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Dealing with Ignorance:
Resilience for Nuclear Safety-Security

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Main Question

If dealing with unanticipated disruptions is important for nuclear the safety and security of nuclear power plants (NPPs), how could policymakers explicitly integrate it to the existing conceptualisation of nuclear safety-security (NSS)?

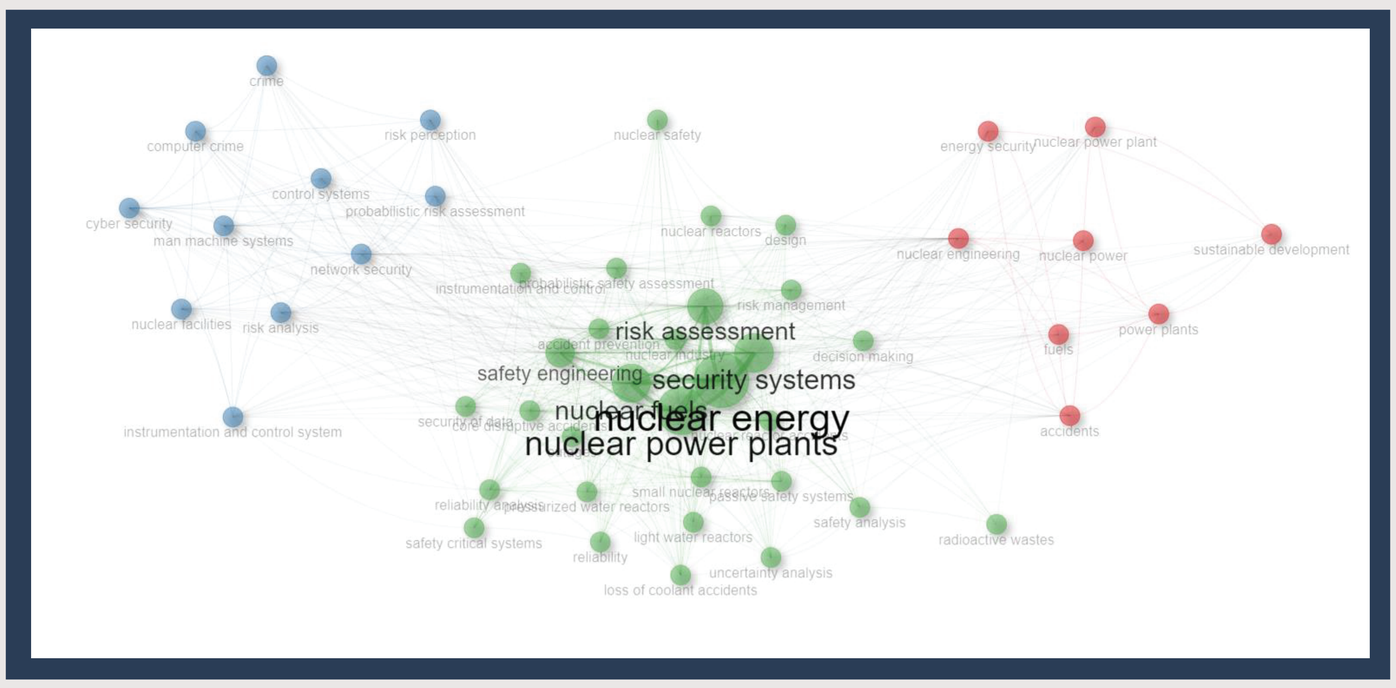
Proposal

Beyond the continuous effort to reduce ignorance or unknown unknowns, ignorance has to be addressed as such, i.e. as unanticipated and permanently lurking in addressing NSS issues.

Methods

Literature research on IAEA documents and academic papers on NSS conceptualisation and NSS assessments [1]
Philosophical analysis uncertainty and ignorance from the philosophy and ethics of risk literature[2].

State of the art: NSS as currently conceptualised facilitates uncertainties more, but less on ignorance [3]



Philosophical contribution: Integrating ignorance consideration from resilience thinking into NSS conceptualisation to enhance NSS practices

The IAEA's Conceptualisation of NSS [1]

Nuclear safety: "the achievement of proper operating conditions, prevention of accidents and mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation risks."
Nuclear security: "the prevention and detection of, and response to, criminal, or intentional unauthorized acts involving or directed at nuclear material, other radioactive material, associated facilities or associated activities."

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Ignorance consideration from resilience thinking

- Resilience thinking address the readiness of a system to deal with disruptions, anticipated and unanticipated.
- Ignorance consideration is a part unanticipated disruptions from resilience thinking.
- Ignorance consideration means addressing the unknown unknowns as such beyond the effort to reduce it.

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Enhanced NSS practices

From NSS Conceptualisation:
- Performing quantitative safety-security assessments for nuclear power plants (NPPs).
- Applying engineering strategies into NPPs design to prevent and mitigate radioactive hazards.

From resilience thinking:
- Constant and regular evaluation of safety-security measures in NPPs.
- Regularly updated, transparent public communication NPPs' safety-security features.

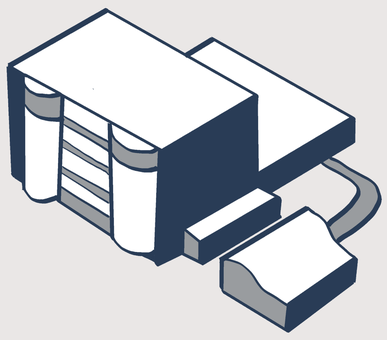
Nuclear policy relevance:

ignorance consideration enables policymakers to 1) visualise NSS states beyond numbers and 2) regularly enhancing accident mitigation strategies

1) Visualising NSS states beyond numbers:

- *Understanding the NPP's overall design*
- *Understanding the NSS features offered by the NPP*

*Small Modular Reactor**



2) Regularly enhancing accident mitigation strategies:

- *Regularly evaluating the NPP's preventive and mitigative features to deal with disruptions, both anthropogenic and non-anthropogenic*
- *Regularly updating the general public with the NPP's overall safety-security performance*

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[1] IAEA Nuclear Safety and Security Glossary. in Non-serial Publications. Vienna: INTERNATIONAL ATOMIC ENERGY AGENCY, 2022. [Online]. Available: https://www.iaea.org/publications/15236/iaea-nuclear-safety-and-security-glossary
[2] Roeser, S., Hillerbrand, R., Sandin, P., & Peterson, M. (Eds.). (2012). Handbook of risk theory: Epistemology, decision theory, ethics, and social implications of risk. Dordrecht; Springer.
[3] Co-occurence keywords on 250 studies using bibliometrics analysis via R software on February 6, 2024. There are 295 studies gathered selected by inputting 'nuclear safety', 'nuclear security', 'assessment', and 'energy system' under 'topic' in Web of Science and 'article title, abstract, keywords in Scopus. After removing duplicates, further removing conference proceedings and selecting only studies which talk about nuclear energy systems bring the number down to 250 Visualisation is done using the 'keyword plus' function to include not only words in the authors' keywords list, but also words within the titles and abstracts.
[*] Small Modular Reactor Technology icon by Carolus Astabrata