Cognitive biases in spatial risk analysis: Design of an experiment

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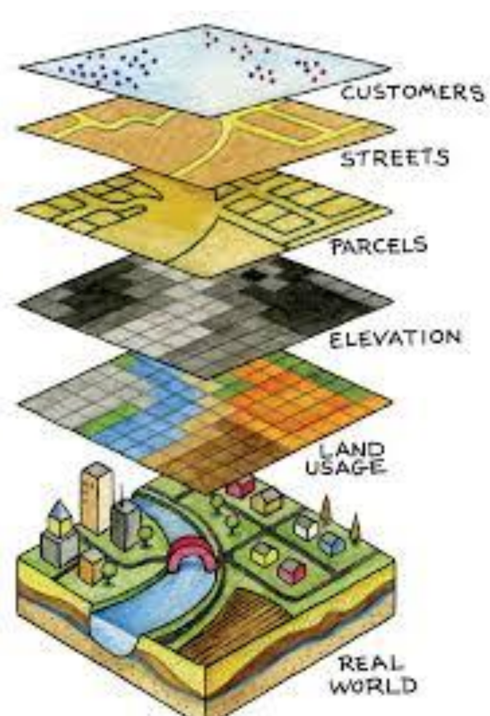


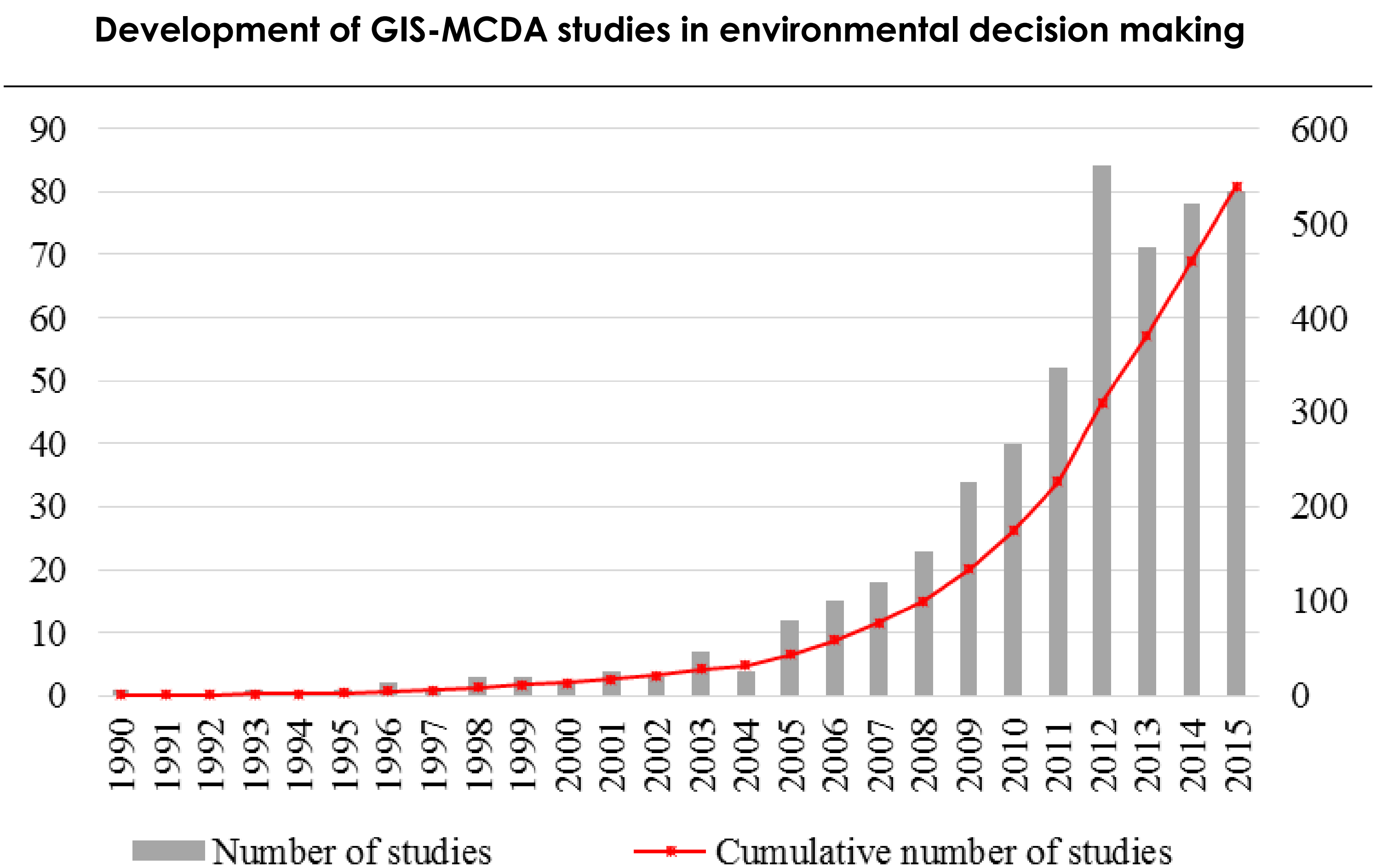
Outline of the talk

1. Context and objective of the research
2. Spatial biases
3. Experiment highlights

Context of the research
Environmental Risk Analysis

- ✓ High degree of uncertainty
- ✓ The existence of a spatial distribution of the different impacts
- ✓ Existence of conflicting values and views
- ✓ Possible irreversible outcomes
- ✓ Difficulties of balancing short term gains against long term losses
- ✓ Limited resources for mitigation measures

Context of the research
Environmental Risk Analysis



Context of the research
Environmental Risk Analysis

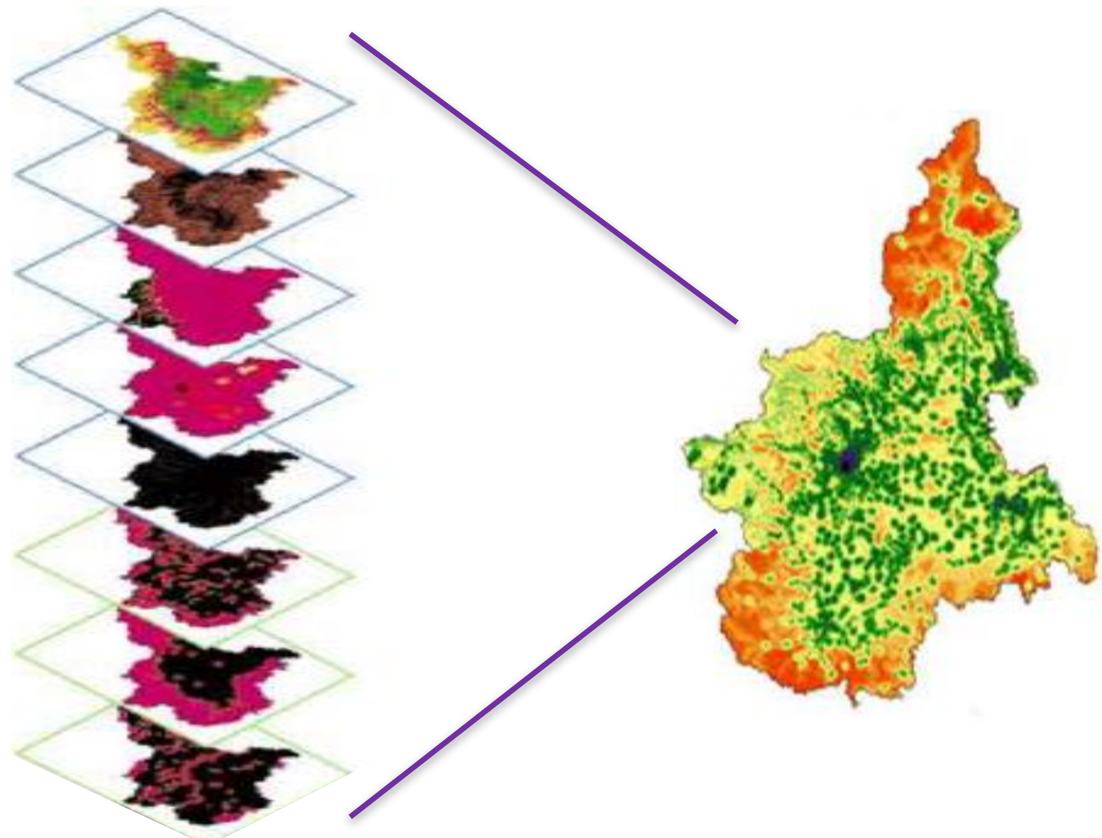
1. **Designing the decision process**

2. **Structuring the Multicriteria model**

3. **Eliciting utility functions**

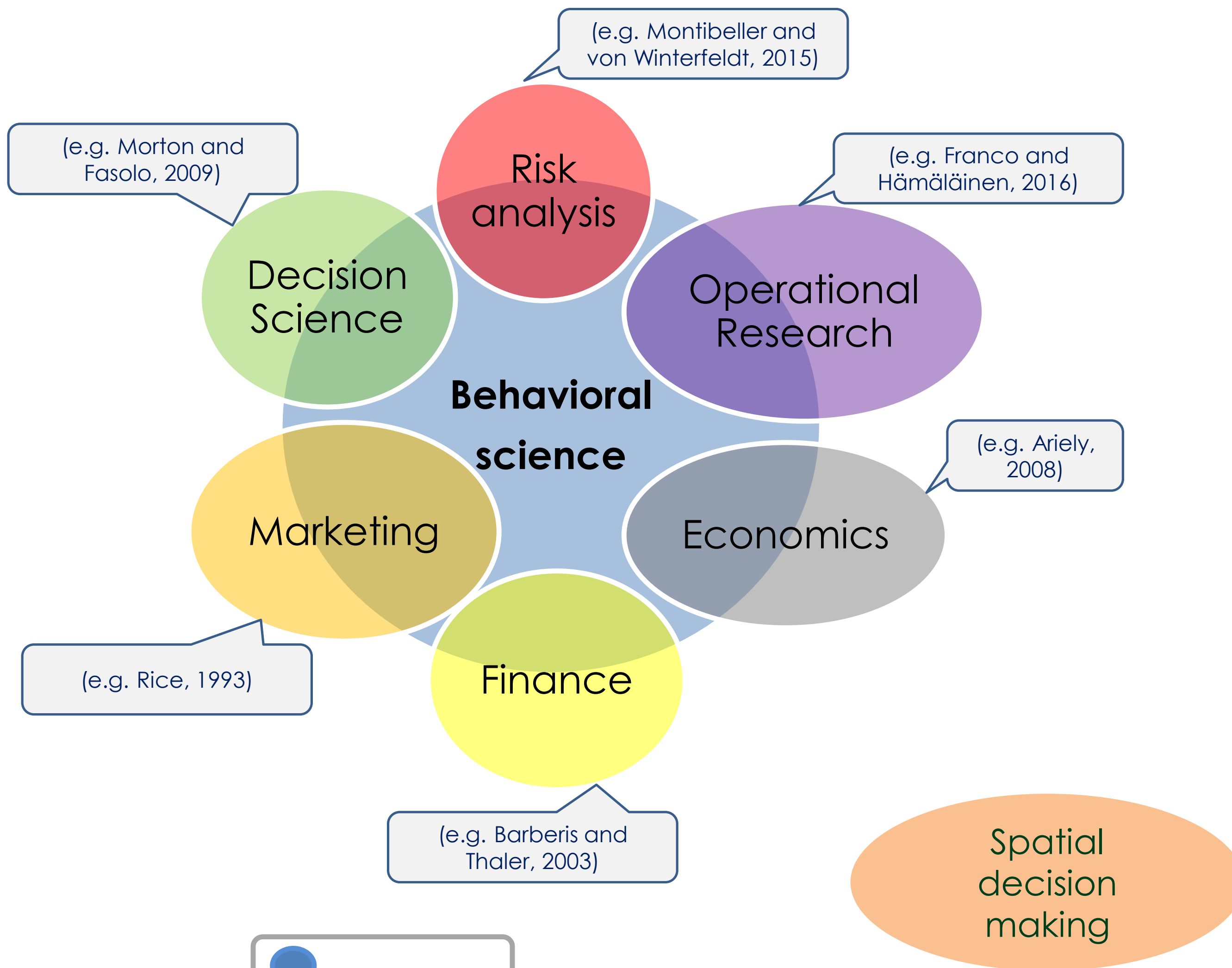
4. **Aggregation of partial performances**

5. **Analysis of results and recommendations**



Context of the research
Environmental Risk Analysis

Environmental decision-making is a growing field of research and the time is now ripe for exploring behavioural and cognitive issues in this context (Hämäläinen, 2015).

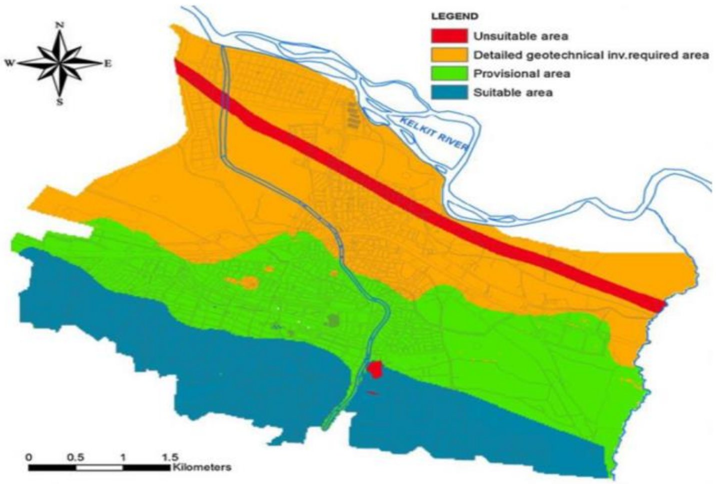


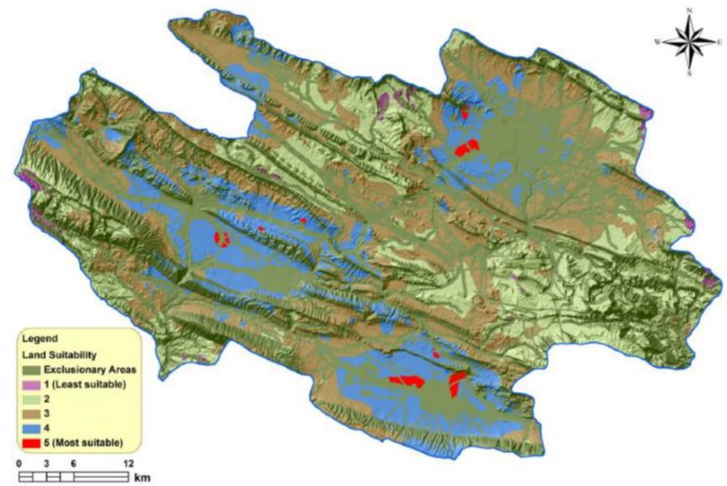
Objective of the research

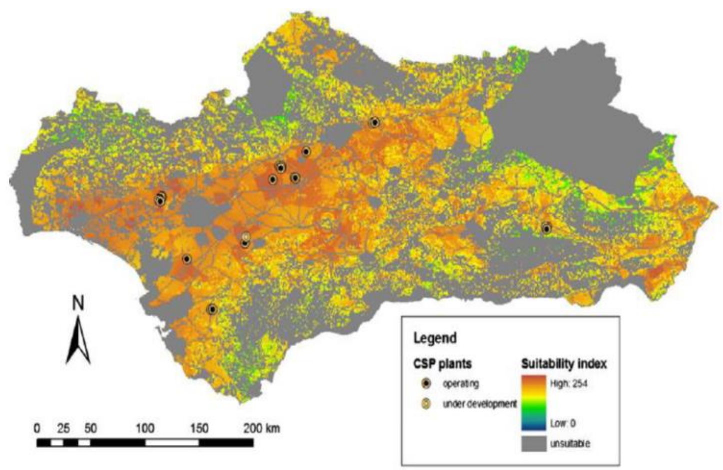
To investigate which cognitive biases affect experts' judgment elicitation when modelling uncertainties in a spatial decision and policy making context

Highlights from a recent literature review

How are the maps "framed"?







(Ferretti and Pfaller, in progress)

Design of a behavioural experiment

Can geographical maps "bias" experts judgement in spatial risk analysis for countermeasures allocation?

cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

Motivation for the experiment

Four main reasons for undertaking a **map comparison** have been discussed in the literature (Boots and Csillag 2006; Foody, 2007; Stehman, 1999), i.e.:

1. to obtain a basic characterization of the degree of similarity between two or more maps;

2. to detect changes that have occurred over time;

3. to support model comparison activities;

4. to evaluate similarities in landscape representations.

Motivation for the experiment

Table I. Cognitive Biases in Decision and Risk Analysis that are Difficult to Correct

Bias	Description	Evidence of Bias in Decision and Risk Analysis with Modeling Tasks Affected	Debiasing Techniques
Anchoring (PB errors)	The bias occurs when the estimation of a numerical value is based on an initial value (anchor), which is then insufficiently adjusted to provide the final answer.[1]	*Evidence*: Several areas, such as estimation tasks, pricing decisions, and also in negotiations.[32,33] *Tasks*: UM2, UM3, VM3, CM1, CM3, CM4	• Avoid anchors • Provide multiple and counteranchors • Use different experts who use different anchors
Availability/ease of recall (AB errors)	The bias occurs when the probability of an event that is easily recalled is overstated.[34,35]	*Evidence*: Simple frequency estimates;[34,36] frequency of lethal events;[37] rare events that are anchored on recent examples. *Tasks*: UM1, UM2, VM1, CM1, CM2, CM3	• Conduct probability training • Provide counterexamples • Provide statistics
Certainty effect (PB errors)	People prefer sure things to gambles with similar expected utilities; they discount the utility of sure things dramatically when they are no longer certain.[38,39]	*Evidence*: Probability- versus certainty-equivalent methods produce different results.[40,41] Task: VM3	• Avoid sure things in utility elicitation • Separate value and utility elicitation • Explore relative risk attitude parametrically
Equalizing bias (PB errors)	This bias occurs when decisionmakers allocate similar weights to all objectives[17] or similar probabilities to all events.[42,43]	*Evidence*: Elicitation of probabilities in decision trees[42,43] and elicitation of weights in value trees.[17] *Tasks*: UM2, VM4, CM3	• Rank events or objectives first, then assign ratio weights • Elicit weights or probabilities hierarchically
Gain-loss bias (PB errors)	This bias occurs as alternative descriptions of a choice and its outcomes[44] either as gains or as losses and may lead to different answers[44–46] (see also *status quo* bias below).	*Evidence*: Several areas involving choices of risky options, evaluation of a single option on an attribute, and the way consequences are described to promote a choice.[46,47] *Tasks*: VM2, VM3, VM4, CM3	• Clearly identify the *status quo* (SQ) • For value functions, express values as marginal changes from SQ • For utility functions, elicit utilities for gains and losses separately
Myopic problem representation (AB errors)	This bias occurs when an oversimplified problem representation is adopted[48] based on an incomplete mental model of the decision	*Evidence*: focus on a small number of alternatives,[51,52] a small number of objectives,[53,54] or a single future state of the world.[55] See also Payne *et al.*[48] *Tasks*:	• Explicitly encourage to think about more objectives, new alternatives, and other possible states of the future

(von Winterfeldt and Montibeller, 2015)

Experiment design
Research questions

(i) Can the presence of a few geographical units (g.u.) characterised by high risk levels determine a “saliency effect” in the way people perceive risk?

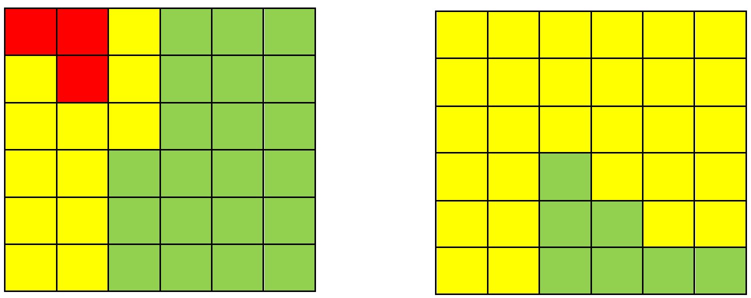
(ii) Can the position of the g.u. characterised by high risk levels influence people’s perception of risk?

(iii) Can the contiguity between the g.u. characterised by high risk levels influence people’s perception of risk?

(iv) Can the proximity of delicate receptors (e.g. a village or a natural protected area, etc.) to g.u. characterised by high risk levels influence people’s perception of risk?

(v) How does the normative aggregation approach based on expected utility theory differ from map users’ aggregation approach in the spatial context?

Example of a task



Proposal for the first task of the experiment. Participants are going to be confronted with two risk maps showing areas characterized by high levels of risk of something happening (red cells in the Figure, e.g. areas with high risk to be flooded), areas characterized by a medium risk level (yellow cells) and areas characterized by low risk levels (green cells).

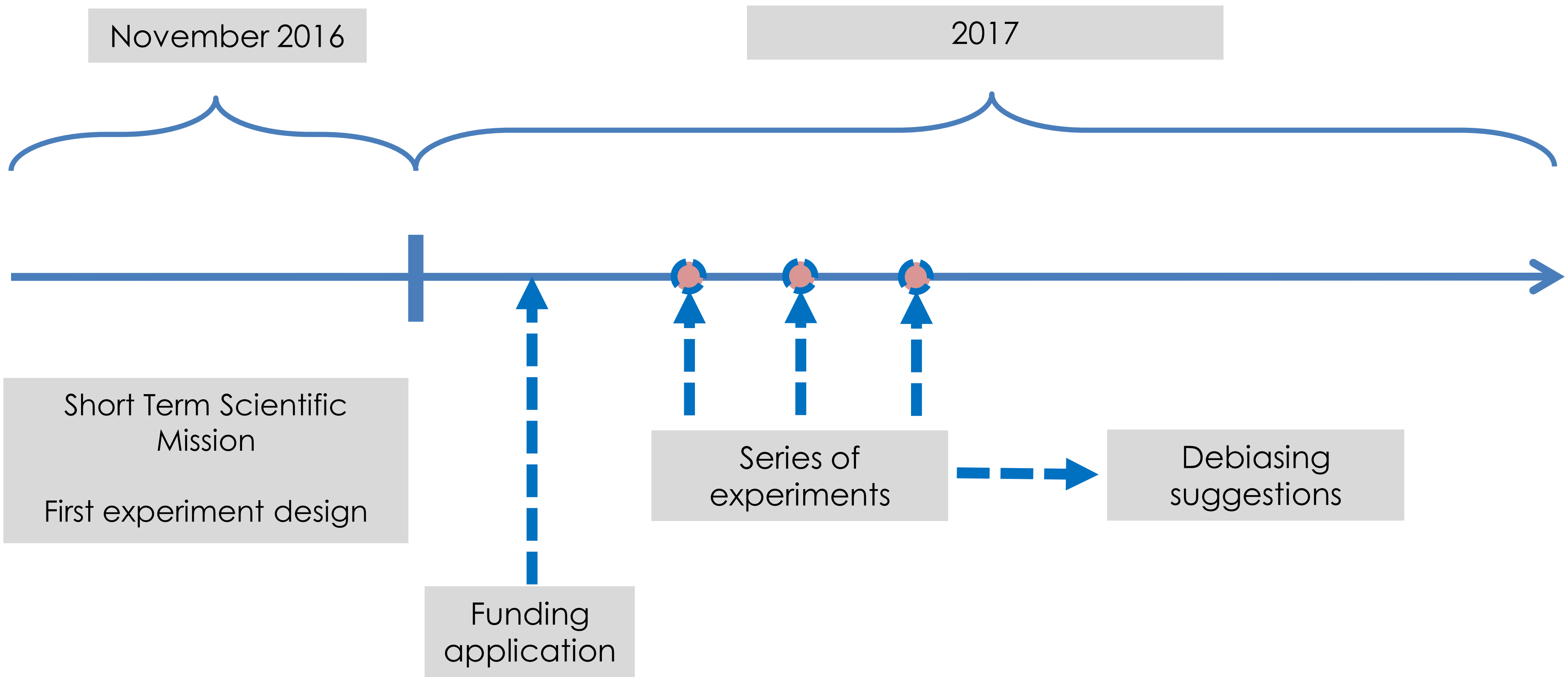
Participants will then be asked to state which of the two maps they perceive as characterized by the highest risk and to decide where to allocate resources for countermeasures.

A first experiment
Design

A first experiment
Design

Trade off between:
Cognitive burden on participants (which dimension of the map should we propose them?)
Realism of the task

Next steps


November 2016
2017
Short Term Scientific Mission
First experiment design
Funding application
Series of experiments
Debiasing suggestions

Expected impact

Discovering whether or not and to what extent spatial decision processes are biased could: (i) **generate better awareness on the meta-choices available to decision analysts and environmental planners** when designing Spatial Decision Support Systems (Ferretti and Montibeller, 2016), (ii) improve the practice of Environmental Decision Making, (iii) **initiate a study about debiasing strategies** for robust environmental decision making procedures.

Thank you for your attention

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