An integration of decision aiding tools to support problem formulation in innovation processes

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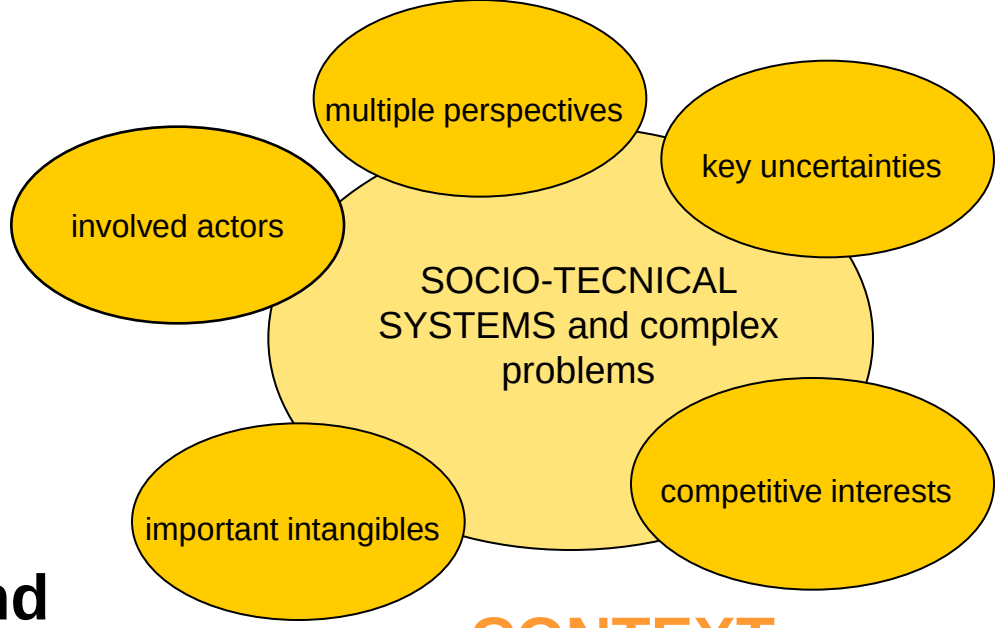
Overview

- *Context and process of the analysis*
- *Methods: integration and interdisciplinary approach*
- *Application on a real case*: *SMAT project*

A Problem Structuring Method offers a way of representing the situation that enables participants to clarify their predicament, converge on a potentially actionable problem, or issue within it, and agree commitments that will at least partially resolve the problem situation (Rosenhead and Mingers, 2004)



INTEGRATION of PSM and soft and hard TOOLS

Problem structuring

Constraints, Problem key issues, Stakeholders, Uncertainties, Values, Goals, Alternatives and preferences

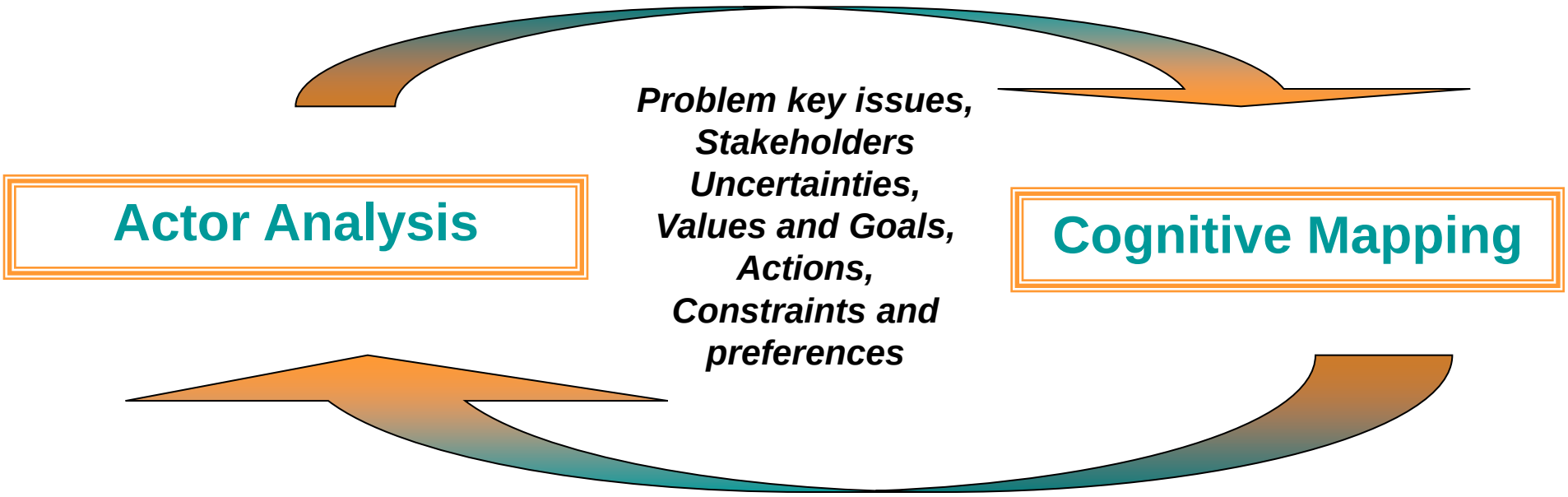
Model structuring and formal elaboration

Specifying Alternatives, Defining Criteria, Eliciting values

Using the model

Challenging intuition, Creating new alternatives, Communication and information validation, Robustness analysis

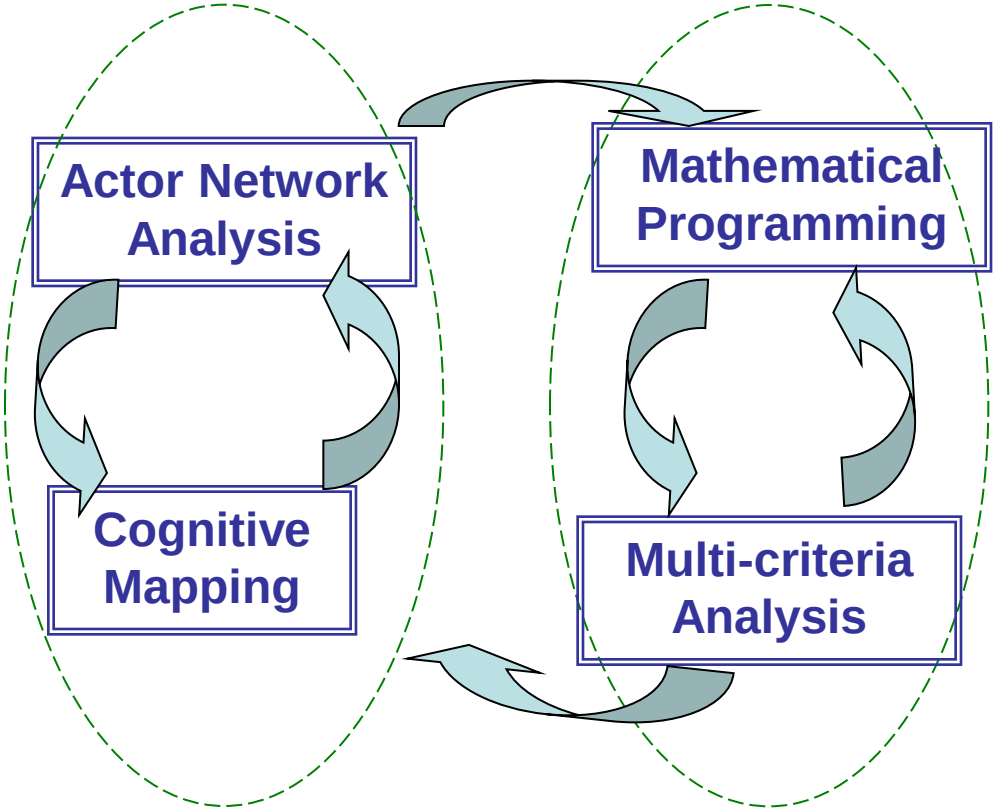
STRUCTURING PROCESS



Actor analysis methods to study the structure of the contexts where the individual/organizational actors (or the potential actors) play a role (or multiple roles) and activate relationships

Cognitive mapping as an action-orientated thinking that facilitates the understanding of the problem perception from the actor's point of view and the structuring of the (present but fragmented or tacit) knowledge elements

Cycling between modeling approaches gave benefits that could not have been attained by either hard or soft modeling in isolation (Eden and Akermann, 1997)



From concepts and relationships to structured models (with actions, criteria and parameters, or variables, objectives, constraints and parameters) in order to elaborate possible solutions, compare them and identify new aspects and points of view or modify the models

Learning cycles by "simulated" applications of methods, result analysis and new cycles of knowledge structuring

Learning cycles of problem formulation and model structuring by an integrated use of Problem Structuring Methods (PSM) and classic OR methods (in contexts of Innovation, New Product Development, Conceptual Design,…)

SMAT project

SMATF1

SMAT main objective is to define, design and develop an Advanced Environment Monitoring System, based on Unmanned Air Systems

Three segments have to be organized (aerial, ground and communication) and the architecture has to be integrated with the existing surveillance network

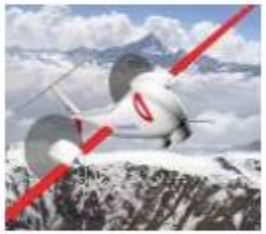
SMAT main components

Aerial Segment

Innovative UAV platforms:

- Molynx
- Falco
- D-Fly

Payloads (e.g. EO/IR, hyperspectral, radar, …)



Ground Segment

- Control Stations
- Supervision and Coordination Station

Communications

- Wireless (data-link)
- Landlines and control centres

Progetti strategici su tematiche di interesse regionale o sovra regionale Misura Ri.7-
LR 34/2004, Asse 1 Ricerca e Innovazione, FESR P.O.R. 2007 - 2013

REGIONE PIEMONTE

The aim of our work in the first phase of the project (SMAT-F1)

Identification of ***the potential end users*** with their ***needs*** and technological, organizational and economic ***constraints***

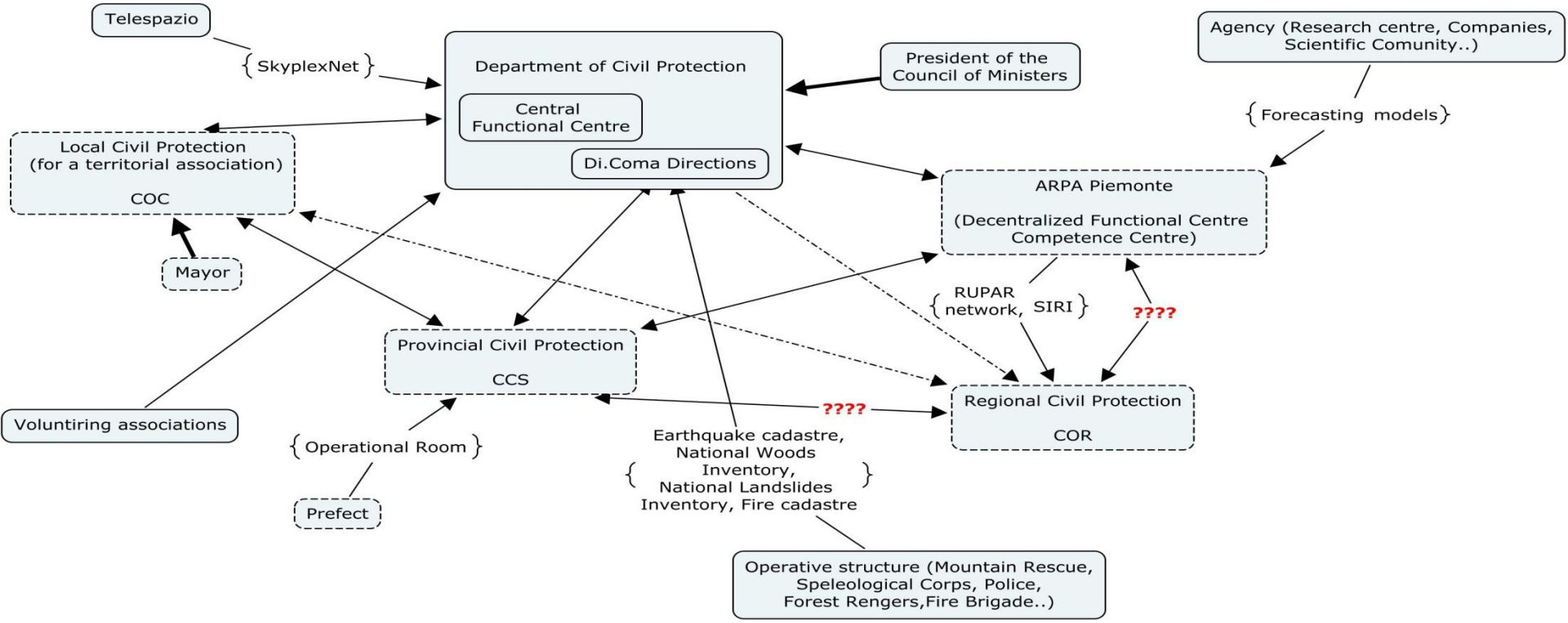
…in order to structure knowledge elements for the requirement analysis in SMAT – F1 and to support preparatory actions for the next phase of the design process (above all identification of the actors, to be involved in the collaborative space of conceptual design, and generation of admissible design alternatives and criteria, to be used in the conceptual design)

Open interviews are more useful than a questionnaire

How can the collected knowledge elements be validated and used?

Some soft OR tools should be used to deal with unstructured knowledge elements and integrated with data bases/structured data and MP/MC methods

Actor Network Analysis: Risk assessment, forecast, prevention and management



Actors in emergency context

ARPA Piemonte Relationship

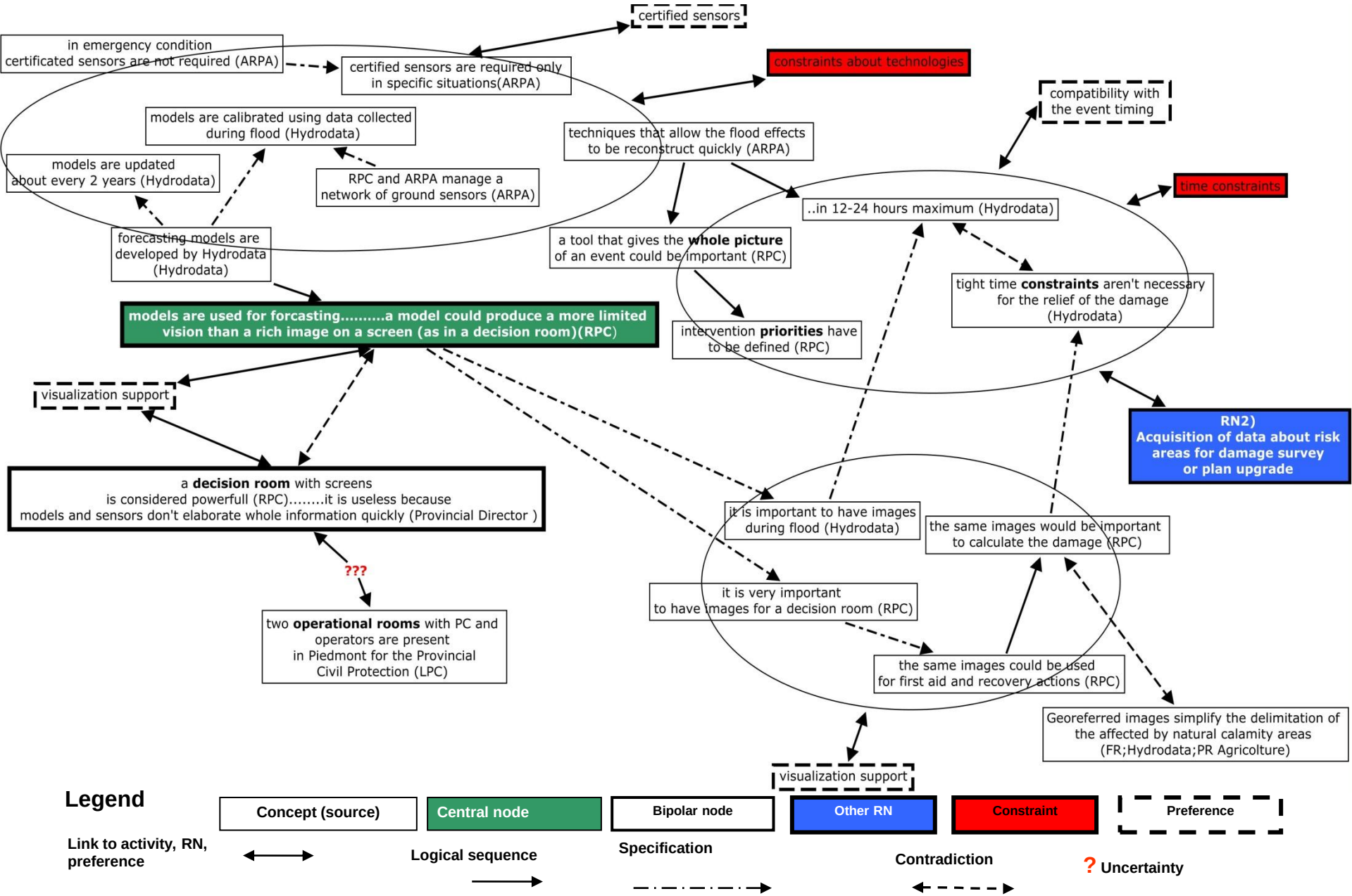
Economic and organizational constraints. Proposals of comunication action

Legend

Local Public Actor (PA) | National PA | International PA | {…} Non Human Actor

??? Uncertainity | Data Exchange | Monetary resources exchange | Responsability

Representation network (RN) of the subject *"Data acquisition and quick communication during an event when the phenomenon evolution is informative"*



Category and (activity) Macro parameters	Area target and monitoring characteristics	Workload Max delay	UAV type	Payload	Mission time extension	Frequency (times /year)	Total demand per year	UAV number per mission
I (3) or IV (4), OD/ST, L	Linear extension (L, in Km), UAV speed and footprint, Passage Number (PN)	8/16/24 B: min		4. or (2. and 3.)	H (KmxPN/ km/h)	A	L or A x H	H/B
I (5), II (1, 2), III (2), IV (1) PA/BA, P	Average surface (Km^2) and number of sites per year	8 B:unimportant		2. and/or 3.	Sites/day	X	days/year	
IV (3) OD/ST, P	Barycentre position in the area target	8/16/24 B: min		6.	H=Event time extension	A	A x H	
III(3), IV(2) PA(notice is short)/ST, P or L/P/W								

From structured and unstructured knowledge to a logical model formulation (for example in the mission planning context)

Objective functions

Max number of monitoring activities per unit of time, in order to min mission costs

Min payload weight and size

Variables, parameters and constraints (hard or soft constraints)

Demand of monitoring activities (sizing)

Time characteristics of the demand (notice, time window, duration, frequency, period of the year)

Technology requirements (in relation to the mission target and climate conditions)

Normative constraints (ENAC)

Unmanned Aerial Systems (number and typology, technological constraints for each typology)

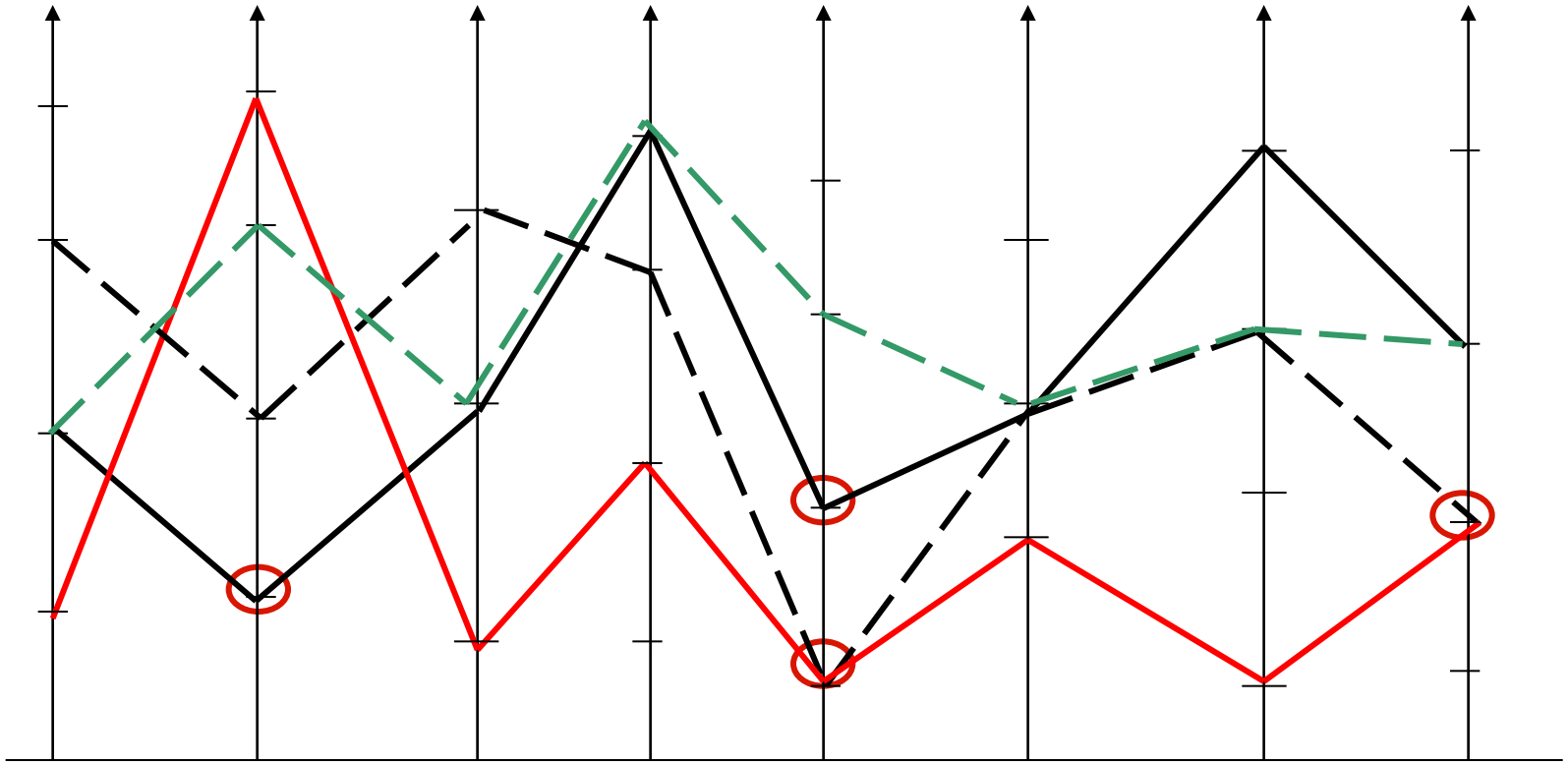
Payload (kind of sensor, communication and buffering system; weight limits and required performances)

Actions	Dimensions	Suggested criteria
Monitoring technologies (satellites, helicopters, ground sensors, direct inspections, UAS)	D1 Economical D2 Technological D3 Organisational D4 Psychological	D4: Deterrent action (the surveillance, by satellites, is possible without to be visible) Pressure-anxiety limitation (the presence of a risk that has to be measured is not stressed if the technology is not in evidence)
Monitoring service typologies	O1 Coordination and control O2 Integration O3 Organizational complexity	O1:Administrative coordination. Restriction forms to get to the service. End users' control of the procedures and/or the data quality O2: Integration of data to be shared; of new projects of data acquisition and storage; of procedures of data transfer O3: Change as a consequence of the introduction of a new monitoring service. Resistance to change
Mission typologies or Mission planning typologies	T1 Flexibility T2 Payload adequacy to the requests T3 Data handling and information processing	T1: e.g. Compatibility with the monitoring time requests, the previous technologies, the upgrade of previous data,… T2: e.g. Certified sensors for specific requests. T3: e.g. Performances of the sensors. Data storage capacity at long term.

For each Problem Formulation some actions can be generated trough Mathematical Programming and their consequences analysed by multiple criteria that an integration of Cognitive Mapping Approach and Actor Analysis has suggested

ITERATIVE MODEL BUILDING PROCESS

Mutiple Criteria approach to action elaboration



Thanks

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