Spatially-Aware Group Multicriteria Decision Support for Integrated Territorial Management of Natural and Technological Risks

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Partnerships (non-exhaustive list): INERIS, IRSN, ONF/RTM - Natural Risks Directorate
Disciplines: Decision and information sciences, artificial intelligence, operations research, social sciences (as secondary discipline)
Doctoral School: SPIN Doctoral School (Science for Engineering & Digital Technology): https://ed-spin.doctorat-bretagne.fr/fr
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Context and Issues

The management of natural and technological risks typically begins with a technical risk analysis phase, followed by a risk evaluation phase conducted by decision-makers to select risk reduction strategies. In each decision context, options are generally chosen collectively (by elected officials, experts, state services, infrastructure managers), based on several technical, economic, environmental, and social criteria, the relevance of which depends on the stakeholders involved and the location of the proposed actions.

During consultation phases, differing perspectives confront each other, evolving initial positions based on stakeholders' preferences and admissible thresholds. These phases are supported by methods like multi-stakeholder and multicriteria analysis, to address the multidimensionality and, ultimately, the complexity of decision-making.

Although many multicriteria decision support (MCDA) methods exist, few approaches natively consider:

1. The sequencing and interactions between different decision contexts over time, space, and stakeholder types;
2. The combination of multiple risks, both natural and technological;
3. Group decision-making challenges;
4. The territorial aspect of decision contexts.

Project Objectives

This doctoral research lies at the intersection of natural and technological risk management, MCDA, and territorial planning. It is part of the national PEPR IRIMA project, uniting the scientific community around risk-related themes. It aims to develop integrated methods to support group decision-making in spatially-aware, multi-stakeholder, multi-risk contexts.

Key challenges addressed include:

- Dealing with imperfect information;
- Interactions between diverse decision contexts;
- Combining multiple risk types;
- Territorial specificity of decisions.

The main objectives are:

- Develop an integrated, adaptive MCDA approach for multi-stakeholder contexts using imperfect, multi-source information;
- Characterize and improve the effectiveness of decision-support methods and processes;
- Propose methodologies for risk management and territorial planning by integrating thematic and spatial information;
- Conceptually model decision-making processes, including decision and negotiation algorithms to help converge toward consensus;
- Integrate these algorithms into a spatial decision support environment and test their performance and applicability in operational settings.

Scientific Contributions

Expected contributions of the thesis include:

- Proposing new group decision-support methodologies applied to risk management;
- Integrating expertise domains and stakeholder input for better assessment of cascading risks and efficient decision-making;
- Managing decision scale complexity and multi-temporal/spatial contexts;
- Ensuring traceability in expertise and decision processes, considering information imperfections;
- Developing explainable models to make recommendations understandable to all stakeholders.

Approach and Methodology

The proposed scientific approach involves several key steps:

- **Literature review:** Study of multi-risk approaches, MCDA methods, and multi-stakeholder negotiation techniques;
- **Conceptual modeling:** Develop a systemic methodology for formalizing nested and juxtaposed decision contexts;
- **Algorithm design:** Develop decision-support and negotiation algorithms to foster consensus with enhanced explainability;
- **Integration into a decision-support tool:** Implement results into the *deSEAsion* tool to test model generalizability in concrete applications (e.g., NATECH risk management in the Lower Seine industrial zone, natural risks in alpine and Pyrenean mountains).

Outlook and Collaboration

This interdisciplinary project will draw on engineering, information, communication, and social sciences to address preferences, perceptions, and risk acceptability. Advances in AI will be leveraged for experience capitalization and valorization. Development opportunities include collaboration with projects focusing on risks and society, as well as tool deployment and valorization. The PEPR framework offers numerous opportunities for scientific and operational collaboration at local and national levels.

Thesis Conditions : The PhD will begin in September 2025 and will be hosted at IMT Atlantique, with travel to study sites and to INRAE/IGE in Grenoble. Applications (CV, Master's transcripts, cover letter) should be sent to: Patrick MEYER (patrick.meyer@imt-atlantique.fr) **;** Jean-Marc TACNET (jean-marc.tacnet@inrae.fr)