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Applicant: Dr. Valentina Ferretti

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

Host Institutions: Aalto University, Helsinki (Finland)

STSM title: Spatial environmental decision making with portfolio decision analysis: design and development of a behavioural experiment

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.

Several **behavioural and cognitive biases** may impact spatial decision-making processes (Hämäläinen, 2015). For instance, the order in which standardization, constraints elimination and weighing are performed may impact the decision maker or expert perception about the relative importance of the different criteria under analysis. Range insensitivity may also happen during the preference elicitation phase (i.e. the tendency to give too low weights for attributes with wide ranges) and might be characterised by different levels of intensity depending on the spatial distribution of the criteria under consideration.

The aim of this Short Term Scientific Mission was to **design a behavioural experiment to test the presence of range insensitivity in spatial decision-making processes**, focusing on the implications for structured expert elicitation.

Description of the work carried out during the STSM

To achieve the aforementioned aim, Dr Valentina Ferretti carried out a Short Term Scientific Mission in Aalto University (Helsinki, Finland) from April 10 to April 28, 2017 (host: Prof. Raimo Hämäläinen). During the STSM the following activities were carried out:

(i) **discussion** about key issues and challenges in spatial decision-making processes (week 1).

(ii) **Delivery** of two research seminars by Dr Valentina Ferretti on the topic of behavioural biases and spatial decision-making processes, highlighting findings from a recent literature survey and from a first behavioural experiment dealing with Spatial Decision Support Systems (the first seminar was given at the Systems Analysis Laboratory in Aalto University and the second one at the Finnish Environmental Institute) (week 1).

(iii) **Joint design of possible tasks for an experiment** aiming to test range insensitivity in spatial decision-making processes (please, see the next session for more details about the preliminary structure of possible tasks) (weeks, 1, 2 and 3);

(iv) **Preliminary test** of the understandability of the proposed experiment tasks with a researcher from the Systems Analysis Laboratory in Aalto University (week 3).

(v) **Presentation of a talk** about biases in spatial risk analysis at the COST Action IS1304 Conference "Building expertise for Innovation", April 25-27, 2017, Aalto University, Espoo (Finland) (week 3).

Following the STSM, the following activities are foreseen:

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

(ii) writing of an application for funding to be used to pay the participants taking part in the real experiment (at least 50 people);

(iii) 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);

(iv) presentation of the preliminary results arising from the experiment at the 2018 EURO and INFORMS Conferences to get feedback from experts in the field of behavioural Operational Research;

(v) 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 behavioural operational research.

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

In particular, the knowledge exchange between the applicant and the host allowed to identify the range insensitivity bias as a behavioural aspect that might have important implications in decision-making processes making use of maps.

The search, analysis and discussion of the relevant literature about spatial multicriteria analysis (e.g. Malczewski, 2000) indeed highlighted that important steps, such as constraints' removal from the maps, can be undertaken at different stages of decision-making process, thus determining different performance ranges for the spatial criteria under consideration.

Within this context, we developed a series of ideas for tasks intended to test the presence of range insensitivity in spatial decisions, i.e.:

Task 1: we show to the participants 4 attributes' maps removing those areas that are considered unsuitable and including ranges for the values in each map and we ask participants to provide weights for the different criteria.

Task 2: we show the attributes' maps to the participants without masking constrained areas but showing the ranges for the values in each map, which are now different from the ones shown in task 1 and ask them to provide weights for the different criteria.

For example, Figure 1 shows a set of maps representing the spatial distribution of 4 attributes under consideration for the location of a new student accommodation building. Participants will be asked to provide weights for the different attributes taking into account their ranges of performances, as shown in the maps.
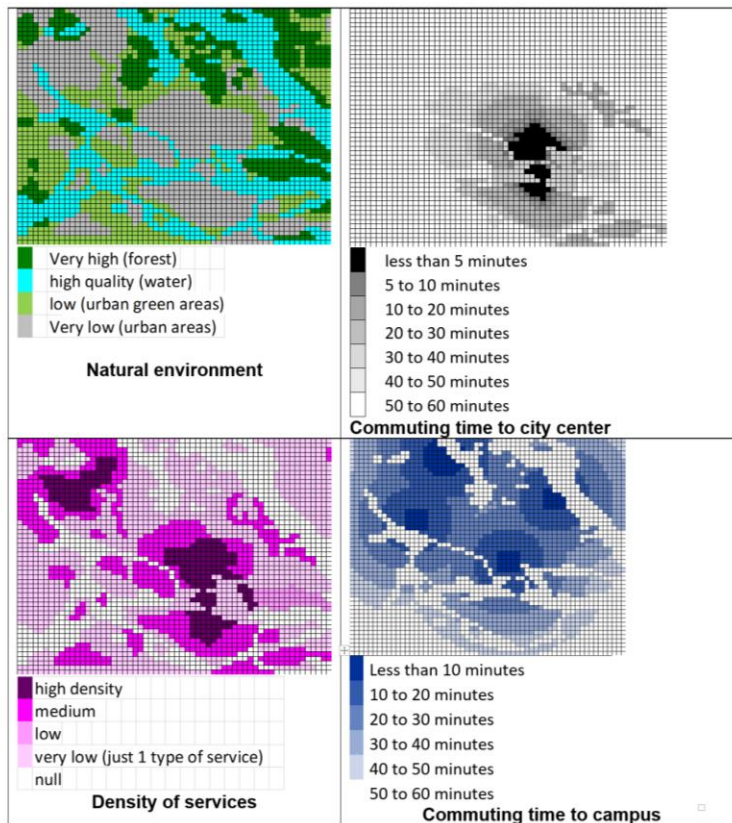
Figure 1 Example of four attribute maps for the location of a new student accommodation building before taking planning constraints into account (i.e. areas that have to be excluded from further analysis)

Our research question is the following one: are participants going to revise the weights of the different attributes if they are then provided with maps where constrained areas are masked and thus ranges of performances are different? If yes, how much?

Future collaboration with the Host Institution

The collaboration between the applicant and the host is planned to continue and to result in jointly authored publications and jointly chaired session in international conferences.

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 a top scientific 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 completing the experiment and presenting the preliminary results in relevant international conferences, in order to include relevant feedback in the final version of the manuscript.

References:

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.

Hämäläinen, R.P. 2015. Behavioural issues in environmental modelling – The missing perspective. Environmental Modelling & Software. 73, 244–253.

Malczewski J., 2000. On the Use of Weighted Linear Combination Method in GIS: Common and Best Practice Approaches. Transactions in GIS, 2000, 4(1): 5-22.