	FAO											Ecosystem diversity				
	Biodiversity	Vertical distribution of various components and species that characterizes the degree of vertical complexity and the degree of vertical change and effect the distribution of a broad range of fauna and flora (Shaw et al. 2001).	species/decade/m ²	FAO												Ecosystem diversity			
	Biodiversity	Vertical distribution of various components and species that characterizes the degree of vertical complexity and the degree of vertical change and effect the distribution of a broad range of fauna and flora (Shaw et al. 2001).	species/decade/m ²	FAO													Ecosystem diversity		
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	Biodiversity	Vertical distribution of various components and species that characterizes the degree of vertical complexity and the degree of vertical change and effect the distribution of a broad range of fauna and flora (Shaw et al. 2001).	species/decade/m ²	FAO															
Land use / Land use change	Land use	Assessment of the percentage of land use in the total area (area/total area).	%	FAO											Land use / Land use change				
	Land use	Assessment of the percentage of land use in the total area (area/total area).	%	FAO												Land use / Land use change			
	Land use	Assessment of the percentage of land use in the total area (area/total area).	%	FAO													Land use / Land use change		
	Land use	Assessment of the percentage of land use in the total area (area/total area).	%	FAO														Land use / Land use change	
	Land use	Assessment of the percentage of land use in the total area (area/total area).	%	FAO															Land use / Land use change
	Land use	Assessment of the percentage of land use in the total area (area/total area).	%	FAO															
Forests	Forest area	Total area of the forest land cover (FAO, 2001).	km ²	FAO											Forests				
	Forest area	Total area of the forest land cover (FAO, 2001).	km ²	FAO												Forests			
	Forest area	Total area of the forest land cover (FAO, 2001).	km ²	FAO													Forests		
	Forest area	Total area of the forest land cover (FAO, 2001).	km ²	FAO														Forests	
	Forest area	Total area of the forest land cover (FAO, 2001).	km ²	FAO															Forests
	Forest area	Total area of the forest land cover (FAO, 2001).	km ²	FAO															
Water	Water quality	Assessment of the water quality in the total area (area/total area).	index	FAO											Water				
	Water quality	Assessment of the water quality in the total area (area/total area).	index	FAO												Water			
	Water quality	Assessment of the water quality in the total area (area/total area).	index	FAO													Water		
	Water quality	Assessment of the water quality in the total area (area/total area).	index	FAO														Water	
	Water quality	Assessment of the water quality in the total area (area/total area).	index	FAO															Water
	Water quality	Assessment of the water quality in the total area (area/total area).	index	FAO															
Climate	Precipitation	Annual precipitation in the total area (area/total area).	mm	FAO											Climate				
	Precipitation	Annual precipitation in the total area (area/total area).	mm	FAO												Climate			
	Precipitation	Annual precipitation in the total area (area/total area).	mm	FAO													Climate		
	Precipitation	Annual precipitation in the total area (area/total area).	mm	FAO														Climate	
	Precipitation	Annual precipitation in the total area (area/total area).	mm	FAO															Climate
	Precipitation	Annual precipitation in the total area (area/total area).	mm	FAO															
Environmental hazards	Vulnerability	Assessment of the vulnerability in the total area (area/total area).	index	FAO											Environmental hazards				
	Vulnerability	Assessment of the vulnerability in the total area (area/total area).	index	FAO												Environmental hazards			
	Vulnerability	Assessment of the vulnerability in the total area (area/total area).	index	FAO													Environmental hazards		
	Vulnerability	Assessment of the vulnerability in the total area (area/total area).	index	FAO														Environmental hazards	
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	Vulnerability	Assessment of the vulnerability in the total area (area/total area).	index	FAO															



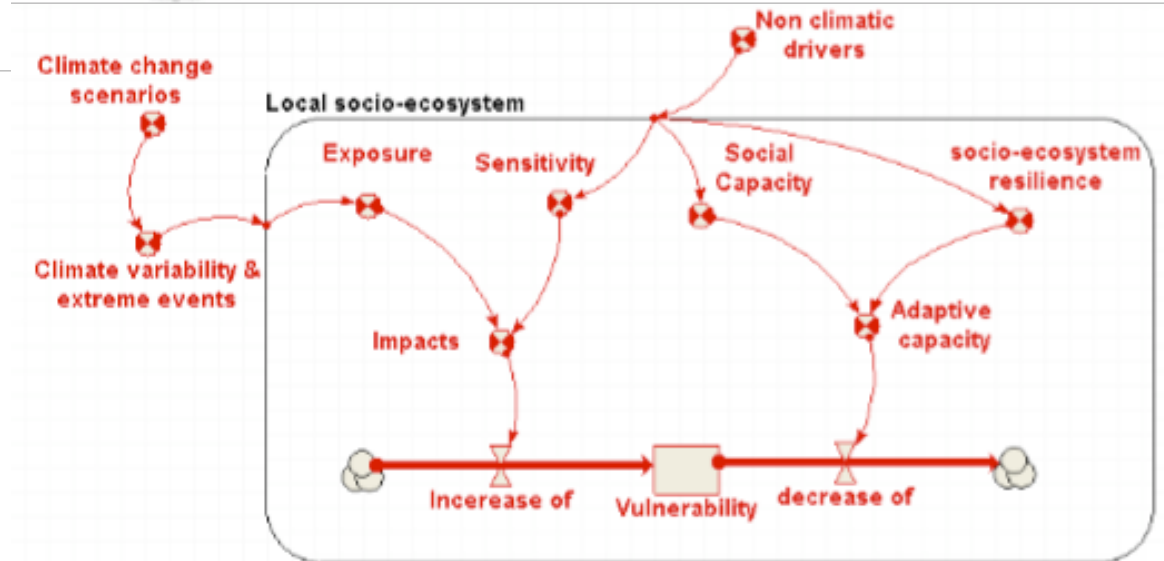
Creative System Modelling 5/9



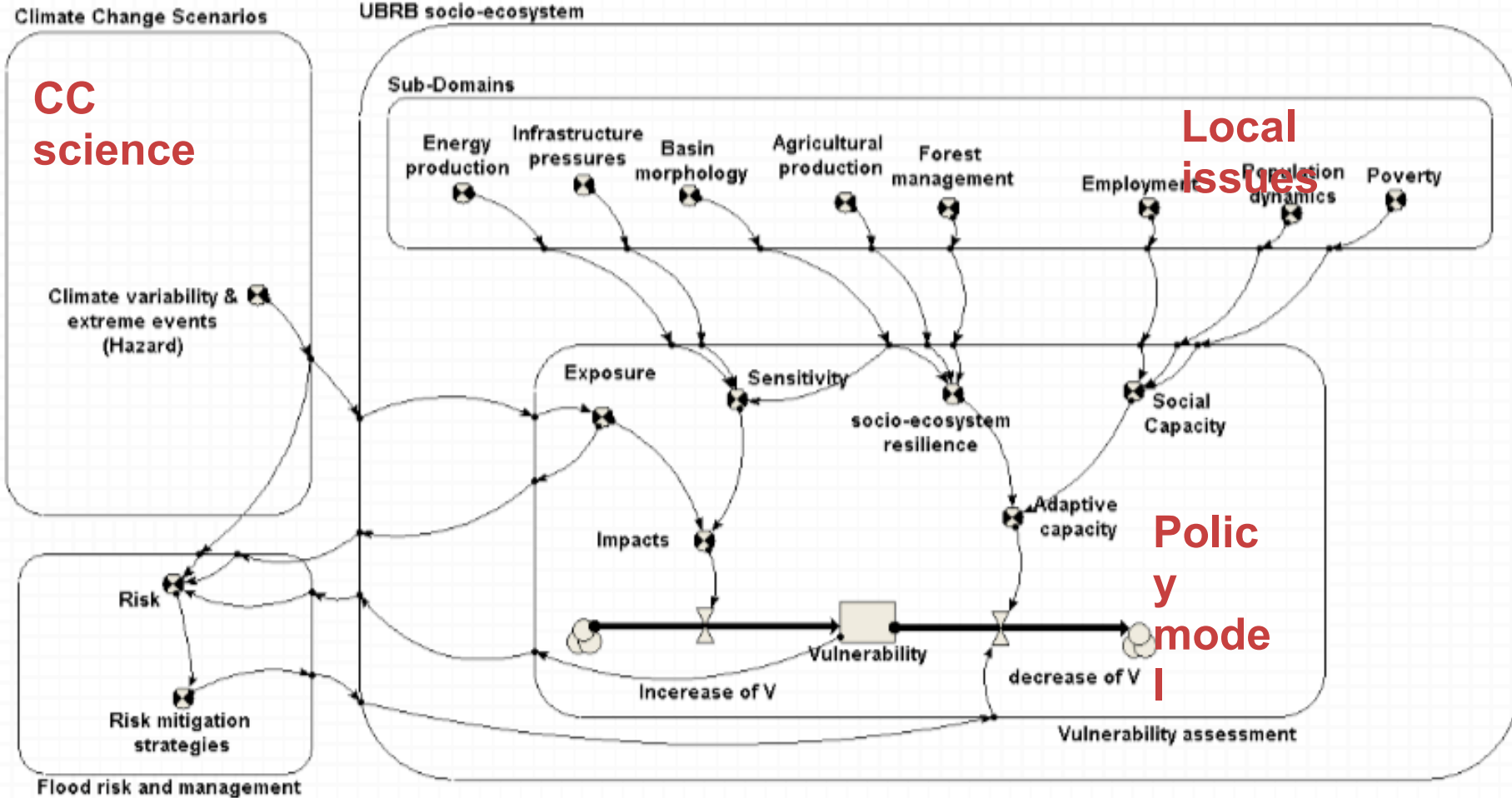
Cognitive map framed in the DPSIR model

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Generic conceptual vulnerability assessment model



Creative System Modelling 6/9



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Policy making

Participatory modelling



Creative System Modelling 7/9

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BRAHMATWINN MEETING, 4-5 MAY 2009, MUNICH

Partner: _____

Sub-domains selected by stakeholders for the UBRB:

- basin morphology
- forest management
- vulnerability
- poverty
- population dynamics
- infrastructure pressures
- energy production
- agricultural production
- employment

Examples of curves:

Stewart, 2000: Figure 4-1

Steps:

1. choose type of curve (some examples are shown above)
2. define values at each time step
3. graph curve

Consider the following time steps: 1980 – 2000 – 2020 – 2040

Consider the present state of each Sub-domain to be equal to 0.5

- values higher than 0.5 represent an improvement of the state
- values lower than 0.5 represent a worsening of the state

Please sketch the possible trajectory considering:

- the climate change scenario shown
- no response strategy is implemented

UBRB 1

WHAT TREND WILL THE SUB-DOMAIN HAVE?

basin morphology

forest management

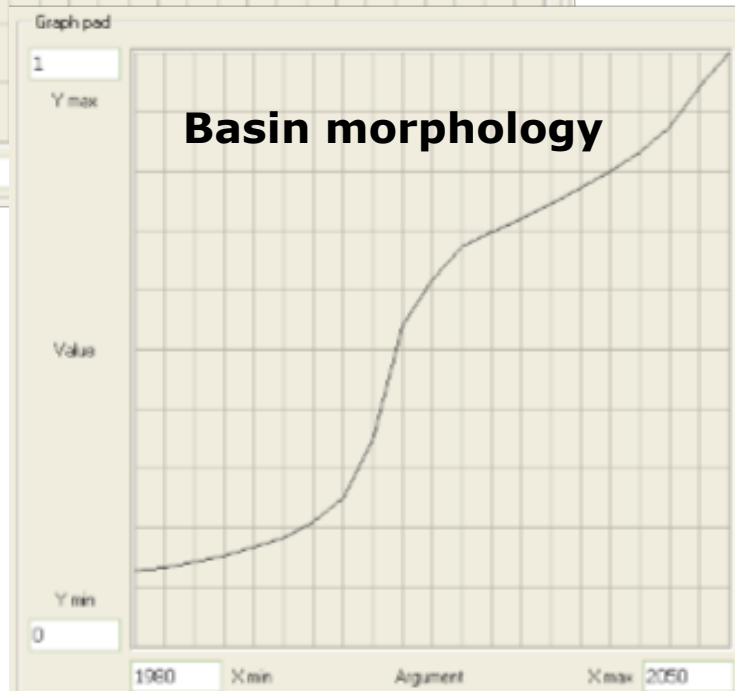
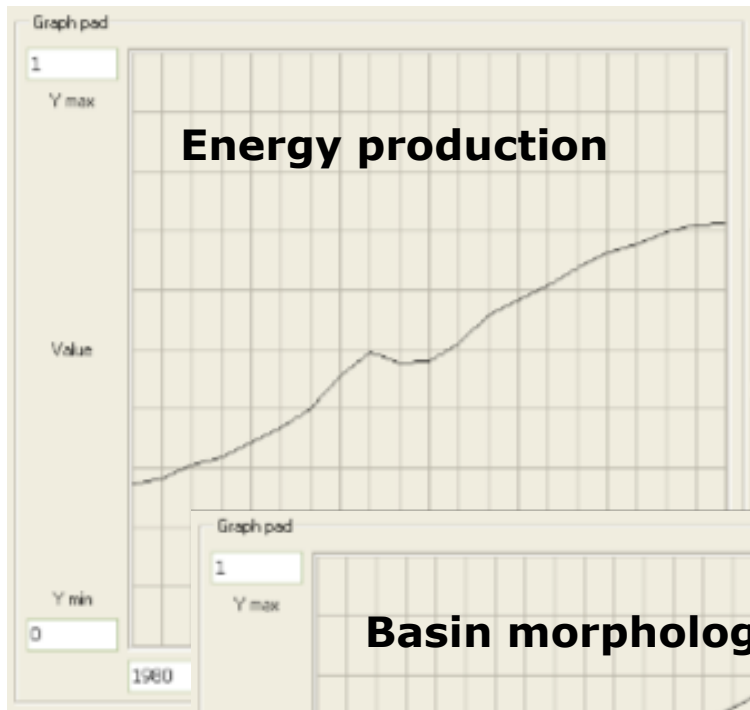
UBRB 2



Expert knowledge elicitation

Creative System Modelling 8/9

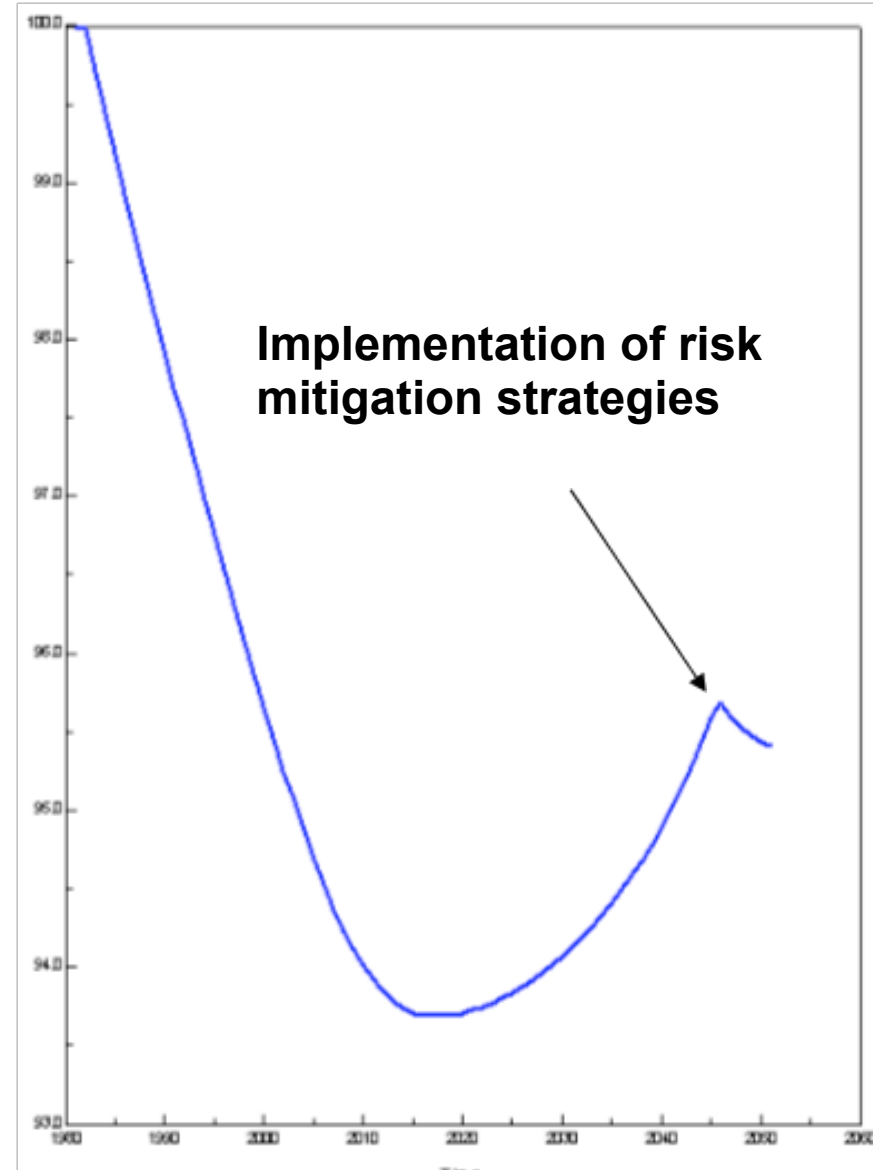
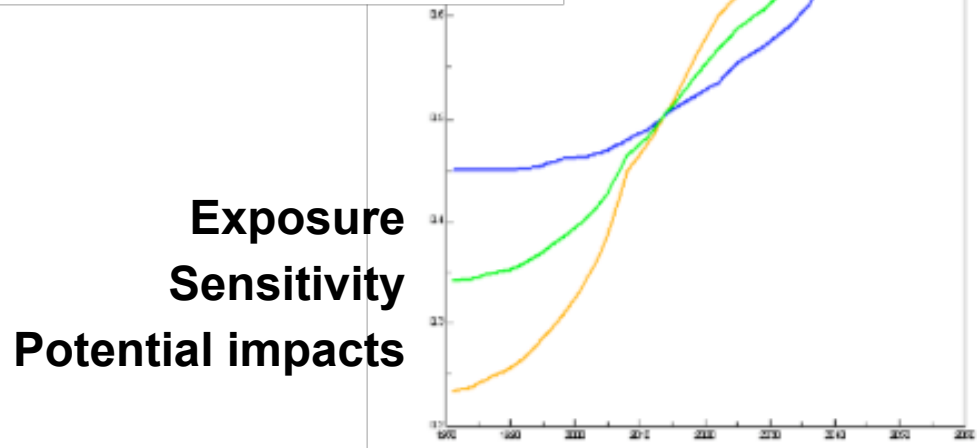
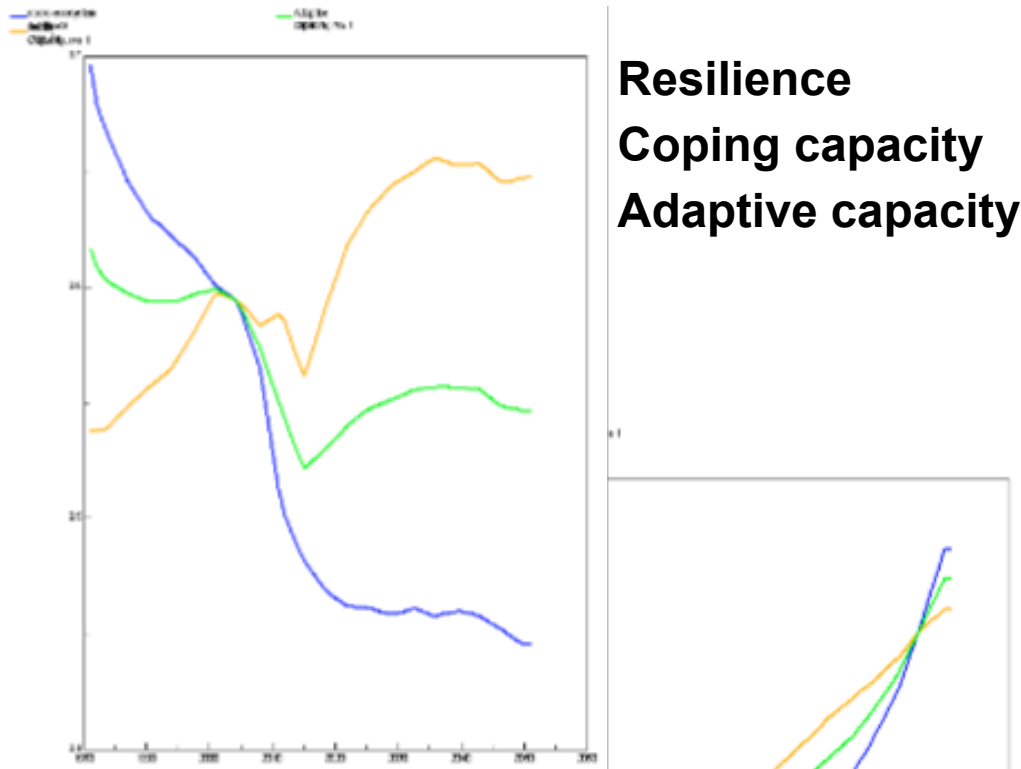
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Expert knowledge elicitation for participatory

Creative System Modelling 9/9

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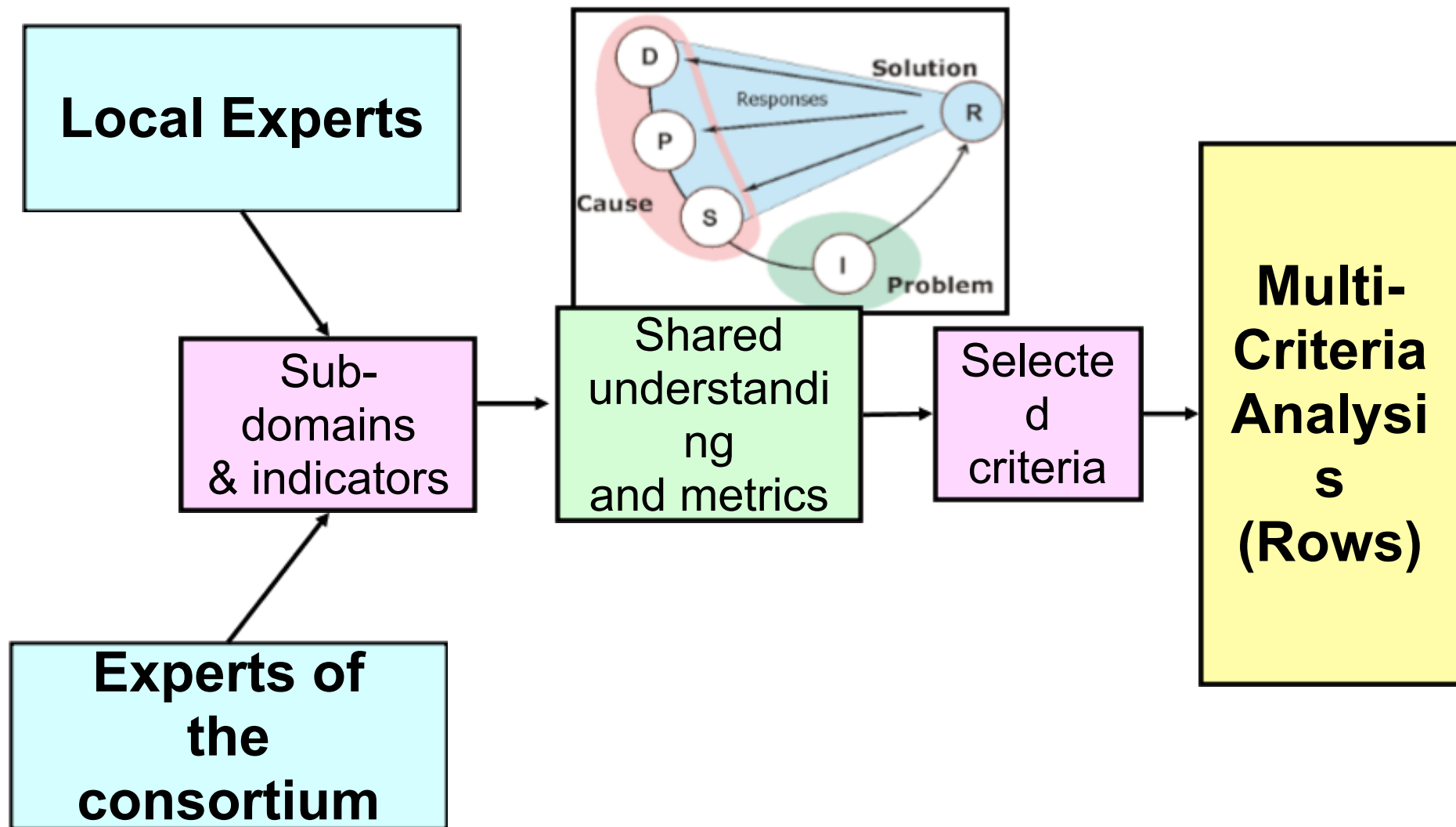
Vulnerability



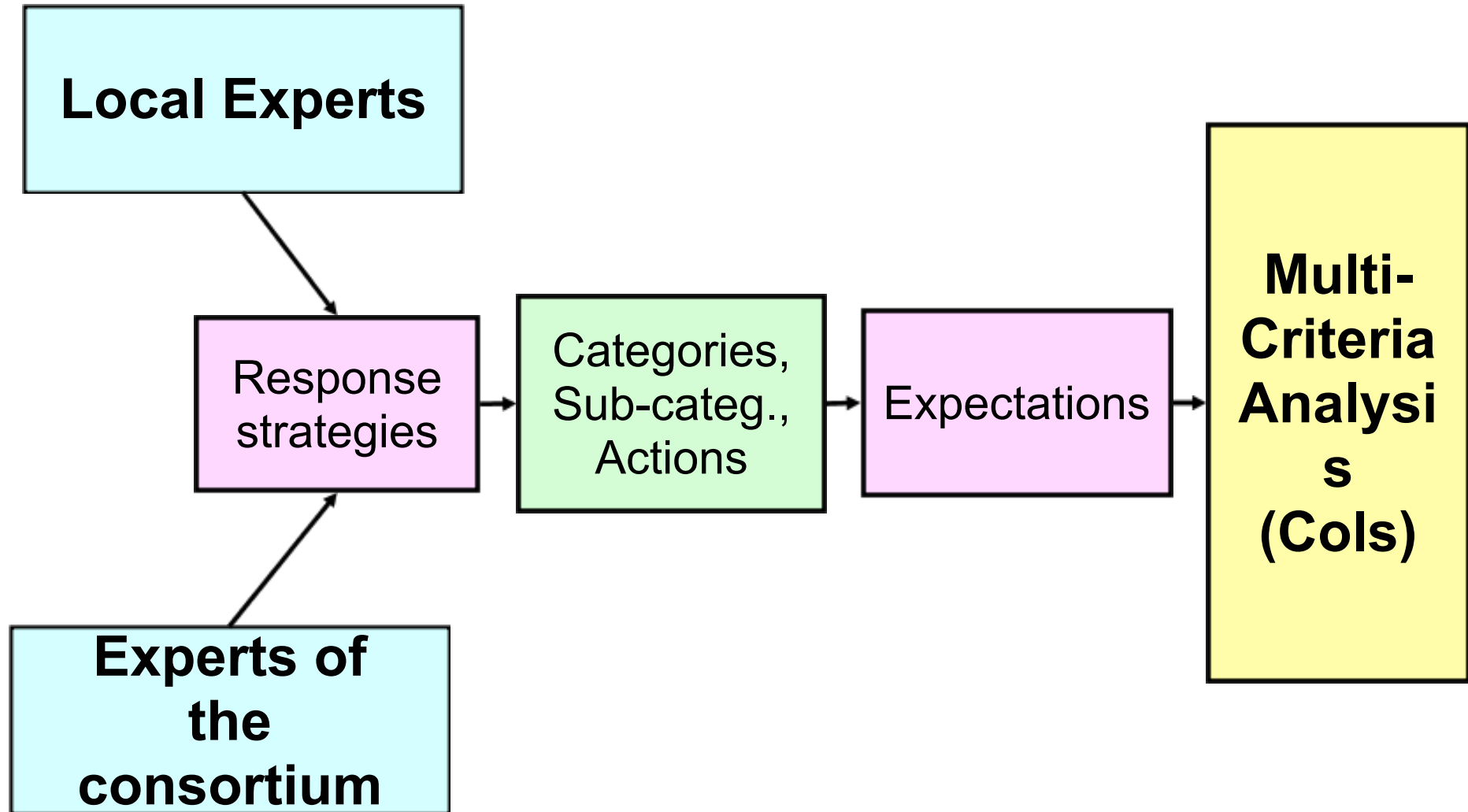
Future research plans

- Experimental design for participatory modelling of CC vulnerability and adaptation strategies:
 1. Single expert curves supported by literature references and data bases (deterministic)
 2. Multiple experts curves for uncertainty analysis (stochastic)
 3. Partial/complete substitution of empirical curves with model outputs
- Dynamic Multi-Criteria Analysis of alternative strategies
 1. ...

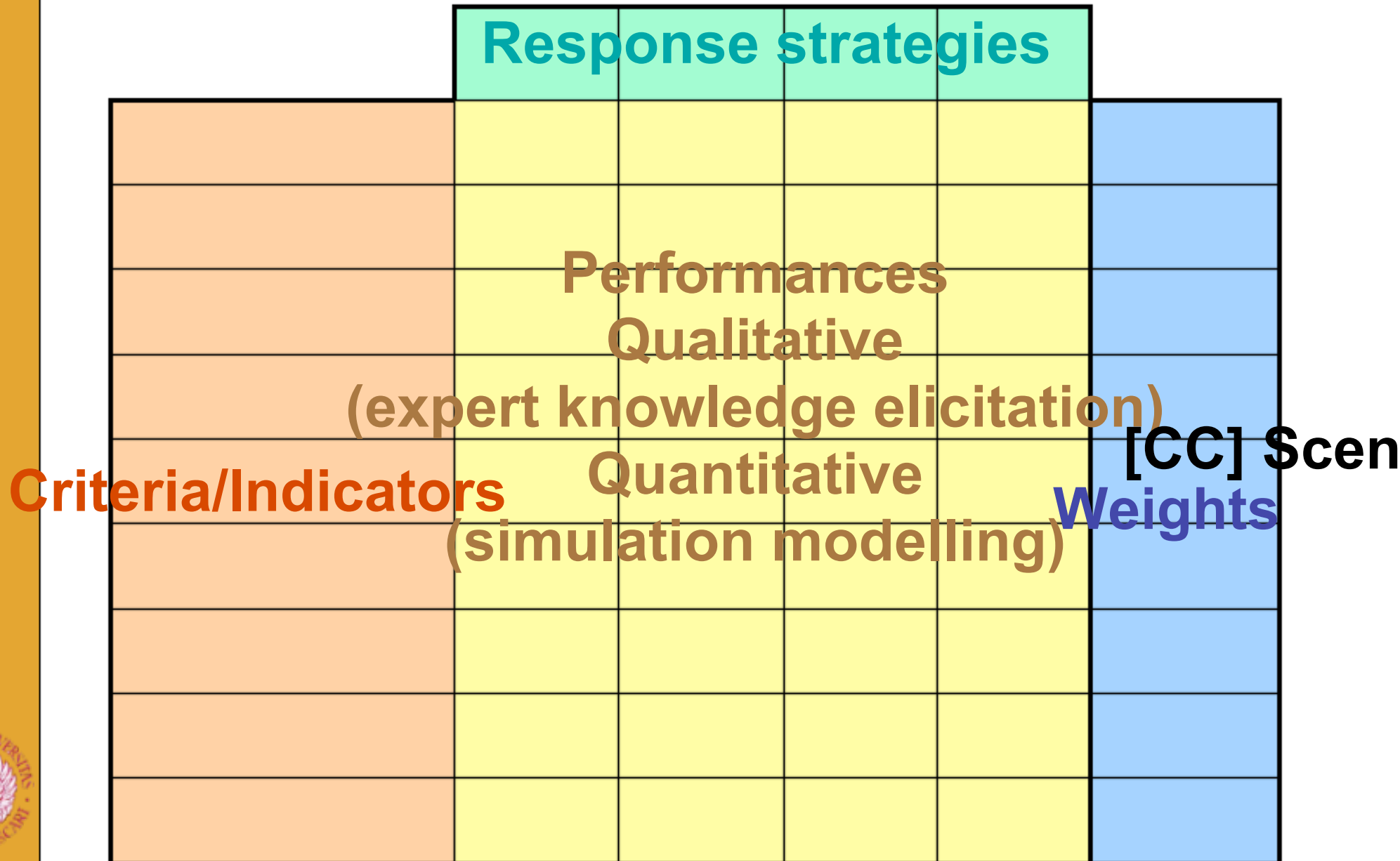
Decision Support 1/2



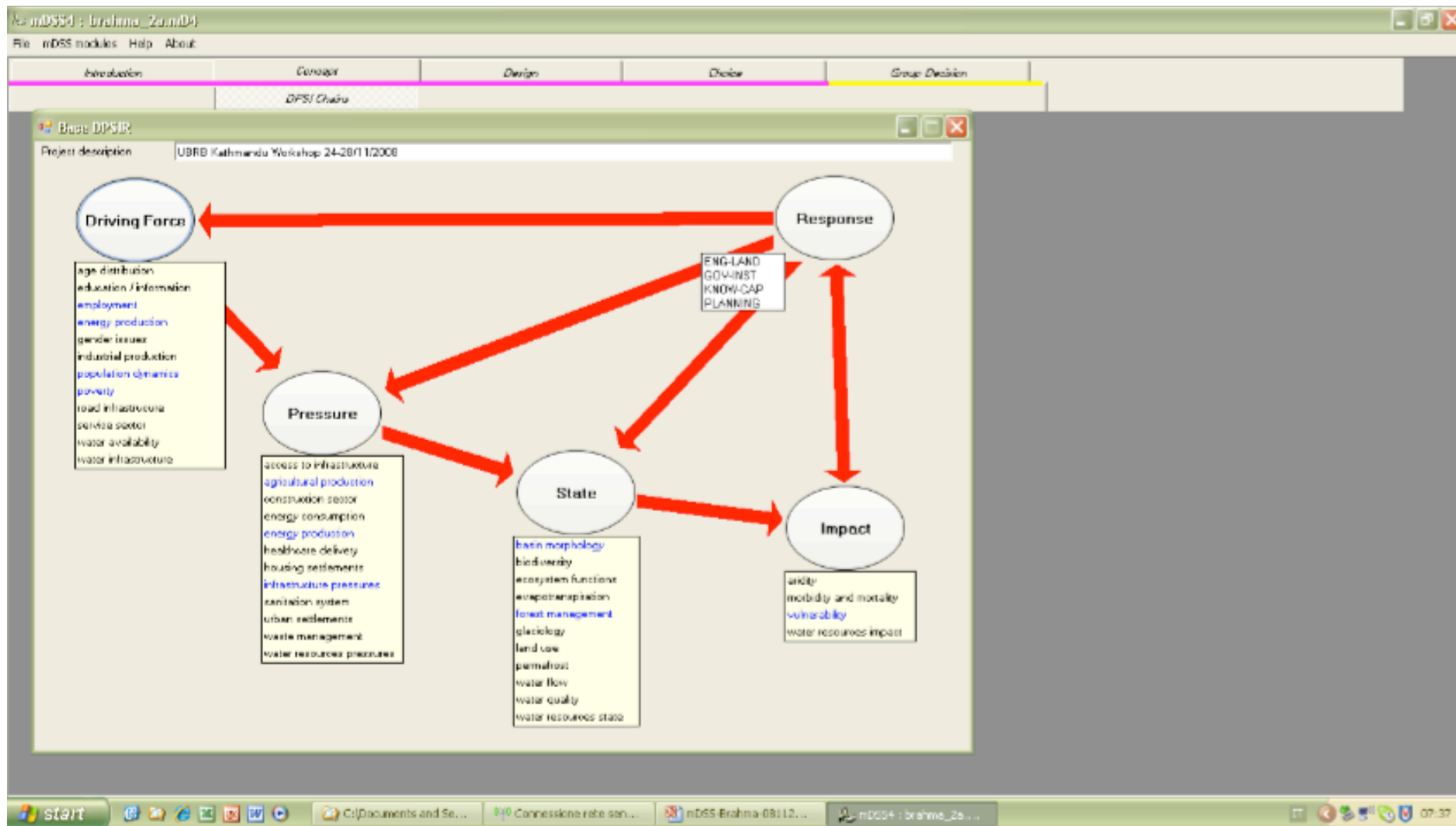
Decision Support 2/2



Responses, criteria, performances, weights, scenarios



Dpsir framework: selection of criteria (sub-domains)



Analysis matrix

Scenario: Brahma_2a.mcd4

File nDSS modules Help About

Resolution Concept Design Choice Group Decision

Analysis Matrix

File ANALYSIS MATRIX

ANALYSIS MATRIX

	PARAMETERS	Constant	ENG LAND	GOV/INST	KNOW/CAP	PLANNING
1	poverty		3.00	1.00	2.62	2.20
2	population dynamics		3.05	2.33	2.62	1.71
3	infrastructure pressures		2.14	2.62	2.75	2
4	vulnerability		1.95	2.15	2.25	1.7
5	basin morphology		2.43	3.05	2.52	2.38
6	forest management		1.95	2.1	2.24	1.81
7	agricultural production		2.33	2.43	2.6	2.1
8	energy production		2.1	2.57	3	2.24
9	employment		3.52	2.52	2.52	2.40

Load AM from... Save AM to... List

Advanced

Continue with SAW
 Continue with TOPSIS
 Continue with ELECTRE

Windows taskbar: start, C:\Documents and Se..., 0-11 Concessione rete sen..., nDSS Brahma-08112..., nDSS4 : brahma_2a..., 07:38



Normalization

mDSS4 : brahma_2a.mD4

File mDSS modules Help About

Resolution Concept Design Choice Group Decision

Value Function SAVR D194

Value Function

ANALYSIS MATRIX

PARAMETERS	PLAN001	GOVANS7	ANUP-24P	PLAN003
poverty	3.33	1.86	2.62	2.25
population dynamics	3.05	2.33	2.62	1.71
infrastructure pressures	2.14	2.62	2.76	2
vulnerability	1.95	2.15	2.25	1.7
basin morphology	2.43	3.05	2.52	2.36
forest management	1.95	2.1	2.24	1.81
agricultural production	2.33	2.43	2.6	2.1
energy production	2.1	2.57	3	2.24
employment	3.62	2.62	2.62	2.43

EVALUATION MATRIX

CRITERIA	PLAN001	GOVANS7	ANUP-24P	PLAN003
poverty	0.43	0.78	0.59	0.68
population dynamics	0.49	0.67	0.59	0.62
infrastructure pressures	0.72	0.6	0.56	0.75
vulnerability	0.76	0.71	0.68	0.62
basin morphology	0.64	0.49	0.62	0.66
forest management	0.77	0.73	0.69	0.8
agricultural production	0.67	0.65	0.6	0.73
energy production	0.73	0.61	0.5	0.69
employment	0.37	0.62	0.62	0.64

VALUE FUNCTION FOR: poverty

A: 0

B: 0

Coord.	X	Y
A	1.86	0
B	3.33	0

Standardise options

Value Function

Benefit type

Cost type

Send to EM Cancel

Change Me Refresh Change Me Save Value Functions Load Value Functions

Add

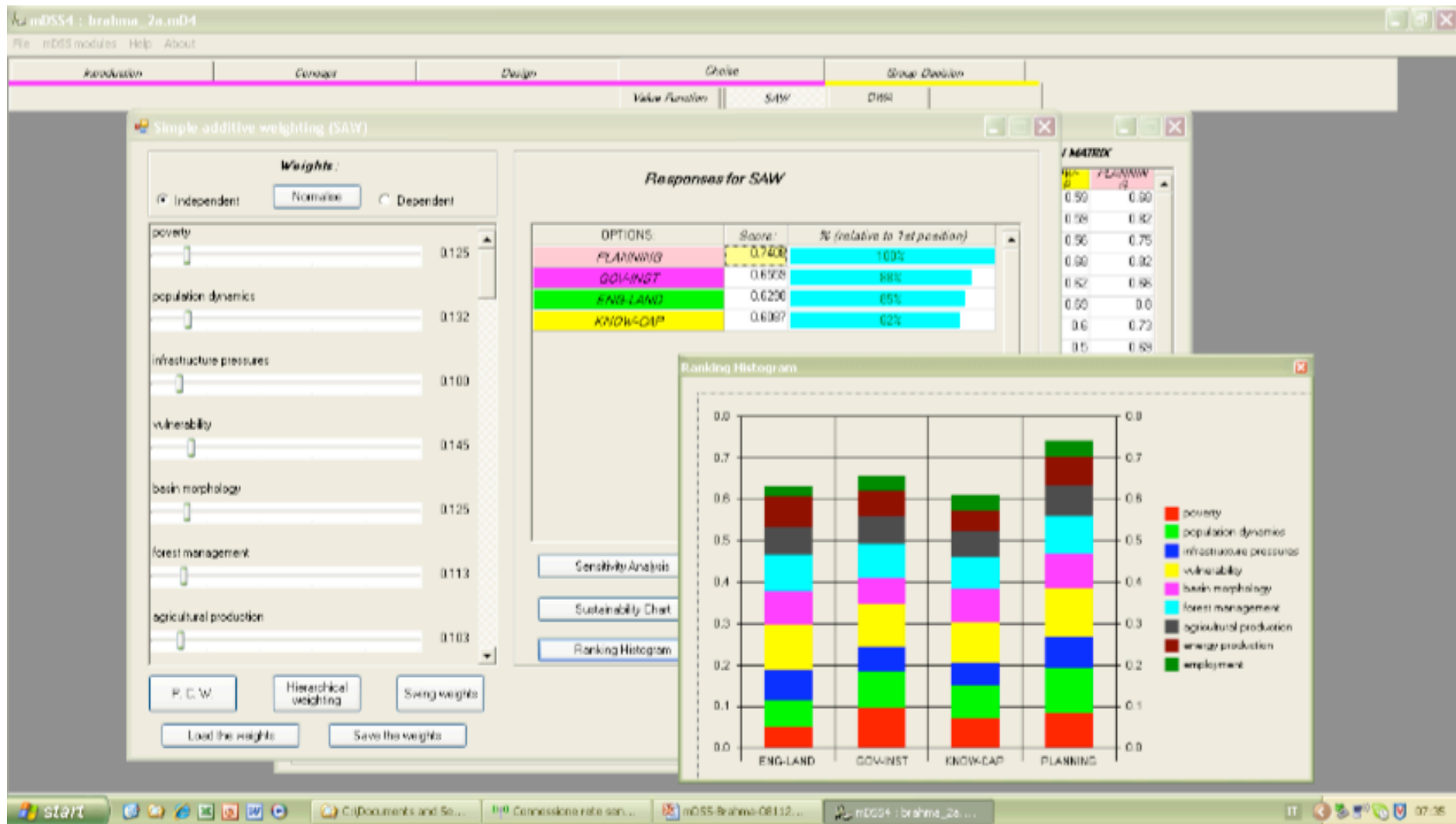
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C:\Documents and Se... 0% Commission rate son... mDSS-Brahma-08112... mDSS4 : brahma_2a...

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Ranking of strategies



Sensitivity analysis

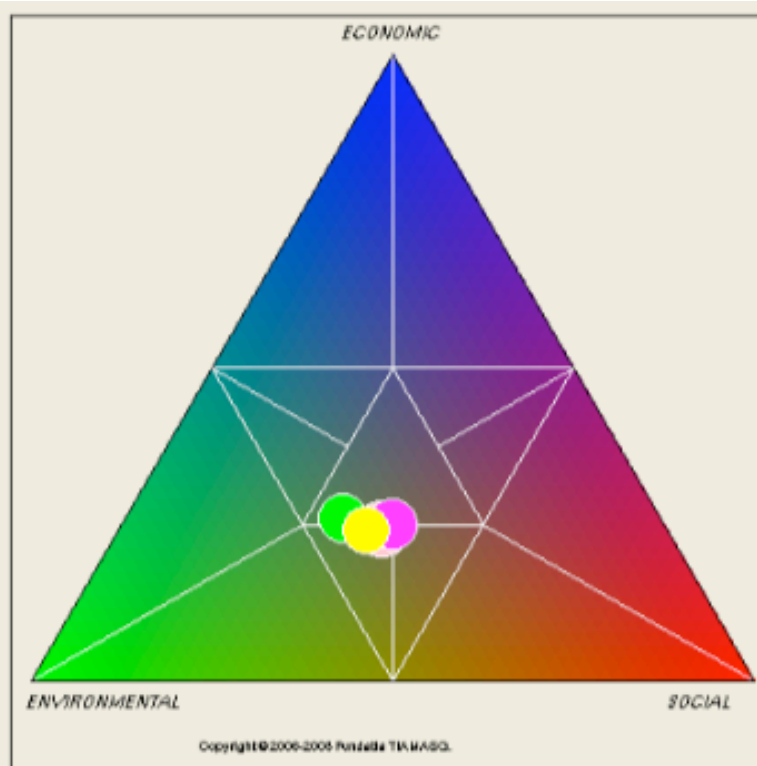
The screenshot shows the mDSS4 software interface with a 'Sensitivity Analysis' window open. The window contains the following elements:

- Critical criterion matrix for SAW method:** A table showing the sensitivity of the best option (GOV-NET) to changes in criterion weights. The most critical criterion is 'poverty' with a sensitivity of 0.85.
- TORNADO diagram:** A horizontal bar chart showing the sensitivity of the best option to changes in each criterion's weight. 'poverty' has the largest impact.
- Control Panels:**
 - Weights:** A list of criteria with sliders for adjusting their weights. The 'Independent' option is selected.
 - Basic Option (best option):** Set to 'PLANNING'.
 - Challenging option:** Set to 'GOV-NET'.

New weights set	poverty	population dynamics	infrastructure pressure	vulnerability	basin morphology	forest management	agricultural production
Weights	0.13	0.13	0.13	0.15	0.13	0.11	0.10
Options / Criteria	poverty	population dynamics	infrastructure pressure	vulnerability	basin morphology	forest management	agricultural production
GOV-NET vs.	0.85						
ENG-LAND vs.							
HNOVI-CAP vs.							
ENG-LAND vs.	0.07		-0.22	-0.52	-0.17	-0.55	-1.30
HNOVI-CAP vs.					-0.35		
HNOVI-CAP vs.	-0.12	-0.21					



Sustainability analysis

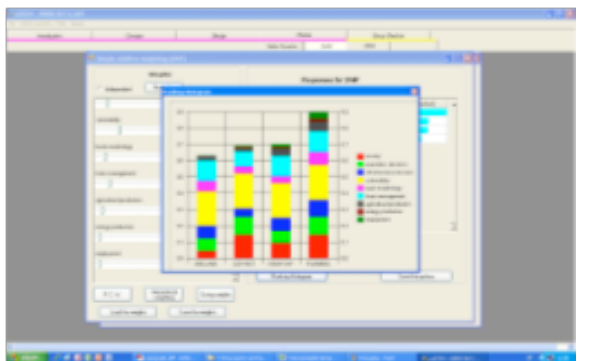
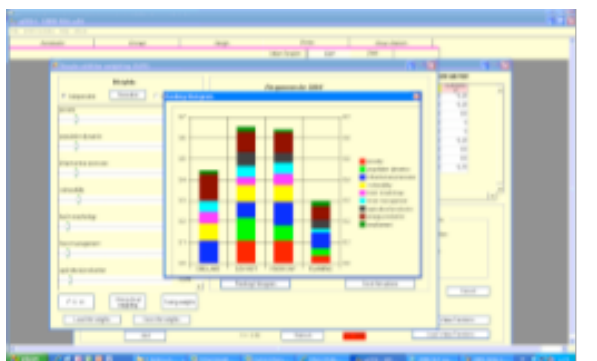
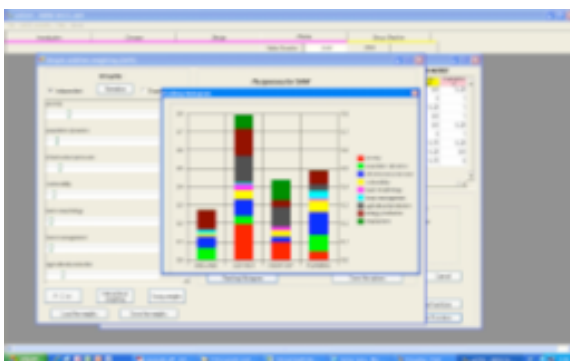


- Options:*
1. PLANNING = 0.7408
coord: (0.39, 0.36, 0.25)
 2. GOV-INST = 0.6559
coord: (0.38, 0.37, 0.25)
 3. ENG-LAND = 0.6298
coord: (0.44, 0.30, 0.26)
 4. KNOW-CAP = 0.6087
coord: (0.42, 0.34, 0.24)

CRITERIA	Envir onme ntal	Soci al	Eco no mic
poverty	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
population dynamics	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
infrastructure pressures	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
vulnerability	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
basin morphology	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
forest management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
agricultural production	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
energy production	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
employment	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



Diversity of preferences



Group decision making

Compromising final solution

USER DEFINED OPTIONS ORDER

	Best option	...>>...	...>>...	Worst option
UBRB-SH1.opt (SAW meth	PLANNING	ENG-LAND	KNOW-CAP	GOV-INST
UBRB-SH2.opt (SAW meth	ENG-LAND	KNOW-CAP	PLANNING	GOV-INST
UBRB-SH3.opt (SAW meth	ENG-LAND	GOV-INST	PLANNING	KNOW-CAP
UBRB-SH4.opt (SAW meth	KNOW-CAP	PLANNING	GOV-INST	ENG-LAND
UBRB-SH5.opt (SAW meth	PLANNING	KNOW-CAP	ENG-LAND	GOV-INST
UBRB-SH6.opt (SAW meth	PLANNING	ENG-LAND	GOV-INST	KNOW-CAP
UBRB-SH7.opt (SAW meth	GOV-INST	KNOW-CAP	ENG-LAND	PLANNING
UBRB-SH8.opt (SAW meth	ENG-LAND	GOV-INST	PLANNING	KNOW-CAP
UBRB-SH9.opt (SAW meth	PLANNING	GOV-INST	KNOW-CAP	ENG-LAND
UBRB-SH10.opt (SAW meth	PLANNING	GOV-INST	ENG-LAND	KNOW-CAP
UBRB-SH11.opt (SAW meth	PLANNING	KNOW-CAP	GOV-INST	ENG-LAND

Condorcet Borda

Compromising final solution

Compromising final solution

USER DEFINED OPTIONS ORDER

	Best option	...>>...	...>>...	Worst option
UBRB-SH1.opt (SAW meth	PLANNING	ENG-LAND	KNOW-CAP	GOV-INST
UBRB-SH2.opt (SAW meth	ENG-LAND	KNOW-CAP	PLANNING	GOV-INST
UBRB-SH3.opt (SAW meth	ENG-LAND	GOV-INST	PLANNING	KNOW-CAP
UBRB-SH4.opt (SAW meth	KNOW-CAP	PLANNING	GOV-INST	ENG-LAND
UBRB-SH5.opt (SAW meth	PLANNING	KNOW-CAP	ENG-LAND	GOV-INST
UBRB-SH6.opt (SAW meth	PLANNING	ENG-LAND	GOV-INST	KNOW-CAP
UBRB-SH7.opt (SAW meth	GOV-INST	KNOW-CAP	ENG-LAND	PLANNING
UBRB-SH8.opt (SAW meth	ENG-LAND	GOV-INST	PLANNING	KNOW-CAP
UBRB-SH9.opt (SAW meth	PLANNING	GOV-INST	KNOW-CAP	ENG-LAND
UBRB-SH10.opt (SAW meth	PLANNING	GOV-INST	ENG-LAND	KNOW-CAP
UBRB-SH11.opt (SAW meth	PLANNING	KNOW-CAP	GOV-INST	ENG-LAND

RESULTS

Condorcet **Borda** Extended Borda

Compromising final solution using BORDA rule

Options	PLANNING	GOV-INST	KNOW-CAP	ENG-LAND
Total Borda Mark	45	29	25	21

Save this option's rank ...



Lessons learned

- The combination of **qualitative models developed by stakeholders** and more **complex simulation models** within the same conceptual and decision framework may contribute to the uptake of research products by the competent administrations and thus to the **quality of decision/policy making process**;
- **Models and DSS** tools should be seen as the **ICT component** of a structured, modular and flexible approach for supporting decision **processes**, with a fundamental role played by a trained **task force** including **facilitators of PP**;
- **Training and capacity building** activities carefully embedded in the **local institutional and social contexts** are needed for effective implementations given the system complexity, the number of tools,...;

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