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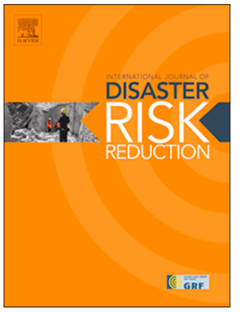

Editorial. Risk-Based, Pro-Poor Urban Design and Planning for Tomorrow's Cities

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Editorial. Risk-Based, Pro-Poor Urban Design and Planning for Tomorrow's Cities

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Introduction

Tomorrow's Cities[1] is the £20m United Kingdom Research and Innovation (UKRI) Global Challenge Research Fund (GCRF) Urban Disaster Risk Hub. The Hub aims to support the delivery of the United Nation's Sustainable Development Goals and priorities 1 to 3 of the Sendai Framework for Disaster Risk Reduction (DRR) 2015-2030 [1]. We work in four cities: Istanbul, Kathmandu, Nairobi, and Quito. We collaborate with local, national, and global organisations to strengthen disaster risk governance by undertaking integrated, multi-scale, and multi-disciplinary research to better understand natural multi-hazard risks and their drivers.

Ongoing rapid urbanisation and urban expansion provide a time-limited opportunity to reduce disaster risk for the marginalised and most vulnerable in tomorrow's cities [2]. We aim to catalyse and support a transition from crisis management to pro-poor, multi-hazard risk-informed urban planning and people-centred decision-making in expanding cities worldwide.

Tomorrow's Cities is a fully-functioning, fully-funded international collaboration of communities, governance organisations, researchers, and risk professionals. We are developing our Phase 2 programme planned for 2021-24, which will build on the Phase 1 research and partnerships forged since our inception in early 2019. We seek global partners to co-produce and implement a new approach to risk reduction, through risk-sensitive design of tomorrow's cities.

Recognised need

The Sendai Framework for DRR 2015-2030 identifies an urgent need for a global effort by researchers, practitioners, and governments to integrate science with action to support risk-sensitive decision making [1]. The Hub aims to co-produce methodologies and guidelines for this action-oriented, pro-poor, multi-hazard risk-based decision-making agenda.

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[1] https://www.tomorrowscities.org/

Understanding and acting on risk is complex. Risk assessments are necessarily based on significant simplifications of the underlying physical and social processes, they are difficult to validate, and the reporting process often obscures caveats implicit in underlying assumptions (e.g., [3-4]). Technical outputs may have an inappropriate impact due to inaccurate expectations and limited comprehension (e.g., [5-6]).

Experience also shows that state-of-the-art risk modelling on its own is not sufficient to build risk reduction into development planning and to support a movement to pro-poor, resilient actions (e.g., [7-8]). Institutional inertia, exclusive decision-making structures, and competing interests can mean even the best new knowledge is used only to enhance existing policy and practice (e.g., [9-10]).

This means that risk science has to be built on the best current methods and must also understand the development context within which risk and resilience are positioned by competing actors in a city. It must then be used to convene policy and practical spaces for new coalitions of interest to cohere and bring pro-poor resilience into policy and action.

Current limitations

Current approaches to DRR decision support in both research and practice are hampered by historical inertia, and display many common problems limiting their use in forwarding planning of urban expansion and transformation (Figure 1). They typically:

- Concentrate risk-quantification efforts on existing exposure and vulnerability rather than on a better understanding of the consequences of today's decisions on tomorrow's risk and resilience (e.g., [10-11]).
- Neglect the dynamics of hazard, exposure, capacities, and vulnerabilities, treating each as static over time, and ignoring their interactions and dependencies (e.g., [10]).
- Avoid considerations of the drivers of governance, planning priorities, and broader socio-economic processes in uneven vulnerability and risk creation (e.g., [12]).
- Do not adequately synthesise vulnerability across different physical and social contexts, qualitative and quantitative metrics, and local city-scale analysis (e.g., [13]).
- Ignore current advances in physics-based natural-hazard modelling, deploying dated representations of hazard that often rely on limited empirical data (e.g., [14-15]).
- Employ only a limited set of risk metrics, emphasising asset value, providing incomplete measures of the total impact of natural hazards, and undervaluing risk experienced by marginalised communities (e.g., [16-18]).
- Neglect disruption to socio-economic and technical networks and systems and to the communities they serve (e.g., [19]).
- Underemphasise social vulnerability as a policy domain for reducing urban disaster risk (e.g., [20]).
- Examine the impact of single hazards, overlooking interactions and dependencies between hazards and human activity (e.g., [21-22]).
- Exclude users from access to an examination of, or control over, underlying assumptions or weightings in the risk quantification process (e.g., [23]).
- Limit involvement of local stakeholders (e.g., [24]).

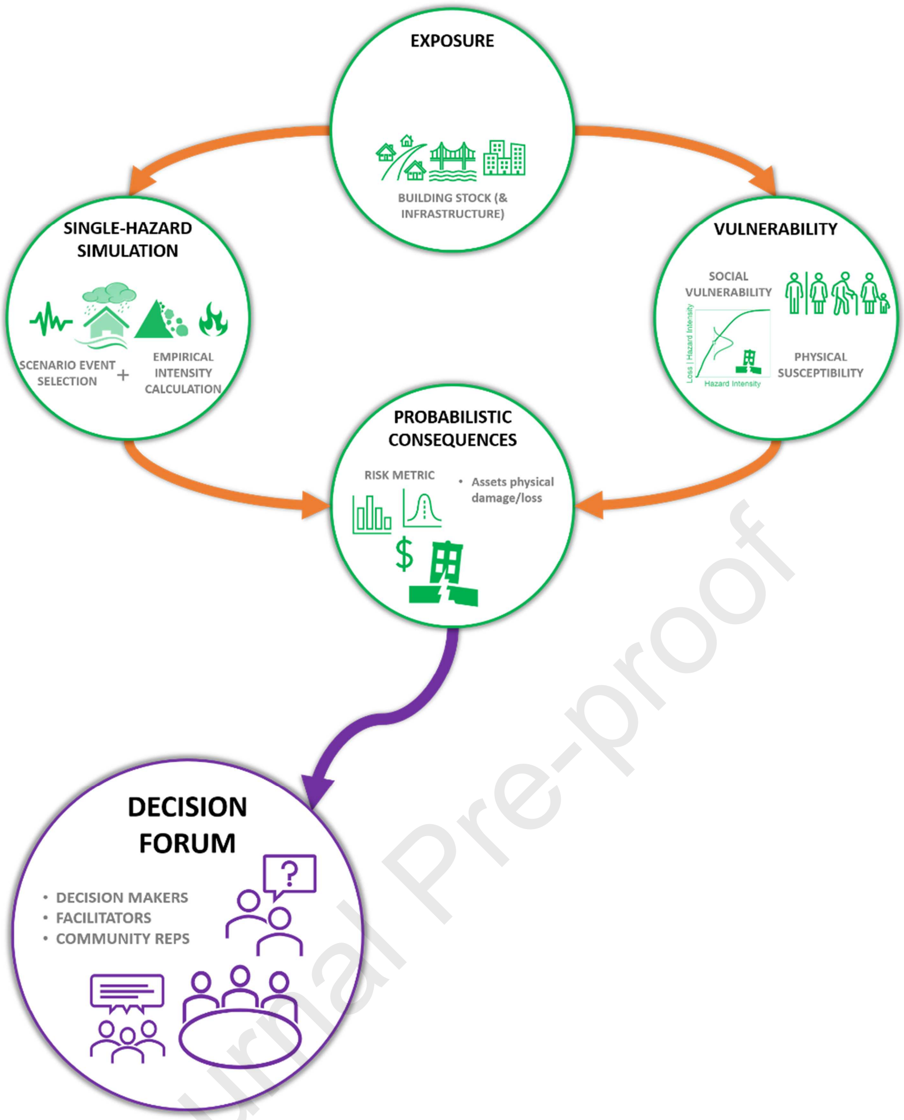

Figure 1. A conventional risk modelling framework. An exposure module contains details on the location and characteristics of the (existing) inventory at risk, possibly including human exposure to death or injury. The hazard module generally deals with a representative catastrophic single hazard, assessing the resulting hazard intensity across a geographical area under consideration. The vulnerability module quantifies the susceptibility to damage or other forms of loss to structures/infrastructure and their contents. Typically, vulnerability is confined to comprise only direct economic losses, often described in terms of their repair/replacement costs. In some cases, social aspects of vulnerability are also considered (often simplistically). The effects of natural hazards on coupled social-engineered systems are conventionally studied using computational models representing the behaviour of each asset in isolation. Moreover, current modelling approaches generally estimate risk using a snapshot of the conditions at one point in time. The main output of a conventional risk model is a description of the annual probability of exceeding certain economic loss levels and related statistics. Results are generally delivered to decision makers through a one-way process in which many of the underlying assumptions and details of the various modules/models are not adequately communicated and made accessible to end users.

Risk & Uncertainty in Tomorrow's Cities

Existing threats from natural hazards, social drivers of risk, and the vulnerability of existing building stock, housing and infrastructure, present a major challenge to the well-being of marginalised communities in the world's cities (e.g., [25]). However, Tomorrow's Cities is dedicated not to the reduction of existing risks but to the systematic and systemic reduction of risk in future development (e.g., [10]). We aim to advance holistic assessments for multi-hazard risk within complex engineering- social systems and develop new stakeholder partnerships for DRR.

We recognise the concept of potential risk, a property of yet-unbuilt infrastructure, yet-unknown socio-economic characteristics, and as yet-unmade decisions, which can be reduced by modifying urban design and planning as well as the institutions that deploy them. Extending existing evaluations based on the economic value of physical assets to include the livelihood consequences of systems disruptions results in more inclusive urban planning and action (e.g. [26]).

Our aim, therefore, is to develop a two-stage Tomorrow's Cities Decision Support Environment (DSE) based on detailed multi-hazard scenarios co-developed with stakeholders to provide 1) a transparent and rigorous assessment of potential risk inherent in urban design, housing and infrastructure planning, around which 2) decision makers and those at risk might consider the risk consequences of particular decisions (Figure 2).

Both stages elucidate the consequences of particular choices, and both provide opportunities to foreground the perspective and experience of the at-risk poor. Using customised visualisation and multi-faceted communication strategies, the selected scenarios also provide learning loops through which different perceptions of risk can uncover novel risk metrics and modify risk models and assessments.

We bring a deep understanding of the inherent uncertainties involved in integrated social and physical vulnerability analysis, and the expertise to deal with these in a sophisticated way (e.g., [27]). We embrace uncertainty as an opportunity rather than a hindrance, ensuring the most effective deployment of models, transcending simplistic single perspectives and exploring multiple, quantitative and qualitative approaches to risk (e.g., [28]).

In this way, we use the convening power of interdisciplinary science and simulation, rather than the frequently unspoken implication of scientific certainty, to enable inclusive decision making. Scenarios cover a wide range of scales from single high-magnitude events through to repeated small disruptions, connecting intensive risk to extensive or even every-day multi-hazards, and bridging the near-real-time priorities of the urban poor with longer-term strategic planning. Disaggregation of impact on different sectors of society (income classes, ages, genders, and marginalised communities) will help identify different intervention options to reduce impacts. Further, by framing these analyses with assessments of social and economic drivers of vulnerability and exposure through co-produced, participatory community-level research, we build on established social impact and risk assessment methodologies.

Rather than usurping local decision authorities, these two DSE stages enable science to become a tool for decision support in a collaborative environment , where decision makers and local partners are involved early in framing and addressing the research questions. Rather than scientists and engineers providing definitive forecasts, they provide a critical but supporting role in an ongoing multi-disciplinary process, where local authorities and communities are integral to the risk analysis process.

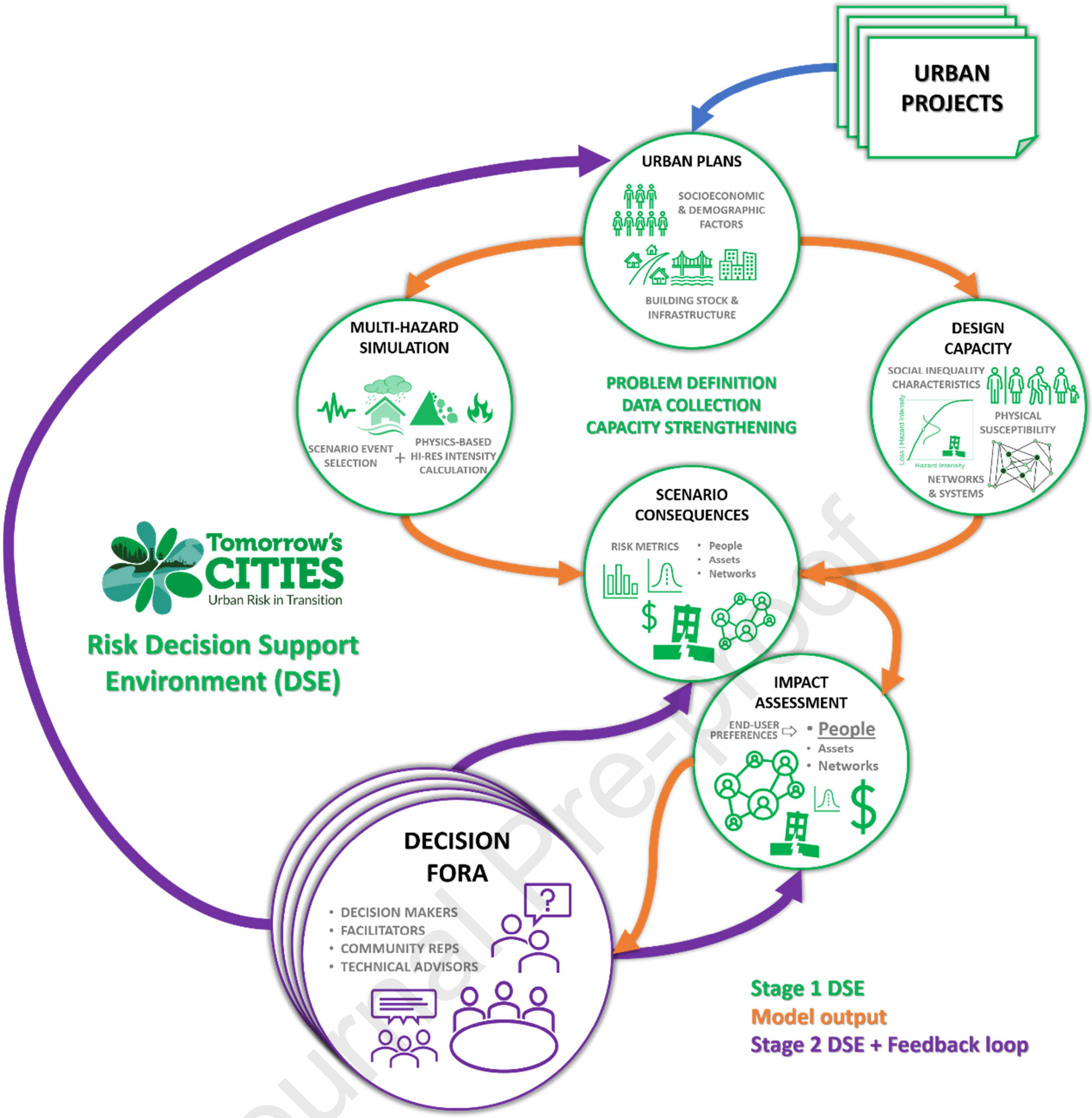

Figure 2. The Tomorrow's Cities approach to DRR in planned urban transformation or expansion. Draft urban plans, including the design capacity of individual elements, social indicators, and models of networks and functioning systems, are described in detail. These planning suggestions inform event scenarios, for which high resolution, physics-based simulations of the important multiple hazards (incorporating detailed descriptions of uncertainty) coupled with dynamic physical and social vulnerability analysis provide an array of potential risk metrics for consideration and weighting. Multi-disciplinary teams integrate these metrics into impact assessments and detailed descriptions of the consequences of the chosen events, using a wide range of expertise and methods. The entire process is interactively co-produced by decision makers, facilitators, community representatives and technical experts, using advanced visualisation and communication capabilities to facilitate deep understandings of the consequences of different aspects of the original plans and of the impact assessments under different transparent assumptions and planning options. Feedback loops, which potentially give decision-makers influence over all aspects of the process, provide opportunities for interactive, evidence-based, and inclusive planning decisions.

Components of the Tomorrow's Cities Decision Support Environment

The Tomorrow's Cities DSE is built around complex, layered understandings of urban risk with particular consideration for the priorities of marginalised urban populations who bear the brunt of disaster impacts. This emphasis necessitates novel approaches to understanding risk and its quantification, built on a flexible virtual space in which future development scenarios and detailed urban design and policy options can be considered, evaluated, modified and rated by a range of stakeholders.

To achieve the Hub's desired transition to multi-hazard urban risk-based planning, the Risk DSE must be designed as a component of existing, wider Hub activity and be co-designed with city-level decision makers. Most important is to integrate the best physical, engineering, and social science in the Risk DSE and co-produce the methods with city-level urban planning partners within the context and at the fora in which decisions are being made. It must be co-owned from the start by city actors and, in this way, will enable inclusive, evidence-based policy advocacy and debate. Navigating this shift from risk management to integrated risk-based planning as part of a city and community-level urban development is the Hub's core challenge. Existing Hub city institutional mapping can identify the needs of specific policy groups so that the Hub understands how best to communicate and co-design the vision, mechanisms, and outputs of the Risk DSE. Skills and capacity in risk sciences that are developing across the Hub combined with substantial Phase 2 funding, enable us to address this challenge confidently.

Building on research and partnerships developed in the Hub inception phase, Phase 2 of the Hub will bring diverse stakeholders into shared processes of co-production, and the Tomorrow's Cities DSE will open a new decision-making space to explore novel evidence-based solutions to difficult policy challenges.

The DSE will:

- Be co-produced with local, national, and global decision makers and research partners.
- Have a global application but will succeed through city-level deployment and local action.
- Concentrate on reducing the potential risk inherent in today's decisions appropriately through the design and planning of tomorrow's built environment and social systems.
- Foreground the role of governance, planning, and community capacity in risk creation/reduction.
- Enable assessing different policy and planning options in terms of their impact on various economic, environmental, and social objectives.
- Deploy state-of-the-art hazard and physical vulnerability models to develop validated simulations around which multi-layered physics-driven scenarios can be constructed and considered.
- Deploy state-of-the-art social vulnerability assessments and examination of risk creation processes through local, participatory methodologies and historical Forensic Investigations of Disasters (FORIN) analysis.
- Combine physical and social sciences in innovative integrated analyses to reveal the pathways to, and drivers of vulnerability.
- Employ a wide range of risk metrics, including those that capture the risk experience of marginalised communities and the outcomes of socio-political and technical system analyses.
- Account for the loss of function of systems and networks.
- Examine the impact of multiple hazards and the resulting risk interdependencies.
- Emphasise the use of appropriate visualisation to communicate the complexities of the underlying modelling and its inherent assumptions.
- Perform rigorous uncertainty modelling for each component of the risk assessment framework and ensure open dissemination of the related results.
- Provide all data and models as open-source tools, including complete documentation and records of the development and previous case studies.

Tomorrow's Cities have convened a group who are actively working on this approach to risk, building on the Phase 1 research effort in our four cities.

We are now looking for partners to work with us to co-produce the details of the methodology to achieve a good fit between the concept and its delivery.

Expressions of interest from and meetings with appropriate partners are welcomed and actively encouraged.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: