COST-STSM-ECOST-STSM-IS1304-271016-080182

STSM scientific report

London, December 6, 2016

Applicant: Dr. Valentina Ferretti

Home Institution: London School of Economics and Political Science, London (United Kingdom)

Host Institutions: Instituto de Ciencias Matematicas (ICMAT, Madrid -Spain)

STSM title: Behavioural biases in expert judgment for uncertainty modelling in the spatial domain

Purpose of the STSM

There is an increasing use of multi-criteria spatial decision support systems in recent years for dealing with problems that have a spatial distribution of consequences (Ferretti and Montibeller, 2016).

Compared to other contexts, environmental decision making is characterized by higher degrees of uncertainty (about future impacts and consequences as well as about their spatial distributions) and thus relies heavily on expert' judgement elicitation.

The aim of this Short Term Scientific Mission was to **explore cognitive and motivational biases which could affect expert' judgment elicitation when modelling uncertainties in a spatial decision making context**. The specific purpose of the STSM was thus to design a behavioural experiment together with the host in order to be able to test under which conditions cognitive and motivational biases can indeed influence a spatial decision making process involving the modelling and aggregation of uncertainties.

Description of the work carried out during the STSM

In order to achieve the aforementioned aim, Dr Valentina Ferretti carried out a Short Term Scientific Mission from October 27 to November 10, 2016, visiting the Instituto de Ciencias Matematicas (ICMAT, Madrid -Spain, host: Prof. David Rios). During the STSM the following activities were carried out:

(i) **discussion** about key issues and challenges in relation to information aggregation by policy analysts as well as by experts dealing with spatial risks analysis (week 1);

(ii) **joint design of possible tasks for an experiment** aiming to explore cognitive and motivational biases that affect experts' judgment elicitation when modelling uncertainties in a spatial decision making context (please, see the next session for more details about the preliminary structure of possible tasks) (weeks 1 and 2);

(iii) **validation** of preliminary ideas and tasks for the experiment during a meeting together with Prof José Vila (University of Valencia, Valencia, Spain), an expert in the field of behavioural studies (week 2);

(iv) **delivery** of a research seminar by Dr Valentina Ferretti titled "Combining analytics to support the regeneration process of disused railways" (week 2).

Following the STSM, the following activities are foreseen:

(i) development of a pilot experiment with a small sample of participants (i.e. 5) in order to verify the actual time needed for completing the proposed tasks and test the design of the whole experiment;

(ii) development of the full experiment using the London School of Economics behavioural lab (http://www.lse.ac.uk/management/research/behavioural-research-lab/home.aspx) and working with a group of at least 50 participants, who will be paid for their participation in the experiment;

(iii) presentation of the preliminary results arising from the experiment at the MCDM Conference (Ottawa, Canada, July 2017) and/or at the IFORS Conference (Quebec City, Canada, July 2017) in order to get feedback from experts in the field of behavioural Operational Research;

(iv) joint scientific paper writing to disseminate the results of the analysis and its implications for structured expert elicitation to support policy making.

Description of the main results obtained

The main results obtained from this STSM can be summarised as follows:

(i) **knowledge exchange** between the applicant and the host institution around their main fields of expertise, i.e. spatial decision making and decision and risk analysis.

(ii) design of preliminary tasks for the development of the experiment.

In particular, the initial knowledge exchange between the applicant and the host allowed to identify the aggregation phase of spatial information as a crucial one in any decision making process and especially in spatial risk analysis when allocation of resources for countermeasures need to take place.

The search, analysis and discussion of relevant literature about map aggregation allowed us to understand what are the four main reasons for undertaking a map comparison (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.

We believe that there is a fifth reason for which maps can be compared, i.e. to make decisions. While trying to address this gap, we are particularly interested in map comparisons for allocating resources for counter measures in spatial risk analysis. We are thus interested in visual comparisons because we want to look at the process from the behavioral point of view. Indeed, when we are dealing with risk analysis and allocation of resources for countermeasures, it is often the case that the final results of the process are a few maps (relative for example to different risk mitigation projects or to different scenarios) and experts and policy makers have to somehow compare these maps and decide what to do and where to do it. We thus identified the need to check whether biases that are relevant in risk analysis (Montibeller and von Winterfeldt, 2015) may also apply in the spatial context and, if so, with what type of characteristics.

Within this context, we developed a series of ideas for small tasks intended to test the presence of biases when dealing with the comparison of risk maps. Different variations of the proposed tasks will constitute the experiment to be run at the LSE's behavioral lab.

For example, Figure 1 shows the first task we are planning to implement in the experiment. In this task, participants are going to be confronted with two risk maps showing areas

characterized by high levels of risk of something happening (red cells in Figure 1, 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.

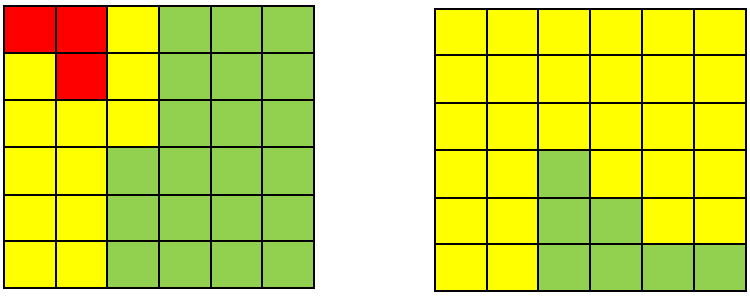

Figure 1 Example of two risk maps to be compared in the experiment.

Our hypothesis/research question in this case is the following one: is the presence of few negative areas going to affect/bias people perception about the overall risk? Are participants going to anchor to the few “red” cells or are they going to trade off with the bigger “yellow” portion of the study area? Is the position of the red cells also playing an influence on how risky participants perceive them?

Future collaboration with the Host Institution

The collaboration between the applicant and the host is planned to continue and to result in, at least, a jointly authored publication, together with Professor Vila.

Foresee publications/articles resulting from the STSM

As a result of this STSM, the applicant and the host are planning to write a scientific publication targeting the Risk Analysis Journal in order to disseminate the results of the analysis and its implications for structured expert elicitation to support policy making. The writing of the paper is expected to take place right after presenting the preliminary results of the experiment at the MCDM Conference and/or at the IFORS Conference in July 2017, in order to include relevant feedback in the final version of the manuscript.

References:

Boots B., Csillag F. 2006. Categorical maps, comparisons, and confidence. Journal of Geographical Systems 8, 109–18.

Ferretti V., Montibeller G. 2016. Key challenges and meta-choices in designing and applying multi-criteria spatial decision support systems. Decision Support Systems, 84, 41-52.

Foody G.M. 2007. Map comparison in GIS. Progress in Physical Geography 31(4): 439–445.

Montibeller G., von Winterfeldt D. 2015. *Cognitive and Motivational Biases in Decision and Risk Analysis*. Risk Analysis. 35(7), 1230-1251.

Stehman S.V. 1999. Comparing thematic maps based on map value. International Journal of Remote Sensing. 20: 2347–2366.