Engineering Risk Analysis Group
Prof. Dr Daniel Straub

MSc thesis or Study project proposal

Sequential decision-making for climate adaptation

Background

In engineering systems, safety margins (or safety factors) are commonly used to account for uncertainty in future demand. If the demand turns out to be larger than expected, safety margins ensure that the system can still cope with the demand. However, if the demand follows the prediction or is even lower than predicted, the safety margin is unnecessary and leads to inefficient use of resources. Therefore, it can be more efficient to reduce safety margins and instead favor a flexible (or adaptable) system design [1,2]. In this case, a larger-than-expected demand can be dealt with efficiently by adapting the system in the future. A particularly relevant source of uncertainty in future demands on infrastructure systems comes from climate change.

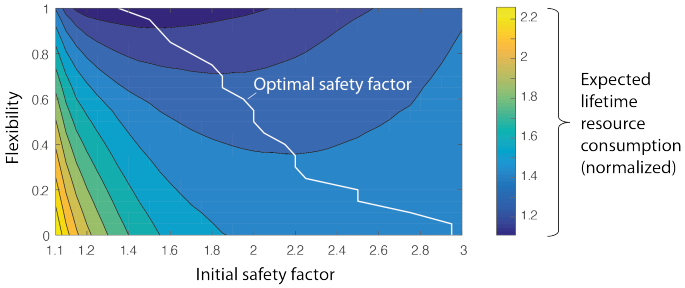

Figure: The relation between the system flexibility and the optimal safety factor [1].

Objectives

The goal of this MSc project is to perform investigations into the factors that influence the effectiveness of system flexibility. Combining sequential decision analysis with different models of future uncertainty, the benefit of different degrees of system flexibility will be quantified for different idealized system settings. This will be complemented by a case study involving climate adaptation, which will be selected jointly with the student.

Methodology

The M.Sc. project will consist of

- Literature review
- Model infrastructure decisions and uncertainties
- Implement Monte-Carlo-based algorithms for optimal sequential decision-making under uncertainty
- Perform systematic numerical investigations
- Implement a climate adaptation case study

Requirements

You should have

- A solid background in probabilistic modeling, e.g., through courses taken at the chair
- Excellent analytical skills
- Experience with programing in Python, Matlab or similar

Starting date:

Flexible, as soon as possible

Supervised by

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References

[1] Straub D., Špačková O. (2016). Optimizing adaptable systems for future uncertainty. Keynote, *14th Probabilistic Workshop*, Ghent University.
[2] Špačková O., Straub D. (2017). Long-term adaptation decisions via fully and partially observable Markov decision processes. *Sustainable and Resilient Infrastructure*, **2**(1): 37-58.