COST-STSM-IS1304 Expert judgement for risk analysis: Assessing the impact of nuclear submarine release

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

Purpose of the STSM:

When a nuclear accident occurs in the maritime environment, the incumbent Prefect needs synthetic information to make informed decisions given the circumstances about issues, such as banning certain economical activities, setting a new water management policy at each relevant zone, or even, evacuating people, to name but a few. As a motivating case study, we shall focus on a possible release from a nuclear submarine at the Bay of Toulon in which there are numerous nuclear submarines and, thus, a high chance of suffer in an accidental nuclear release.

The aim of the Short Term Scientific Mission (STSM) is to establish a formal approach, which takes into consideration the expert judgement, to synthesize the spatial information in the case of multiple attribute eval- uations (describing various axes of the evaluation) and potentially uncertain information over scenarios (release positions, sea conditions,...).To provide the decision maker with indicators about the potential threats at each activity sector and geographic zone of interest.

Description of the work carried out during the STSM:

In order to achieve the aforementioned aim, Oussama Raboun carried out a short term scientific mission from October 15th to December 15th 2016visiting the instituto de Ciencias Matematicas (ICMAT, Madrid-Spain, host Prof David Rios Insuna). Duing the STSM the following activities were carried out:

i. Discussion about the main characteristics of the problem and identification of the set of attributes describing different cells in the bay of Toulon and the sources of uncertainty (week 1)
ii. Design of the impact functions, for each attribute, with respect to experts' judgements.(week 1, 2, and 3)
iii. Calibration model to reduce the cognitive load of experts (week 5)
iv. Developpement of two processes to synthesize the impact of an accidental nuclear release on each sector of activity:

a. An outranking process based on ELECTRE methods aiming to take into consideration experts' prefecences in the aggregation procedure.(week 4 and 5)
   b. An aggregation process based on the expected loss. (week 6)
 v. Validation of th aggregation procedures made during the first six weeks during a meeting with Prof Alexis Tsoukias (Paris Dauphine University, Paris, France), Oussama Raboun (Paris Dauphine University, Paris, France) and Prof David Rios Insuna (Instituto de Ciencias Matematicas, Madrid, Spain). (week 7)
 vi. The development of a multicriteria process to deal with the spatial characteristics of the bay (week 7,8and 9)

After the completion of the STSM, the following activities are foreseen:

 i. Programming the above models on VBA framework
 ii. Computing multicriteria maps for spatial representation
 iii. Implementation of the calibration model of the impact functions developed during the STSM in a multi-expert case (foreseen for January 17th with the marine experts)
 iv. Deal with the case in which the uncertainties over scenarios are imprecise
 v. The development of a weight allocation procedure with respect to expert preferences over criteria

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 multicriteria decision making and risk analysis
 ii. We built a theoretical framework which identify the most areas at risk in the bay of Toulon from the perspective of each attribute. For example, the impact function of the touristic attribute is based on :
   a. The number of tourists (or the corresponding economic impact) giving up visiting the zone under the incumbent release scenario. Qualitatively, the higher the concentration, the smaller the proportion of tourists that will visit the area. One possible example, represented in Figure 1.
   b. The calibration procedure aiming to reduce the cognitive load over the expert judgement. The purpose is to find for few values of cesium concentration the corresponding proportion of tourists given up visiting the area. For this aim, we designed a dichotomous iterative procedure to converge to the median bounding it below and above.
 iii. We set up a process to aggregate the spatial multicriteria information in various scenarios

Figure 1: Impact of cesium concentration in water over tourism.

Proportion of tourists given up visiting a cell i

(y-axis: Prop, from 0 to 1; x-axis: $\bar{C}_w$ with markers α_1 and α_2)
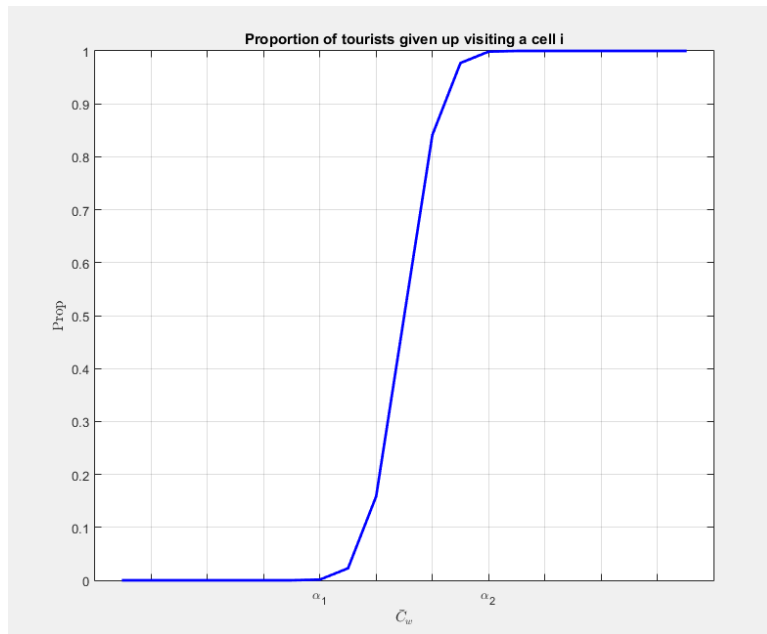
Future collaboration with the Host Institution

The collaboration between the applicant and the host is planned to continue and to result in a couple of papers over this year.

Foreseen 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 International Journal of Multicriteria Decsion Making in order to disseminate the results of this work.

References:

Jankowski P., Anderienko N. and Anderienko G. (2001) – Map centered exploratory approach to multiple criteria spatial decision making – Internation Journal of Geographocal Information Science, Vol.15, No.2, 101-127

Brison V. and Pirlot M. (2013) - Two models for comparing decisional maps – Internation Journal of Multicriteria Decision Making, Vol 3, Nos. 2/3.