



Risk, resilience and sustainability – bridging research and education

Linda Nielsen, PhD Fellow
Dept of Civil Engineering, Aalborg University



AALBORG UNIVERSITY
DENMARK

Problem Context

1. Research and educational activities in the area of risk, resilience and sustainability have grown substantially over the past decade, creating a **vast body of knowledge with little or no coordination among the engineering, natural and social science disciplinary perspectives** involved in the knowledge production.

For example:

- *No agreed definitions of terms and concepts*
- *Inconsistent and/or overlapping principles, procedural and scientific frameworks, methodologies and metrics*



Problem Context

2. In educational practice risk is changing **from a sub-disciplinary specialization** in Engineering and Economics **to a discipline in its own right.**

However:

- *No systematic approach to the identification of a theoretical and methodological body of knowledge relevant to the field of risk*
- *Narrow, domain specific educational programs, strong division between quantitative (engineering & natural sciences) and qualitative (social sciences) programs*
- *No uniform or systematic didactic rationale for the choice of content and learning objectives, the methods by which the content is delivered, or the rationale behind assessment*



Problem Context

3. **State-of-the-art research** integrating risk, resilience and sustainability assessment **vs. outdated** theoretical and methodological **educational practices** stemming from a 1990s risk-based perspective.

Cf.





Design challenge

Develop a *blueprint for a conceptual and methodological learning design for risk education* that is trans-disciplinary, research problem based and ICT-supported. Building on theoretical foundations of systems theory, decision analysis, resilience, quantitative sustainability, and transitional and social learning, the goal of the design is to facilitate the ability of learners to assess and manage risks from the combined perspectives of engineered and social-ecological systems through holistic contextual awareness.





Design research – research environment

Large scale exploratory bibliometric study of the knowledge domains encompassing risk, sustainability and resilience between 1990 and 2017

- Historical evolution of the knowledge domains of risk, sustainability and resilience on a to-date unprecedented scale
- 100+ cluster network maps illustrating the different disciplinary contributions, important authors, geographic distribution of the research, and the organizations producing the research
- An article analyzing the results is currently in press, however the data report can be accessed [here](#):



Methodology

Steps

1. **Identification of search terms** relevant for risk, sustainability and resilience based on expert discussion between the authors;
2. **Data collection**;
3. Bibliometric networks construction: **term co-occurrence and bibliographic coupling**
4. **Data analysis**, results and recommendations

Data

442,171 records extracted from the Web of Science (WoS)

Group 1 (knowledge domains)	Group 2 (multi-disciplinary perspectives)	Group 3 (concepts)
Risk 1990-2000	Ecological Resilience	Planetary Boundaries
Risk 2001-2010	Spatial Resilience	Natural Capital and Ecosystems
Risk 2011-2017	Engineering Resilience	Circular Economy
Sustainability	Infrastructure Resilience	Social OR Urban Metabolism
Resilience	Robustness	Inclusive Economy OR Inclusive Wealth OR Inclusive Growth
Risk AND Sustainability	Disaster Resilience	Degrowth
Risk AND Resilience	Community Resilience	Adaptive Governance
Risk AND Sustainability AND Resilience	Urban Resilience	Social Cohesion
	(economic) Development Resilience	Social Ecological Systems



Design input from bibliometric study (a selection)¹

- Despite significant increase in the volume of research on risk, resilience and sustainability over the past 3 decades, research integrating all 3 domains is marginal. The vast majority of frameworks that support such integration are purely descriptive. **Given the many trade-offs between sustainability and resilience objectives, the lack of integrated operational frameworks is problematic for the formulation of informed preferences.**
- The top 3 contributing disciplines are (i) Environmental Sciences/Ecology, (ii) Engineering and (iii) Economics representing the natural, engineered and social systems perspectives. There is little integration among the perspectives, each relying on its disciplinary conceptualization and methodological practices. **Trans-disciplinary research is a stated but not a revealed preference.**
- Research in sustainability and resilience is dominated by the highly developed Western countries (USA, the UK, Australia, Canada, and the Scandinavian countries). Thus **conceptual underpinnings as well as preferences and normative choices have strong cultural bias.** This is problematic for the both the **completeness and objectivity of scientific research** and for the **educational agenda, which borders on indoctrination.**

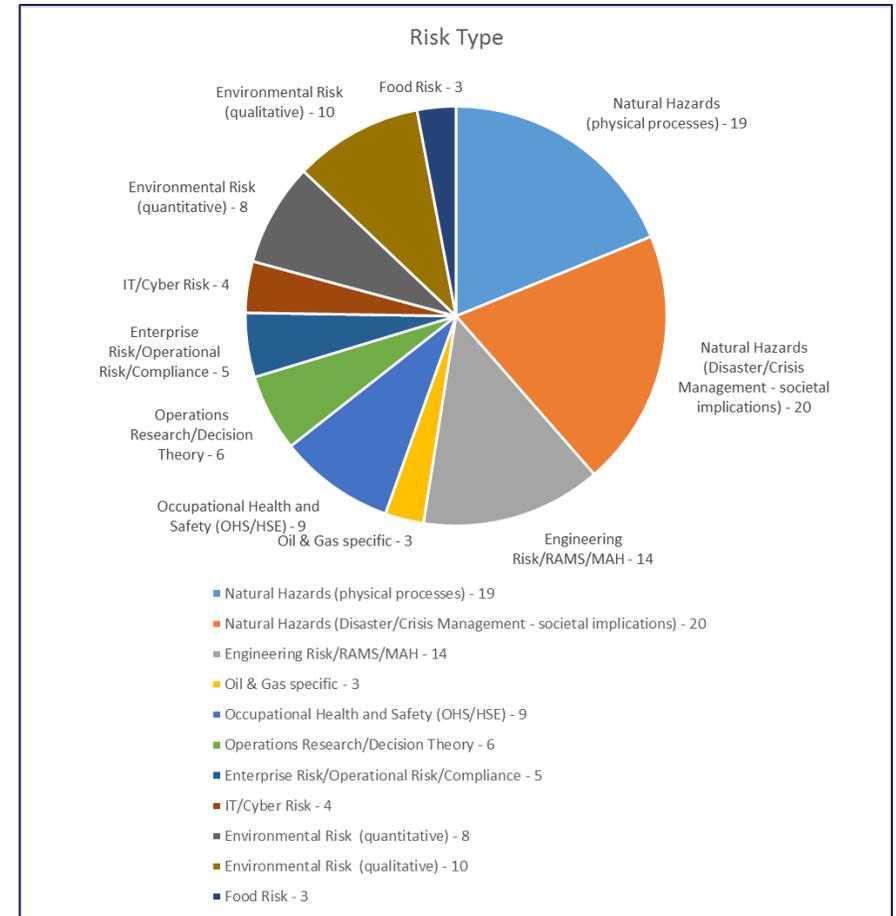


Design Research – education environment

A desktop survey of 100+ master level education programs in Risk in Europe

(for a copy, contact Linda Nielsen
ln@civil.aau.dk)

From the disciplinary perspective risk education typically has the following components, taught (+/-) in the same sequence:



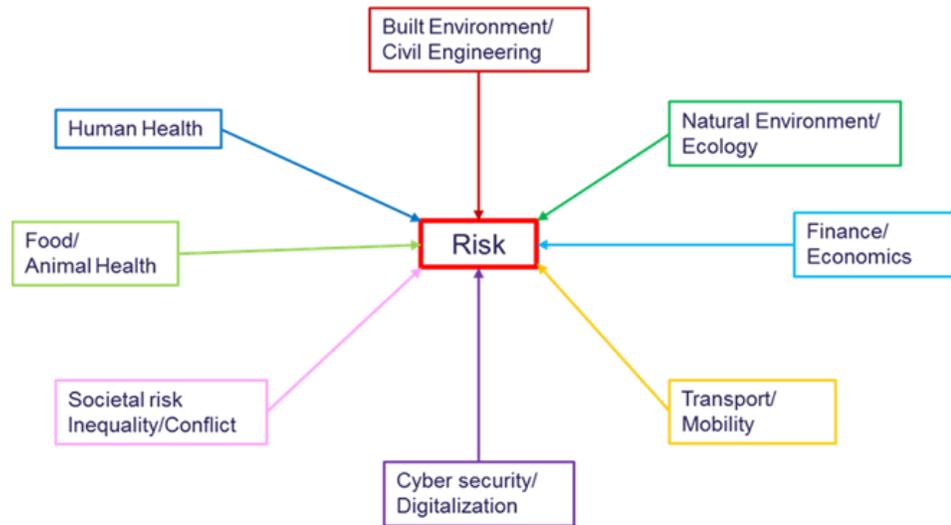
Design input from survey (a selection)

- Explosion of risk related programs over the past decade. Popularity appears to be based on trendiness rather than academic quality. **Reputation of the academic institution \neq scientific rigor of a program.**
- **Division between risk assessment and risk management – the quantitative-qualitative divide** – is as strongly enforced in education as it is in research and in practice.
- **No programs integrate risk with resilience and sustainability considerations.** The latter are typically offered separately and mostly from a social science or management perspective.
- Many programs **lack a "red thread"** (cohesion) either in their purpose or way of delivery, or both.
- Extensive focus on **quantitative** methods, produces expert **"number crunchers"** who are **unable to articulate model assumptions** or identify relations among conceptual schemes from multiple domains.
- Extensive focus on **qualitative** methods, results in **inability to assess either the relevance or the quality** of an expert assessment.



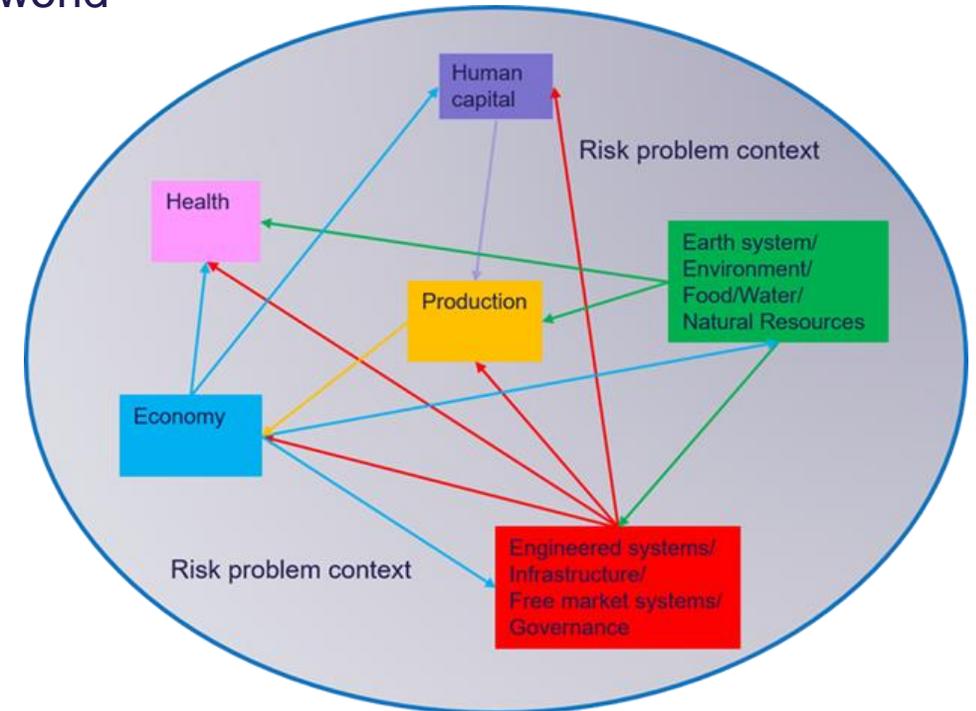
Rationale for the design: Why do we need a new learning philosophy and educational design for Risk?

The integration of sustainability and resilience consideration into risk management necessitates a systems understanding of risk. Our present educational models do not facilitate such understanding.



disciplinary, multi-disciplinary approach to risk (research, practice and education) – the model

trans-disciplinary, contextual, systems approach to risk – the lifeworld



Learning design elements in the blueprint

Characteristics of the knowledge environment

- “Liquid knowledge” – constantly evolving knowledge in the face of complex problems with ill defined borders
- Trans-disciplinarity
- Co-creation
- Civic values: include societal needs and preferences in the formulation of learning objectives and outcomes

Learning Design theoretical foundations

- Research Problem Based Learning – learning methodology
- Hybrid Concept Clusters – organization of content
- Transitional Learning – epistemic values
- Social Learning – social/civic values



Learning design elements in the blueprint

Alignment between Learning Objectives, Teaching and Assessment

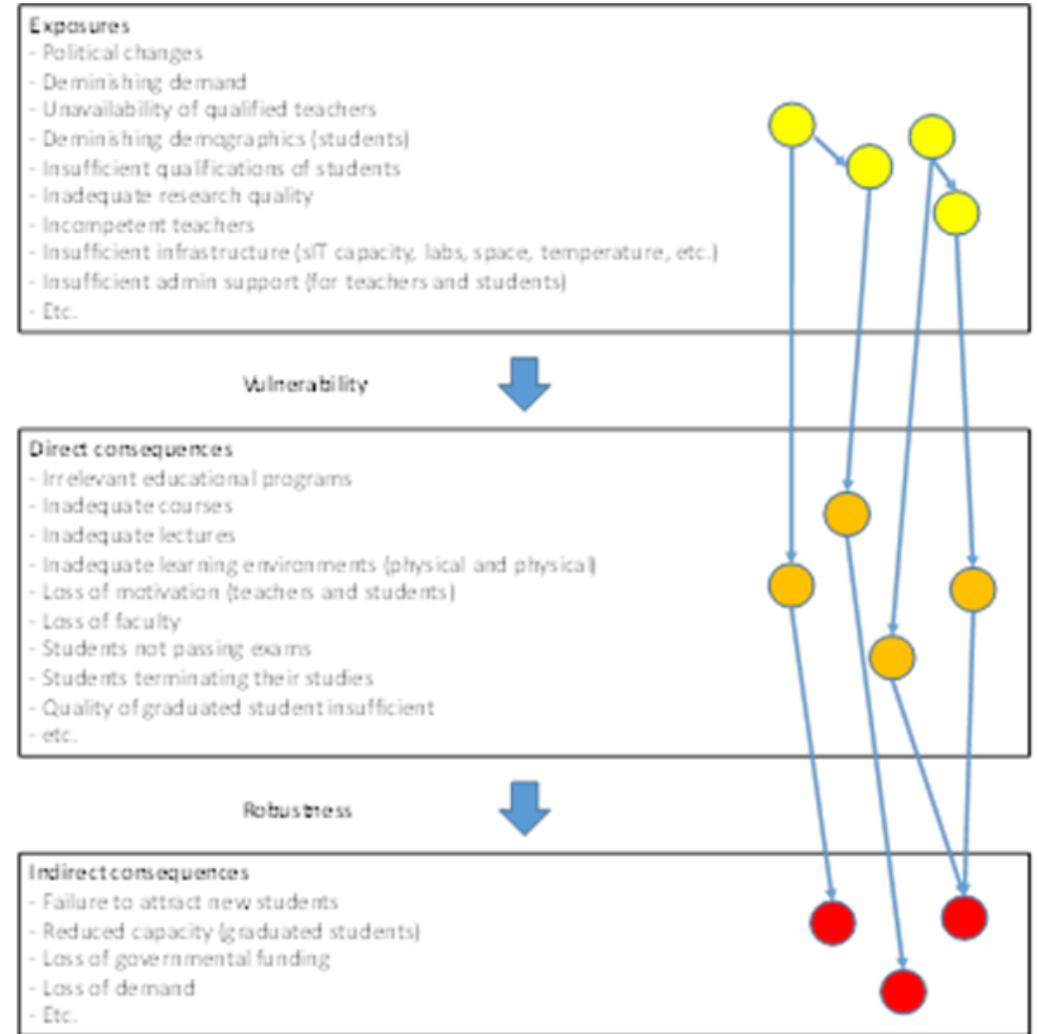
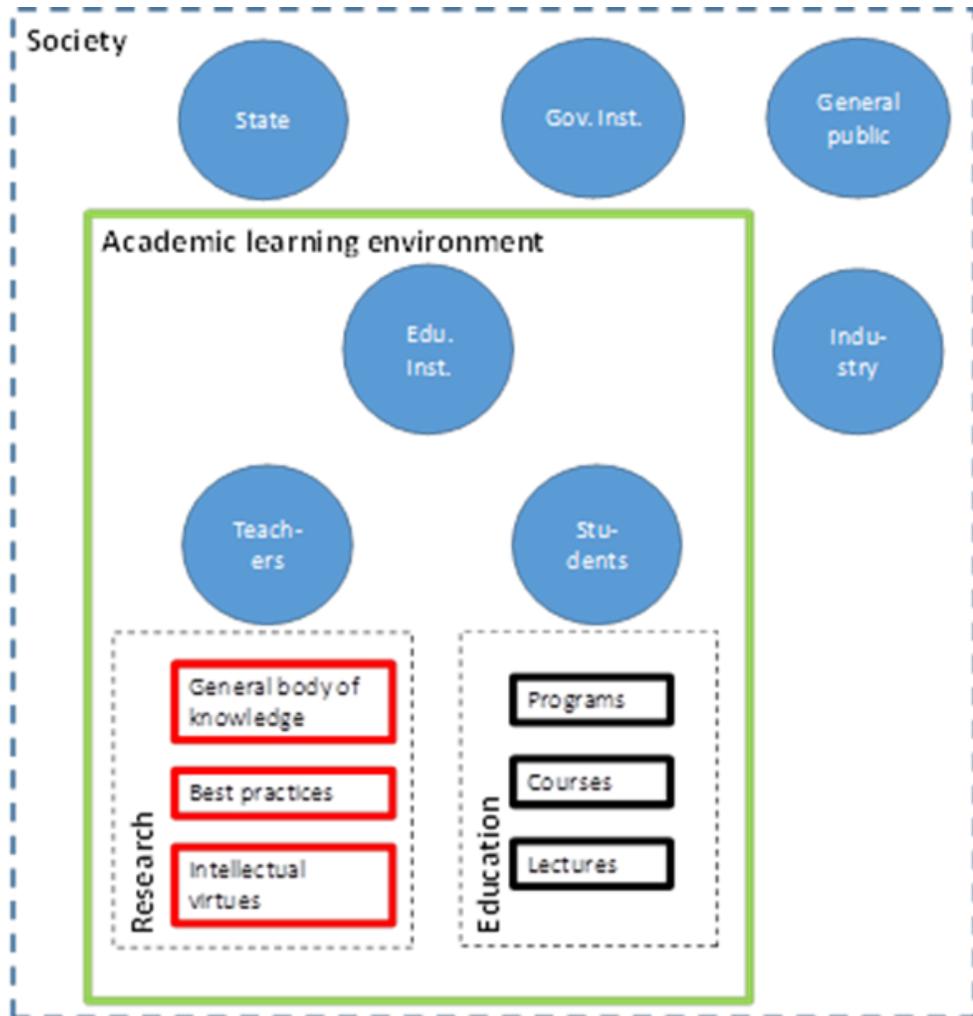
- Trust in students taking ownership of their learning
- Assessment of applied capabilities
- Plasticity in the learning environment through IT-supported platforms

The visual representation of the learning design – multiple functionalities

- A way to communicate the design concept to stakeholders (students, teachers, industry, public authorities)
- A learning tool for learners that affords conceptual overview and understanding of relations among elements in hybrid systems
- A teaching aid to guide students on a learning path that may be highly complex and non-linear
- A basis for updating the taxonomy of the knowledge domain of risk, sustainability and resilience



Strategic necessity of bridging research and education – a systems perspective



**The learning design is work in
progress...**

**If you would like to get involved,
exchange ideas or just ask a
question, please contact me:**

In @civil.aau.dk

THANK YOU!