

Herrenhausen Conference October 9-11, 2019 EXTREME EVENTS – BUILDING CLIMATE RESILIENT SOCIETIES.

Report of session 1 “Challenges of Extreme Events for Resilient Infrastructures”

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The eight speakers and around 30 participants of the session „Challenges of Extreme Events for Resilient Infrastructures“, coming from different research fields, enterprises, NGOs, national and international organizations from around the world have been working based on the following methodological frame:

Extreme climate events, disasters, and emerging risks in the context of global environmental change are becoming increasingly critical and potential major threats to reaching the Sustainable Development Goals (SDGs). Therefore, the session focused on the role of energy, transport, drinking and waste water infrastructures and their potential to alter societal resilience. During the first part of the session potential impact chains, thresholds and scenarios have been discussed. The discussion focused on systemic interactions among extreme events, infrastructures and the resilience of linked natural, technical and societal systems. After the group had agreed on a working definition of resilience, the participants discussed potential obstacles across infrastructure sectors towards reaching societal resilience in a changing climate. The group started with identifying concrete knowledge gaps and action needs for resilient infrastructure and society in the face of extreme events. Next, the participants identified the most relevant obstacles. Here, the broad expertise and perspectives of practitioners influenced the discussion in a productive manner. The group integrated recent approaches and best practices from different case studies into theoretical discussions and development first ideas for implementation. During the last part of the session, the participants identified solutions to remove the identified key obstacles. With respect to intended results and recommendations for different target groups, these solutions were differentiated into research questions and actions to be implemented into practice.

Results: Contributions to resilience research and mentioning of the term “resilience” in official documents have grown exponentially over the past three decades. The following description served as orientation during the session: „(Urban) resilience refers to the ability of a(n urban) system - and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales - to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.”¹ Climate change, along with other socio-natural and technological threats (such as earthquakes), is an important source of external disruption to the operation of infrastructures. This is documented e.g. for heatwaves, droughts, heavy

¹ Meerow, S., Newell, J. P. and Stults, M. (2016) Defining urban resilience: A review, *Landscape and Urban Planning*, 147, p. 39.

rain, storm surges, flash floods, and fluvial floods. Different reasons for the loss of infrastructure services have been developed. These include above mentioned natural and technical causes as well as socio-economic factors (e.g. governance). Therefore, “infrastructures” are regarded as socio-technical systems. This includes, beside the material elements of build infrastructure, the services delivered, working routines, actors involved, the institutions in which the operation of the infrastructure is embedded, and cognitive elements like knowledge and know how. While the understanding of physical infrastructure in the face of extreme events is pretty well advanced, social aspects of infrastructure and its influence on societal resilience is not. Here, social and environmental justice seems to be a crucial issue. Well-established and standardized methods for resilience assessments are still missing. The question of including transparently normative judgments and/or an evaluation with the help of target systems, for example the SDGs, should be key in future research efforts. It is also worth noting the necessity of a fundamentally interdisciplinary orientation of the work on different strands of resilience and sustainability research on infrastructures. This should integrate numerous disciplines such as engineering, ecology, construction and architecture, social sciences, spatial planning or geography including the cooperation hurdles typical for interdisciplinary work, e.g. among engineers and governance experts. In addition, research with regard to infrastructure and resilience is increasingly carried out in a transdisciplinary manner: these projects involve various social actors in order to create context-specific knowledge about problems, obstacles and solutions.

Projections based on climate and socio-economic scenarios are and will always be subject to uncertainty. There is a need to establish consistency between socioeconomic and climate scenarios. The difficulty of making decisions under uncertainty can be moderated by preparing as precisely as possible for expected impacts. Complex causal relationships can be mapped with the help of impact chains or qualified with other methods. However, only few of these impacts can be analyzed based on quantitative models or established indicators. Several potentially important climate impacts thus cannot be quantified. Furthermore, only a very small number of models incorporate actor behavior. Thus, there is a need for further model or scenario developments. These explanations may illustrate the results of the session summarized in the following table:

Obstacles	Research questions	(Policy) action
Lack of bargained objectives/Conflicting priority setting	<ul style="list-style-type: none"> • How do power relations impact bargaining and priority setting? • How can ownership of decisions be increased? • How can international treaties inform national priority setting? • How can natural assets of global importance be „internationalised“? 	<ul style="list-style-type: none"> • Climate-Change-UNESCO • Alliance of the dedicated at all levels • (Inter)national Critical Infrastructure Protection law
Communication not fit for purpose	<ul style="list-style-type: none"> • What kinds of (science) communication are successful and target group-oriented? • How to enhance participation in decision making processes (communication & knowledge exchange)? 	<ul style="list-style-type: none"> • Include ‚knowledge transfer‘ in curricula & offer trainings • Establish & support networks with experienced journalists
Lack of systems thinking	<ul style="list-style-type: none"> • How to implement systems thinking in all sectors of society (education, private and public sector)? • How to overcome purely economically driven decision making? 	<ul style="list-style-type: none"> • Integrate sectoral coding practices (infrastructure design, planning etc.) • Obligation of collaboration in funding practices

Obstacles	Research questions	(Policy) action
Lack of change management	<ul style="list-style-type: none"> • How can models of change and best practices help to accelerate societal transformation? • How to develop a sense of urgency/mind set for resilience? 	<ul style="list-style-type: none"> • Have your plans ready, make use of media, use windows of opportunity for transformation • Make use of visual simulations incl. actor behavior & imaginaries • Implement a well-assessed policy mix
Lack of engagement	<ul style="list-style-type: none"> • How to set incentives to reach participation and engagement? • How to empower relevant actors? • Why do positive resilience examples work? 	<ul style="list-style-type: none"> • Increase public participation (citizen science, general assemblies, ...) • Encourage and empower grassroots movements
Misaligned incentives	<ul style="list-style-type: none"> • How could financial and institutional incentives contribute to the development of solutions? • How could incentives be better alligned to SDGs? 	<ul style="list-style-type: none"> • Create common vision of ‚resilient society‘ • Transform incentive structures, for example: <ul style="list-style-type: none"> • Change incentives in academia • Include natural resources in GDP • Transform laws, norms, routines, ...

In view of the final panel discussion, the authors of this paper draw the following conclusions:

1. Priorities for research questions and research activities:
 - How can models of change and best practices help to accelerate societal transformation and help to empower relevant actors?
 - Why did positive resilience examples work?
 - How can international treaties inform national priority setting?
 - How to overcome purely economically driven decision-making?

- How to implement systems thinking in all sectors of society (education, private and public sector)?
 - How could reallocation of financial and institutional incentives contribute to resilience and sustainable development?
 - How to enhance participation in decision-making processes (with the help of communication and knowledge exchange)?
2. Priorities for action items: Implement a well-assessed policy mix, especially:
- Integrate sectoral coding practices and norms (infrastructure design, planning etc.)!
 - Transform incentive structures, for example:
 - Change incentives in academia (by e.g. prioritizing the funding of inter- and transdisciplinary studies)!
 - Include natural resources in GDP!
 - Transform laws, norms, routines,!
 - Encourage and empower grass root movements and civil science!
 - Build alliances of the dedicated at all levels, e.g. create a Climate-Change-UNESCO!
 - Make use of visual simulations incl. actor behavior and imaginaries!

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