Risk and Sustainability in an integrated decision making framework: the GDSI open platform

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Risk and Sustainability in an integrated decision making framework: the GDSI open platform

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Introduction

In our everyday life, we face the issue of taking decisions affecting the course of our life in the short and long term and those decisions are driven by our personal and subjective judgment on which we unconsciously rely. However, when stakeholders and governments face the problem of decision making over public safety and health or sustainable development, their judgment has to be justified to the community by objective proofs. In the perspective of climate change, natural catastrophes and human induced changes to the environment, the question for sustainable development and sustainable governmental decisions is gaining more attention, beside the (multi-)risk based decision making, in a wider prospective to achieve resilient communities. Different prescriptive methodologies are available, from subjective probability and utility definitions to more semi-objective ways of modelling preferences and associated uncertainties. Despite that, an holistic framework is still missing and different schools of thought arise.

Background

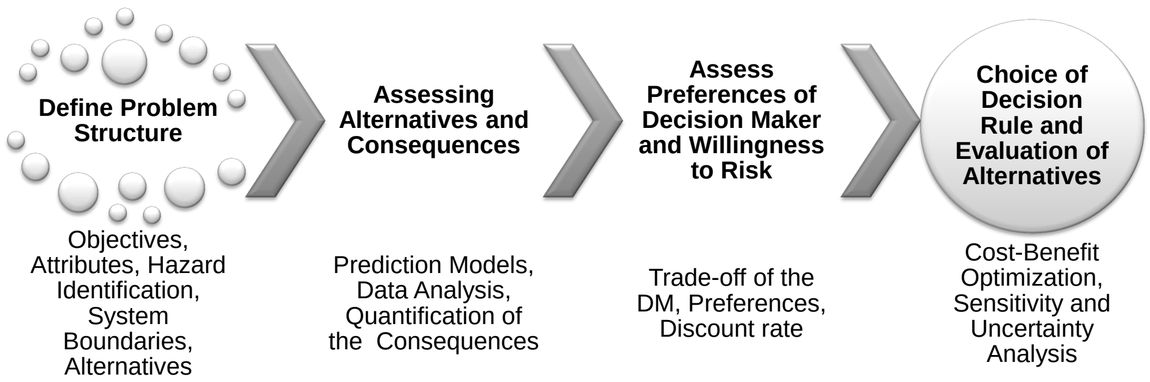
Decision theory generally investigates the mathematical relations and quantitative representations of those relations that can model the judgment and it is largely treated in many scientific fields.

Fundamental aspects of any decision problem can be listed as follows:

- The need to accomplish some **objectives** by **allocating resources**
- Availability of several **alternatives**, one of which must be selected
- Different **consequences** associated with the alternatives
- **Uncertainty** affects the consequences of each alternative
- Consequences are not equally valued.

The main phases of the decision analysis can be identified as:

- **Structure** the decision problem
- Assess possible **impacts /consequences** of each alternatives
- Determine **preferences** of the decision makers
- Evaluate and **compare** the alternatives.



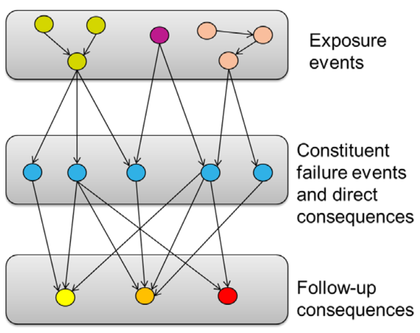
Objectives

Integration of Risk and Sustainability Assessment in Decision Making is possible if the decision making process is seen as a learning process over sequential evidences made available in short and future time. In addition, a generalized methodology in decision making has to assure feasibility, robustness, transparency to users, compatibility with preferences of the decision maker, flexibility and be generalist. Thus, a generalized procedure that focuses also on the evolutionary nature of the decision maker preferences besides model updating and evidences needs to be designed.

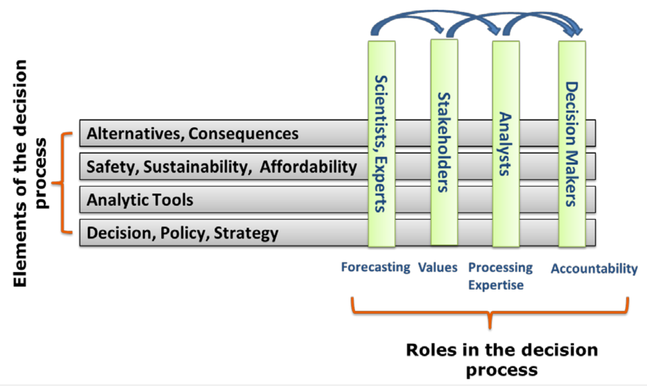
Challenges

The integration of Risk Assessment and Quantitative Sustainability is a main challenge due to the different structure and methods on which the two approaches are originally designed. Especially, the metrics used in risk assessment (3D /Damage, Dollars, Downtime) and in quantitative sustainability assessment (impact categories and Midpoint indicators) need to be integrated at different levels in the decision framework (system boundaries, preferences of the decision maker, consequence analysis et ct…). However, both risk and sustainability assessment converge in terms of *areas of protection* (Human health, Environment, Resources).

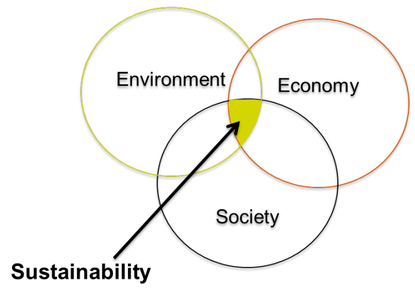
Generic system representation in Risk Assessment



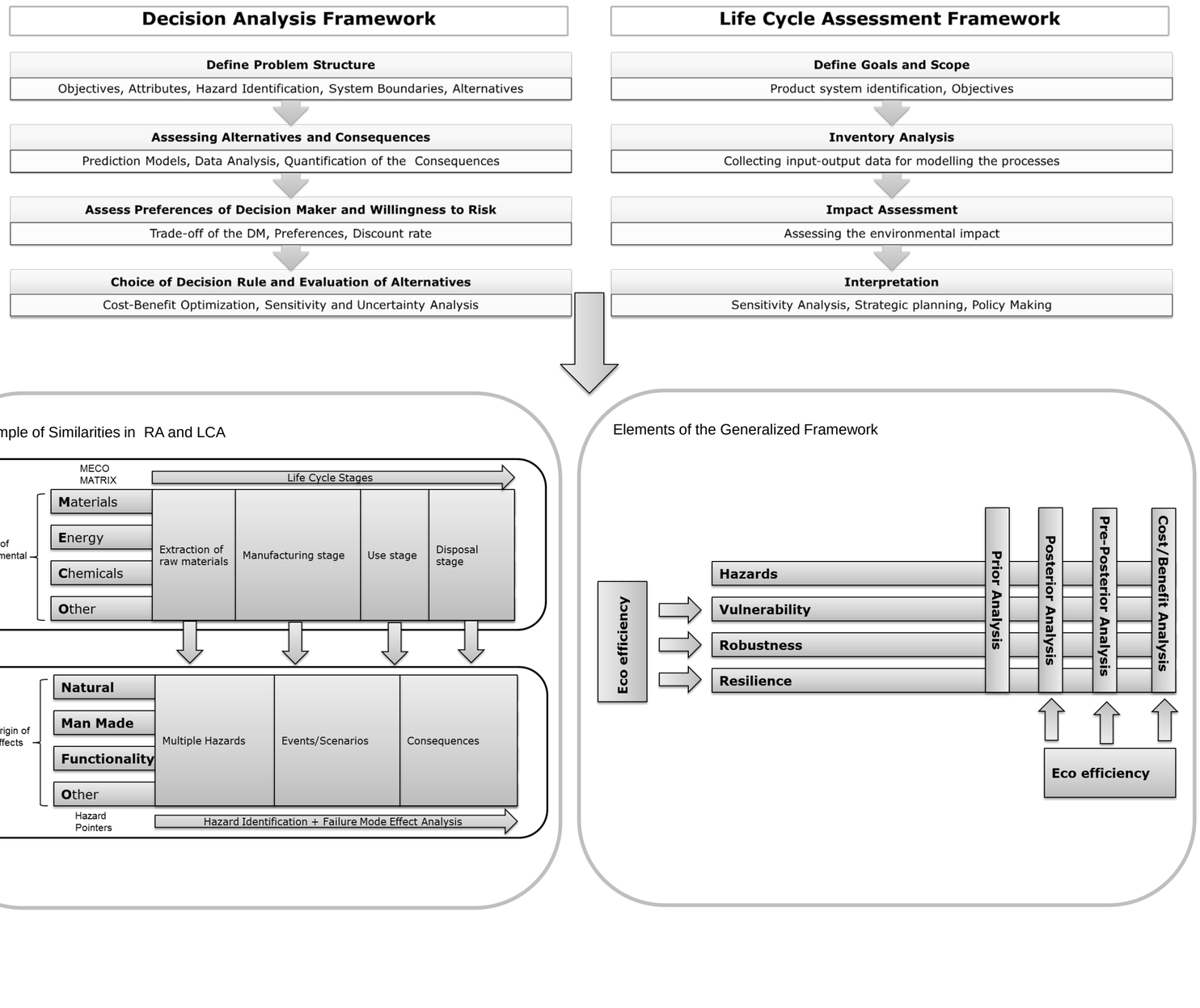
Decision Analysis



Generic system representation in Quantitative Sustainability Assessment



Methodology and Tools for the Integration of Risk and Sustainability Assessment in Decision Making: The GDSI Framework



Methods: Prior/ Posterior/ Pre-Posterior Analysis

Prior analysis is associated to the evaluation of the risk related to a certain activity, while posterior analysis is associated to the evaluation of the effects of a certain action after it has been performed. In Pre-Posterior analysis, the optimal decision is identified with respect to the action to be performed in the future to mitigate consequences, intending both risk reduction activities and/or collection of information for uncertainty reduction.

Tools: Bayesian Network and Influence Diagrams

In the analytic representation of a decision problem, it is more effective to represent it in graphical way to bring the structure of the decision problem to the fore. **Influence diagrams** allow a compact and clear representation of the decision problem and dependencies among alternatives, unknown state of nature and the consequences.

A Bayesian network (BN) is a model for representing the joint probability of a number of random variables. BNs are largely applied for engineering risk analysis, because they allow a graphical representation of the dependence structure among stochastic variables facilitating the consistent modeling of complex problems involving many variables.

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Content: GDSI purpose statement, Glossary, Elements of Decision Theory, Quantitative Sustainability Assessment,…… Elements of Probability Theory, Bayesian Theory, Bayesian Networks and Influence diagrams,……..Risk Assessment, Reliability, GDSI Decision Analysis Framework, Tools for optimization and graphical representation of results with Tutorials….. And much more!

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