GRAPPLING WITH THE CITY - DISASTER NEXUS

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Dear Rector of the University of Twente, Dean of the Faculty ITC, PGM colleagues, ITC and other colleagues, students, family and friends. It is an honour for me to speak to you today about urban planning for disaster risk reduction, the chair to which I have been appointed. It is, indeed, a very great pleasure that several former colleagues have returned to Enschede, some from quite far, to be a part of this occasion.

The title of my inaugural lecture, *Grappling with the city-disaster nexus*, has apparently intrigued and perhaps even puzzled some people. If that is the case, it is my hope that by the end of this lecture, much should have been clarified: how I came to this title, why I consider it a useful manner to describe my current and how it relates to my future research interests? In doing so, I will explain my view of the role of geo-information technologies and related modelling and decision making tools in the field of urban planning for disaster risk reduction. I will also provide a glimpse of an approach to grappling with the interactions of cities and disasters that can be useful, particularly in cities of the Global South, for these are the main foci of my research activities and they fall squarely within the mission of the faculty and my department. I intend to illustrate the value of these technologies but also some of their limitations. In the next 40 minutes or so I will examine what the city-disaster nexus is and why it is important. In my lecture, I will speak about Enschede and I will also take you to Kampala in Uganda, to learn about how geo-information technologies have contributed to developing strategies to reduce flooding and support climate change actions. Thereafter, I will sketch out what I see as the most important directions for my research in the coming five years.

DISASTER TERMINOLOGY

But to set the scene, allow me to first talk a little about disasters. We are all very familiar with the news reports about disasters from around the world. Hardly a day goes by without a disaster related story from some part of the world. Disasters can occur almost anywhere and, by definition, their impact is high. The United Nations International Strategy for Disaster Reduction (UNISDR) defines a disaster as *"A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources"* (UNISDR, 2009). Often a distinction is made between disasters caused by natural hazards

(e.g. an earthquake) or technological hazards (e.g. an explosion in a factory). Many disasters are attributable to multiple-hazards, in which one event triggers another, in what may be termed as coupled or cascading events, sometimes involving combinations of natural and technological hazards (e.g. the Sendai earthquake/tsunami which caused the Fukushima nuclear accident is such a Na-Tech disaster). Global statistics show that in 2017 alone there were 335 reported disasters, which were responsible for more than 9,600 deaths, a staggering 96 million affected people, and an estimated USD 334 million in economic damage. And this was a pretty normal year.

The fireworks disaster in Enschede is an example of a multi-hazard, technological disaster, at city scale. The fire which started at the factory site in a mixed residential/industrial neighbourhood, Roombeek, on 13 May 2000, led to two large explosions at the site which were very destructive and were ultimately the cause of 23 deaths and more than 1000 injured. The explosions and the ensuing fire in the neighbouring community, also destroyed approximately 400 houses and damaged 1500 buildings. The combined efforts of voluntary and professional emergency services from several German and Dutch municipalities were required to extinguish the fires. This event far exceeded the emergency response capabilities of the city of Enschede alone, in part because many first responders themselves were among the casualties of the explosions. Though the assistance of German volunteers was a very welcome reflection of the value of '*noaberschap*' (or *Nachbarschaftshilfe*), their arrival also complicated communications between responders and the chief commander (Bijker, 2009). The event was in every sense of the word a disaster. It has had substantial and long-term impacts on the lives of the directly and indirectly affected populations, as well as local, national and international policy related to the siting and regulation of such businesses. Seven years after the event, a total of Euro 8.5 million in compensation for damages and injuries had been distributed to victims.

Many lessons for planning and emergency management were extracted from its storyline. The recovery phase has extended over more than 15 years. In the aftermath of the disaster came the opportunity (Inam, 2005), not only for recovery but for the co-creation of a new Roombeek. Rebuilding and redevelopment incorporated elements of the old with new features that have transformed Roombeek, through a planning approach

that has been termed as a sort of social-technical therapy (Hommels, 2018), into the popular and lively neighbourhood that it is today. According to Inam (*ibid*) such large-scale recovery processes rely not so much on flexibility, but more the ability of formal routine, standardised bureaucratic processes, such as those found within urban planning and engineering departments of Enschede, to function well in response to crises. However, where such formal institutions are weak, or perhaps even largely destroyed by the disaster itself, as occurred in the Haiti earthquake or Aceh due to a tsunami, the opportunities that may be present after a disaster may not be realised. Moreover, where the planning system is weak, the potential preventative role of planning in disaster risk management (DRM) may be difficult to realise prior to a disaster, leading to higher levels of vulnerability, exposure and thereby risk. Of course, informal institutions and social networks may also enhance resilience (*the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions* (UNISDR, 2009).). Informal social capital and practices can be important stimuli for recovery processes, or for development programmes more generally, if they are recognized and mobilised by the formal (Katomero & Georgiadou, 2018).

It is vital for all societies to critically examine the relationship between cities and disasters. This relationship embodies a duality: cities and their citizens are at risk and, at the same time, they are the *cause of risk* (Wamsler, 2014; Wamsler & Brink, 2014). This is very much in line with Beck's view that risk is deeply entwined in the way modern societies operate and how cities perform (Beck, 1992), that it is literally "..woven into the very fabric of progress" (Jasanoff, 2003, p 224.). It is important to examine more closely what is meant by risk and then to examine this duality more closely and what it implies for urban planning.

Risk is a term which is frequently used and often misunderstood. There are various definitions of risk, and until recently even the DRM community and the climate change community were using different definitions for some basic concepts related to risk. Thankfully, these are now being harmonized, as this will facilitate communication and knowledge alignment between the two fields and, perhaps more importantly, with stakeholder groups in general, who may otherwise be easily confused by such ontological

flexibility. When speaking of disaster risk, I adopt the view originating within the DRM community, which defines risk as being dependent upon the interactions between three components: the probability of a hazardous event occurring, the susceptibility of a community, system or asset to damage or loss (referred to as contextual vulnerability) and the level of exposure of the elements (population and assets) at risk (figure 1).
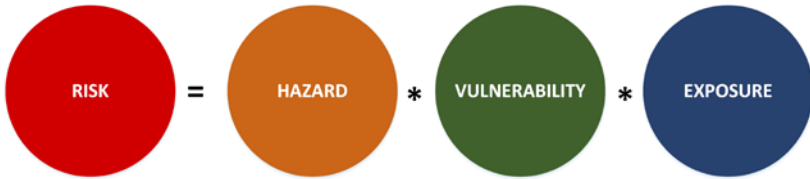
Figure 1
The relationship between risk, hazards, vulnerability and exposure

Using this pseudo-formula to reflect upon the case of the Enschede fireworks disaster, it becomes clearer what each of these terms means. It also helps to clarify what is meant by the city-disaster nexus, and the role that urban planning can play in risk reduction. The SE Fireworks factory, had a licence from the municipality to operate from a certain site; it was therefore a permitted land use. The factory was the source of the hazard, but it was also itself vulnerable and severely exposed to the hazard; next to nothing remained of the factory, in a physical sense, after the event. What became clear after the event was that the level of the hazard posed by the factory was substantially underestimated. The people and assets in the vicinity of the factory also had varying degrees of vulnerability, depending on their specific characteristics. For example, a person's age, income, gender, education level are well-known determinants of vulnerability, and a building's construction type and its quality also determine its susceptibility to damage i.e. its physical vulnerability. The last ingredient in the risk equation, exposure, relates to the extent of the hazard zone which determines who and what are affected and to what degree. Disasters typically have a spatial footprint, and so one's location matters a lot in the determination, perception and experience of risk. If two adjacent buildings, that were equidistant from the source of a hazard and were exposed to the same degree to its forces, suffer different degrees of damage, then this difference is attributable to their different levels of physical vulnerability.

Some may even say that one building was more resilient than the other because it was better able to withstand the shock. In this sense we see that the terms vulnerability and resilience are very closely linked to one another. They are almost opposites and are sometimes treated as such. Every disaster situation entails an interplay between the three risk determinants. Also, we know that urban plans and development processes may have some bearing on all three risk components. Having ready access to reliable urban data sets, including risk assessments, is therefore important for urban planners to be able to contribute to effective DRM programmes. Good data provides a basis for evidence based planning and decision making (Davoudi, 2006).

URBAN DATA AND PLANNING MODELS FOR RISK REDUCTION

Wamsler (2014), has described how a city can be conceived of as a set of interactions between its physical urban fabric, the natural eco-systems in which it situated, its societal and cultural elements, the economy and its governance system (figure 2). When we map and enumerate the city and create an urban geographic information system, we are in a sense, condensing what we observe at a given place and time into snapshots of the urban. These snapshots can be conceptualized as three types of layers: the occupation layer (buildings, land uses, economic functions, population, etc); the network layer (utilities and other services), and the data on the sub-stratum layer (natural resources and environment). Each of these layers consists of several different types of data sets, which together comprise the geo-information model of the city, including its environment. The capability to create regular snapshots at appropriate time intervals provides a foundation for effective planning and routine management practices. Ideally, for cities experiencing very rapid growth, data should be updated more frequently. However, this is not always the case, especially in the Global South.
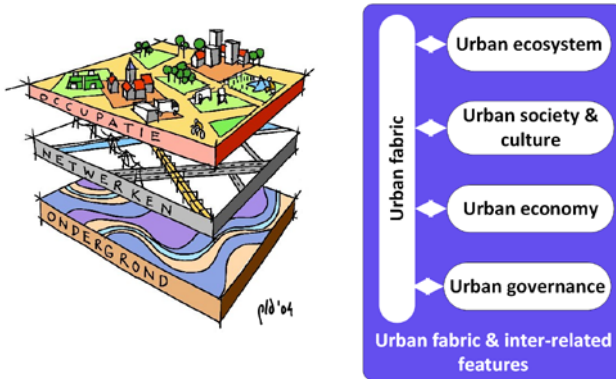
Figure 2
Geographic information layers approach and the urban fabric and inter-related features
(Layers Drawing Peter Dauvellier; Urban fabric adapted from Wamsler, 2014)

Cities are highly dynamic and complex entities. Underlying the city's geo-information model is a notion of cities as a set of interacting systems, which entail multi-temporal and multi-scale connectivity. Planners who attempt to systematically influence what happens in cities require an understanding of not only what the city is (i.e. the present state of its component features), but also an understanding of the underlying processes and interactions which have determined its evolution from past states to its present state. These processes will, to some extent, determine its future states (i.e. its development), albeit in potentially different trajectories which may be taken on the basis of changes in one or systems and their underlying socio-technological interactions. But planners also need to realise the limits of regulative planning, as even in countries with ostensibly highly authoritarian planning regimes such as China, plans are not necessarily followed by all (Smart, 2018; Groenleer et al., 2017).

In a nutshell, the discipline of urban planning for disaster risk reduction is about developing and implementing strategies and actions to guide public and private investments in infrastructure, land, property, and business that will strengthen the city's resilience. In other words, it is concerned with how to create urban areas, communities and societies which are able to withstand, respond to and recover from various types of shocks (Yamagata & Maruyama, 2016). A focus on resilience implies more than being to cope with and adapt to shocks. Rather, it emphasizes transformations

to enhance the performance of entire urban systems (United Nations, 2016). This requires negotiating future socio-economic and environmental pathways with many stakeholders, building alliances and commitment for transformational risk reduction strategies, and guiding, monitoring and enforcing their implementation (EMI, 2015).

There are many different conceptualizations of urban planning processes (Mandelbaum, Mazza, & Burchell, 1996; Rivolin, 2012). One which I find useful is the scenario planning model of Steinitz (2012). Later in my lecture I will speak about the integrated flood management project in Kampala, and we will see how such an approach works in practice. First though, it is useful to briefly examine what is understood by scenario planning, and how it can be used in a spatial planning process. Through the combined efforts of urban researchers, practitioners and other stakeholders we attempt to obtain an adequate understanding of past development trends and issues, including environmental and other processes that have shaped the urban fabric. Figure 3 shows how the past, the present and especially the future, embody uncertainty. In cities of the Global South, which are my primary interest, the levels of uncertainty are likely to be significantly higher than in cities of the Global North. This is due both to the speed of change and to relatively weak urban management systems and the data gaps in the supporting information systems (Sliuzas, 2004). However, even in uncertain situations, the aim of scenario planning is to identify development strategies, which will be feasible and, in keeping with my interests, also lead to a reduction of risk. The method allows for alternative futures to be evaluated with limited information resources and allowing for relatively high level of uncertainty and that contain elements that are outside of planners' span of control (Couclelis, 2005).
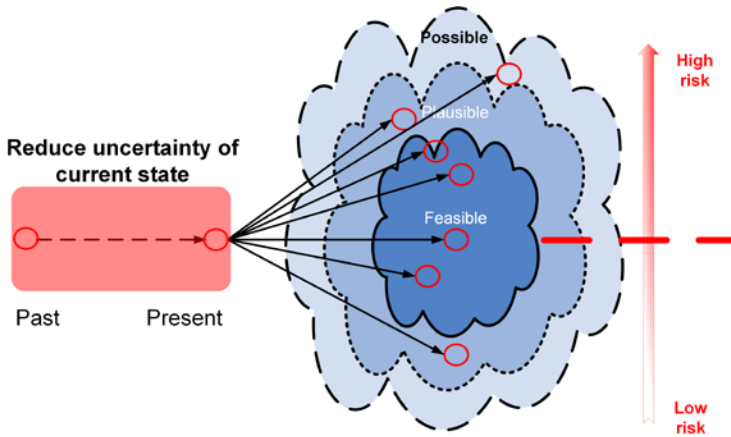
Figure 3
Scenario planning model (adapted from Carl Steinitz)

Such work is by no means trivial. The analysis of the current state requires the development of appropriate representation, process and evaluation models that can effectively communicate the key information about the current state, analyse and explain its historical development and evaluate the key issues that arise from these. This should be done in collaboration with stakeholders, who together should establish a shared agenda for future action (figure 4). In subsequent stages, stakeholders negotiate and develop scenarios, which form the basis of change models, interventions and possible scenarios which must be analysed in relation to their impacts as a basis for group decision making. Several forward and backward loops through the modelling and many rounds of negotiation may be required before consensus is reached and decisions are made. Irreconcilable conflicts may even result in lengthy legal processes to have decisions on plans overturned or modified. As the resources required for such struggles may not be available for all those who oppose a decision, some voices may therefore not be heard, or at least not fully reflected in plan outcomes. This is a form of exclusion which reflects differences in stakeholders' power and their right to the city (United Nations, 2017). Collaborative planning processes are therefore not a guarantee for equitable decision making.
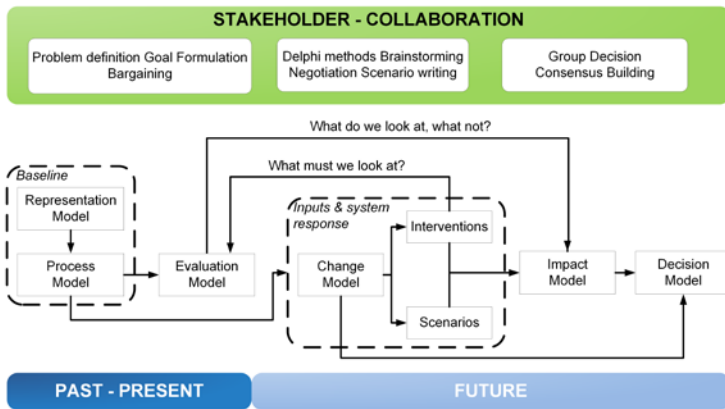
Figure 4
Modelling steps in scenario planning (adapted from (Steinitz, 2012)).

Figure 5
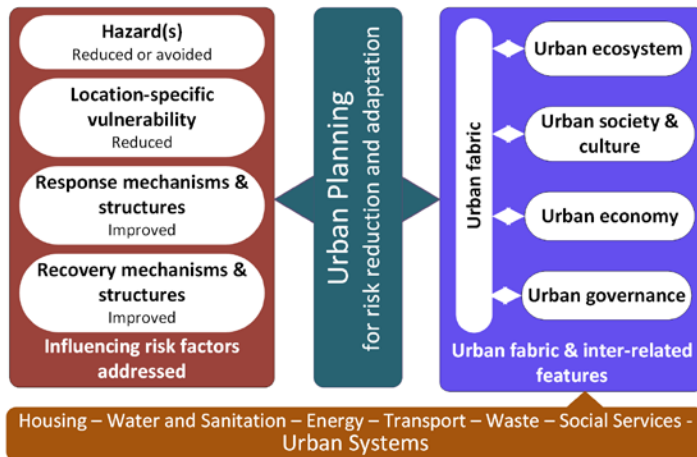*The city-disaster nexus (Wamsler, 2014)*

Scenario planning is an important planning support tool for grappling with the city-disaster nexus (figure 5) (Wamsler, 2014). It incorporates a combination of technical information modelling and evaluation steps combined with and linked to a series of stakeholder engagement practices, each tuned to the specific stage of the planning process. The models

and collaborations can at various times be focussed on the various influencing risk factors that form part of disaster risk reduction. Measures and indicators of the levels of hazards, vulnerability and exposure form criteria against which scenarios can be evaluated. Estimates of losses and damages will be main criteria to be used, along with other planning indicators related to other policy goals, in impact models. In other words, the approach could be used as framework for risk-sensitive urban planning (GFDRR and EMI, 2014). Through collaborative (spatial) ex-ante modelling, opportunities to reduce hazards, reduce vulnerability and exposure and improve response and recovery can be explored in virtual environments as aids to decision making. Carefully designed models can be successfully integrated into collaborative planning processes and provide useful insights into possible futures and help to construct supportive narratives and identify feasible strategies for constructing planning imaginaries (Couclelis, 2005), such as resilient communities and cities.

CASE: INTEGRATED FLOOD MANAGEMENT IN KAMPALA.

To demonstrate how this approach may work in practice, I will now discuss some aspects of the Integrated Flood Management Kampala project (IFMK) which was executed in 2012-2013 as part of UN-HABITAT's Cities and Climate Change Initiative (Sliuzas, Lwasa, et al., 2013). Kampala is Uganda's fast growing capital city, with a substantial amount of informal or unplanned neighbourhoods (Vermeiren, Van Rompaey, Loopmans, Serwajja, & Mukwaya, 2012). Kampala is faced with numerous developmental and planning challenges, of which flooding is one. The three aims of IFMK were: 1) to analyse city-wide flood risk and climate change impacts; 2) to make a detailed analysis of flood risk in a hotspot area; 3) to develop a strategy and action plan for integrated flood risk management. The project combined spatial modelling methods with regular collaborations with the Kampala Capital City Authority, various government ministries, the Buganda Kingdom, and civil society organizations (in particular Non-Governmental Organizations and Community Based Organizations as representatives of slum dwellers).

The assessment of present and future flood risk in light of climate change was a prerequisite to identify feasible alternative planning responses through simulation and evaluation and deliberation processes. Two

modelling tools produced outputs which were inputs in stakeholder dialogues as the basis for strategy development. First, urban growth was simulated for up to 20 years into the future to enable urban land cover, especially imperviousness, to be estimated. These simulations generated some of the data required for modelling surface water runoff and flooding. Given that impervious surfaces are a major contributor to surface water runoff, we measured the current proportion of imperviousness using existing GIS data from KCCA and very high resolution satellite images and estimated future levels of imperviousness across the landscape using spatial logistic models to predict land cover changes up to 20 years into the future. Second, flood modelling was carried out by Prof Victor Jetten with openLISEM (https://sourceforge.net/projects/lisem/). In addition to imperviousness, openLISEM requires other variables such as: rainfall data at high temporal resolution, data on various land cover fractions, soil infiltration rates, slope and drainage channel characteristics.

High levels of uncertainty surrounded much of the variables to be modelled: the changes in the urban fabric, climate and weather patterns and the key natural landscape elements such as soils and vegetation. By combining aerospace images, existing data from KCCA's GIS and data from surveys of soil properties and socio-economic conditions, the project team created a fit-for-purpose spatial database of one flooding hotspot, the Bwaise neighbourhood of Kampala. The models were used to estimate future flood inundation levels and impacts under different stakeholder-based scenarios incorporating two population growth rates and several planning and engineering interventions (Table 1). Throughout the project, stakeholder workshops were used to collect additional data, validate key assumptions and model outcomes, and to produce and evaluate scenarios of plausible future situations.

Model outputs included maps of current and future urban expansion and density (figure 6), various maps of flooding outcomes such duration, maximum depth (figure 7), water velocity, quantified impact indicators for each scenario and videos of each scenario showing the flood dynamics. These products were the key outputs and means of communication with stakeholders. Discussions based upon these products centred around feasible options and acceptable hazard levels and risk, resulting a series of proposed measures related to flood reduction, vulnerability reduction, flood impact mitigation and wetland protection. These measures provided a basis

for the first Ugandan National Workshop on Cities and Climate Change, where stakeholders from throughout Uganda and Kampala helped to identify and develop preliminary budget proposals for their implementation.

Table 1
Modelled scenarios. Source: (Sliuzas, Jetten, et al., 2013)

| Drainage and planning options	Development Conditions		
	Current state	Trend Growth 2020 & 2030 4.75%P.A.	High Growth 2020 & 2030 6.5% P.A.
Baseline - unimproved drainage and current state of development	Scenario 0 Baseline		
Primary - improved primary drain and clean secondary drains	Scenario 1 Primary	Scenario 3b Trend-Primary	Scenario 3a High-Primary
Grass - secondary drains as grassed waterways	Scenario 2a Grass	Scenario 4b Trend-Grass	Scenario 4a High-Grass
Zone – remove buildings from flood zone based on scenario 1, replace with grass.	Scenario 2b Zone	Scenario 5b Trend-Zone	Scenario 5a High-Zone
House – 15,000 house owners add grass to improve water infiltration on plots.		Scenario 6b Trend-House	Scenario 6a High-House
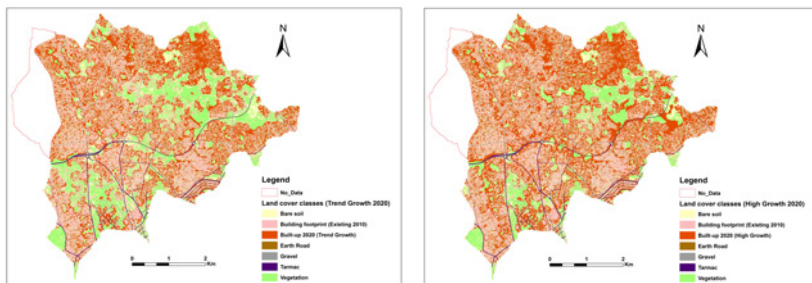
Figure 6
Modelled land cover for 2020 according to a trend growth rate of 4.75 % p.a. (left) and 6.5% p.a. (right).
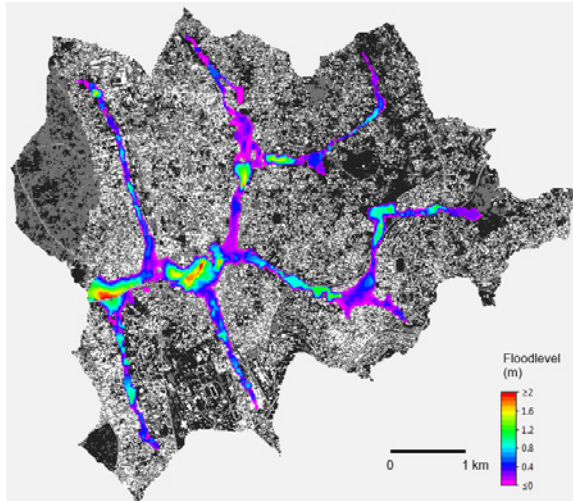*(Fura, 2013)*

Figure 7
Baseline scenario: flood depth (in m) in the Lubigi catchment hotspot (1:10 year, 100mm rainstorm; no improved drainage). The background is the 2010 1m resolution classified satellite image. Source: (Sliuzas, Jetten, et al., 2013).

The project showed how a collaborative, scenario-based planning approach to risk reduction can work in practice, even in what was at that time, a relatively weak institutional environment. The Kampala case is also a good illustration of the city-disaster nexus at work. Both planned and unplanned urban areas contribute to the flood hazard via surface water runoff and some areas are simultaneously also vulnerable and exposed to flooding. The flooding problem involves bi-directional upstream-downstream interactions and questions of exclusion, marginalization and poverty were ever-present during stakeholder processes during which problems and solutions were discussed and negotiated. The inherent multi-dimensionality, complexity and wickedness of flooding issues in Kampala was omnipresent. However, our approach established the benefits of an integrated approach that simultaneously aimed to improve the effectiveness of urban management systems, strengthen social inclusion, while also addressing flood mitigation.

The visual and quantitative model outputs provided an evidence base upon which stakeholders could deliberate and arrive at an improved

understanding of current and future flooding threats, as well as feasible strategies and actions to address them. These strategies and actions addressed all of the flood risk components of hazard, vulnerability and exposure and were of four types: flood reduction (community drain cleaning; community sensitization; sustainable drainage systems measures); mitigation of flood impacts (improved information on soils, development and rainfall); vulnerability/exposure reduction (capacity development, information and awareness, norms and regulations, resettlement); and flood plain preservation (displacement and demolition, wetlands mapping and protection). It is also important to note that even with the full implementation of these measures, flood risk in Kampala cannot be fully eliminated. This is not in itself unusual, as risk is a permanent, spatially variable and dynamic feature of all societies (Beck, 1992).

Later, in 2016, several of the project findings and outputs became inputs into the formulation of the KCCA's Climate Action Plan. This shows how such research projects can contribute to policy change and adaptation practices even in contexts with relatively few resources. However, in such situations considerable time may be required for new policy arrangements to emerge (Bas Arts, Leroy, & Tatenhove, 2006).

GRAPPLING WITH THE CITY-DISASTER NEXUS
The end of the IFMK project in December 2013 was not the end of ITC's engagement with flood risk and climate change in Kampala and other sub-Saharan cities. Rather, it was the foundation for new research related to the city-disaster nexus. In the ensuing years, several PhD projects were commenced which should be seen both as extensions of the IFMK project and also as foundational components of my future research activities and interests.

Over the next five years, through further collaborative research, I intend to co-create geo-information based methods and tools to support the development of strategies, plans and actions in cities of the Global South that address important development goals such as the reduction of disaster risk, poverty, exclusion and, increase urban resilience. In this, I seek to identify and build new relationships between new and existing methods and tools, between people and organizations and, people and geo-information technologies.

In my work I will adopt a perspective that is connected to and emanates from the traditions of science and technology studies (Jasanoff, 2011). The fields of urban planning and disaster risk reduction, as they are studied and practiced at the Faculty ITC, are both deeply embedded in the technologies of geo-information science and Earth observation. Following Kranzberg, as with other technologies, geo-information technologies (GITs) are neither good nor bad, nor are they neutral (Sacasas, 2011). Rather than pre-determining certain actions, GITs create opportunities for human agency, through which GITs have impact. In today's world, in which collaboration and citizen participation are claimed to be important, even if they are not always well practiced, it is useful to complement the development and use of technologies with perspectives that acknowledge the normativity that is embodied within the technical, to recognize the presence of plurality among societal actors and the value of collective learning as technologies are applied (Jasanoff, 2003).

These are not trivial concerns. Ever higher image resolutions and more accurate maps will, in themselves, not alter the outcomes of plans and decisions for urban expansion, resettlement nor risk reduction. Many of the concerns related to technologies and their application, are all too familiar to planning. Promoting technologies of humility as opposed to what she terms technologies of hubris, Jasanoff (2003) identifies four main concerns which she thinks should be addressed by all human agency, which intends to alter society, as planning does. These concerns are *framing, vulnerability, distribution, and learning*. The related questions she poses are: what is the purpose; who will be hurt; who benefits; and how can we know? But we could also add others: who decides on the purpose and on what basis: who is included or excluded from the process and why? These and similar questions will be quite familiar to planners who adopt collaborative approaches in their daily work (Healey, 1997). They are also found in the work of Arts et al (2006) on policy arrangements and the interplay between actors and coalitions, discourses and programmes, resources and rules and regulatory regimes related to environmental problems.

Today, such questions are gaining more importance as groups who were traditionally outsiders to the realm of GIT, are now themselves adopting GIT for autonomous mapping and self-enumeration. For example, in the *Know your City* campaign of Shack/Slum Dwellers International amongst others. Moreover, as open city data movements gain momentum, the distribution

of and access to basic urban data and the role of citizens and civil society as passive receivers of plans may change significantly, to one in which they partner in development processes as co-producers of data, information, knowledge and plans. Although the speed of change in GIT is very fast, in many countries of the Global South such developments may still take quite some time before they become universal. My colleagues, Prof Yola Georgiadou and Prof Karin Pfeffer, are respectively working on governance issues and exploring the notion of infrastructuring urban futures, and I welcome the opportunity to collaborate with them on the infrastructuring of risk-sensitive urban planning processes and related governance concerns.

Before concluding this lecture, I would like to sketch out how such concerns play out in my own research on the city-disaster nexus in the cities of the Global South? Perhaps unsurprisingly, my interests will remain closely tied to the scenario modelling approach that was the basis for work in Kampala. The Kampala experience revealed a number of issues that often must been in mind in such contexts. First, the project and modelling frameworks must be well aligned to constraints in the available resources, capacities of many stakeholders to comprehend the models and especially issues of uncertainty embodied in these. Second, when working with rather complex models and outputs, it is important to have experienced facilitators who know how to communicate the key messages and engage stakeholders in all stages of the deliberations and planning process. Third, it is important to clearly distinguish between empirical modelling and analysis and normative work in planning and decision making. As many planners and decision makers are more familiar with the use of norms and standardised approaches to zoning land and risk, misunderstandings and misinterpretations of empirical analysis can easily arise. Also it is useful to ensure that the evaluation and impact models are focussed on critical issues and not overly-defined with respect to the process and change models. This issue also reflects general concerns about model transparency and uncertainty.

These and related issues gave rise to the title of this lecture: *grappling with the city-disaster nexus*. If both planning and managing the urban and enhancing resilience through risk reduction are recognized as moving targets, then their nexus is a complex setting indeed. Grappling evokes images of close combat or engagement, of wrestlers or martial arts experts battling for strategic advantage and victory. However, as the city-disaster

nexus knows no time limit as such, it is a perpetual exchange in which urban stakeholders seek to gain advantage over current and future risks. This struggle may take the form of strategic and systematically applied measures applied through formal planning and DRM institutions and frameworks. However, it is likely to also encompass numerous individual or collective informal actions, some of which may even be very important ingredients in gaining a strategic advantage over disasters in the longer term. This grappling may even contribute to a fundamental transformation of planning theory and practice (MacDonald et al., 2014).

For now though, I will provide some examples of some of the work that I am engaged in and highlight some key questions, which I intend to further explore. I do this under the heading of *Inclusive Urban Datascapes as Spaces for Urban Resilience* in which methods for urban data acquisition (figure 8), spatial analysis and planning support are central.

Figure 8
Understandascope (Image courtesy of Michael Leunig)

INCLUSIVE URBAN DATASCAPES AS SPACES FOR URBAN RESILIENCE

First, what do I mean by the term *inclusive urban datascapes*? Data for planning must be acquired, stored, analysed, managed, visualized and disseminated in order to be useful. Urban datascapes embodies the notion of urban planning, as a data hungry enterprise, that requires the integration of spatio-temporal data from multiple sources (Dandekar, 1988). Ideally, data integration should be done in a systematic and coordinated manner into a collage of connectable and interoperable databases. In practice, urban datascapes are more likely architectures of coupled, loosely coupled and even fully independent systems. The prefix, inclusiveness, refers to the ideal, within the boundary constraints of privacy and security concerns, that urban datascapes are open and accessible to all urban stakeholders, who can contribute to, draw from and even contest their contents. It also underwrites the importance that I have always placed on addressing the position of the most deprived and vulnerable groups in society and the interconnectedness of the formal and the informal in the urban.

The second part of this section's caption, *spaces for urban resilience*, refers to the spaces of territoriality, governmentality and governance (Lagendijk, Arts, & Houtum, 2009) in which the urban-disaster nexus is an important, but not the sole concern. Here, I refer to the development and use of methods and tools for planning and decision support, which as it were, both feed off and add to the urban datascapes. These operate in settings designed to facilitate inclusive and collaborative planning and decision making, while being sensitive to the reduction of current and future risks. Given rapid urbanization processes with relatively high levels of informality in the Global South, growing concerns about climate change, which will add complexity and uncertainty to existing hazard assessments, extra attention is needed for the preventative work of planning in risk reduction. The testing of possible responses to future risk was recently identified as being relatively under-studied in the disaster risk reduction field (Newman et al., 2017). However, risk reduction must also be aligned with other developmental agendas and policy arrangements.

In the Netherlands, considerable resources are devoted to build and operate the (spatial) data infrastructures upon which the spatial planning and public management processes are dependent. In the Global South, such high quality spatial data infrastructures are rarely found, and their absence

or fragmented character contributes in part to the weaknesses of urban planning and management. But this situation is changing. The numerous very high resolution satellite systems which now provide frequent coverage of all parts of the Earth's surface, web-based mapping systems etc. have begun to dramatically change the urban datascapes of the Global South. Clearly, not all cities of the world have the capacities to utilize these new sources of urban data to the full, but with programmes such as the Global Facility for Disaster Reduction and Recovery (GFDRR), Open Data for Resilience Initiative (OpenDRI) an increasing number of cities are creating and starting to use open data bases for general planning and disaster risk reduction work. Such databases, but also other more traditional databases, which are made accessible for users, together form an urban datascape. An open digital city, as it were, comprised of digital representations of the urban feature sets described earlier, that is open for contributions and use by all urban stakeholders.

The main focus of my current and future research is situated at and between community and city scales, where important considerations on the city-disaster nexus, such as how to best increase resilience in an equitable manner, are most obvious and tangible. Many questions concern issues of informality, both as a source of strength especially through social capital such as grassroots organizations (Katomero & Georgiadou, 2018), but also in relation to vulnerability. Although disasters do not discriminate per se, it is well known that informality is often associated with higher vulnerability levels, in all its dimensions. It is therefore vital to give extra attention to informal areas and their residents in policy and in research and practice. Questions such as: where and how to best address the upgrading of informal areas in hazardous settings; how to manage upgraded areas in order to maintain satisfactory living conditions over time while controlling for gentrification; how will the pattern of informality change over time and what implications will this have for future risks, in light of anticipated changes in climatic and non-climatic hazards?

In her recent PhD, Caroline Gevaert showed how drone images of an informal neighbourhood in Kigali could be used to automatically extract buildings and other features, very high resolution digital elevation models and to generate 2D and 3D representations of informal urban landscapes as a support for settlement upgrading (Gevaert, 2018). Future collaborations with colleagues from Earth Observations Systems (EOS) department could

extend her work to examine how automatic feature extraction (AFE) could be scaled up and possibly integrated with community based methods such as those developed in the Ramani Huria project in Dar es Salaam, Tanzania (www.ramanihuria.org), which are now part and parcel of the Open Cities Africa initiative. Questions related to the effect of AFE on the technical quality of these digital databases, but also how and to what extent the use of AFE would affect the social interactions between the involved groups in community mapping; whether civic engagement might be negatively affected by automation or would it become more robust and sustainable?

Another concern related to inclusive urban datascapes, is how to coordinate and align attention for dynamics across different disciplines? Spatial planning can contribute much in the way of disaster prevention if it is well connected to DRM processes of hazard and risk assessment (Sapountzaki et al., 2011). It is important to address the timely exchange of data and information between these fields, including both current states and possible future scenarios. Here it is necessary to examine the information content of different types of spatial plans, as these describe possible future development states, to explicitly address if and how they can be used in ex-ante risk assessments. This is an issue that I am now starting to explore with colleagues from the Earth Systems Analysis department together with partners from the National University of Colombia (UNAL) and the Metropolitan Authority of the Aburra Valley (AMVA) in Medellin Colombia. However, it is an issue of global importance, if risk-sensitive spatial planning is indeed to be mainstreamed (Wamsler, 2014). It is also an area in which questions of infrastructuring urban futures (Pfeffer, 2018) come to the fore.

Also in Medellin, a new PhD research project on the role of spatial planning in addressing the impacts of cascading, multi-hazard events on critical infrastructures will help to further develop the new collaboration. Around this project, I envisage extra activities related to MSc research projects, capacity building, further project acquisition, traineeships, etc. to become increasingly important. With Medellin being a member of the Rockefeller Foundation's 100 Resilient Cities programme (http://www.100resilientcities. org/) and with AMVA having already invested in developing its urban datascape, this is a useful site for developing and testing new methods and tools around the planning-disaster nexus, some of which may be adapted and transferred to other locations.

In his work in Kampala and Kigali, Eduardo Perez-Molina has been refining the methods for urban monitoring and growth modelling to enhance up-scaled flood risk assessments (Pérez-Molina, Sliuzas, Flacke, & Jetten, 2017). More recently, methods incorporating Spectral Mixture Analysis with theoretical considerations of the Alonso-Mills-Muth model (Takahashi, 2014), have been used to estimate impervious surface change for these two, rather different, cities. These data provide a basis for simulating future developments processes and are being linked to flood models, which also now cover the entire Kampala region (figure 9). The upscaling of these models is important because it allows assessments to be made of the impact of future physical development strategies which now provide the basis for city's growth and development (KCCA, 2012). This is very relevant because these strategies and plans focused mainly on land use, transportation and the formulation of some rather bold visions for Kampala as a modern, high-rise metropolis that gave next to no attention for issues of surface water management, flooding, and urban poverty. Such *fantasy plans* have been criticised for their lack of grounding in the daily realties of African urbanization (Watson, 2013). The neglect of such plans for hazards and risks should be of considerable concern for all stakeholders. In particular, the position of the urban poor, who are most vulnerable to flooding and likely to be affected by the realization of evictions associated with large-scale urban redevelopment projects. Developing and promoting the use of risk-impact models to evaluate plans in relation to current and future hazards may assist under-resourced stakeholders to challenge the most *fantasy-like* planning imaginaries and focus on feasible scenarios and plans that address the local context, culture, institutional setting and available resources.
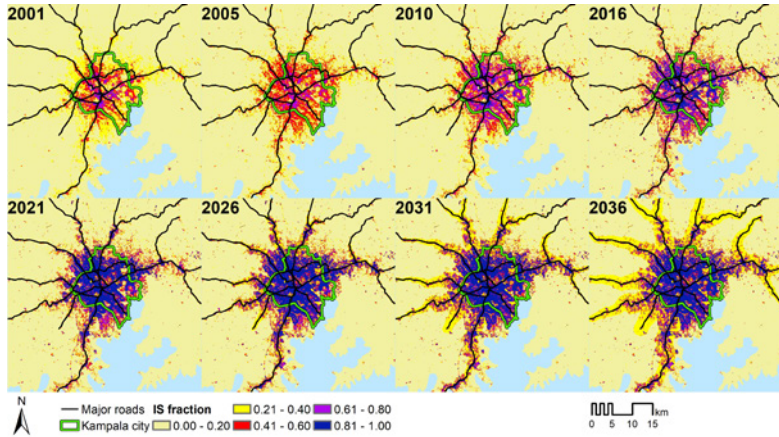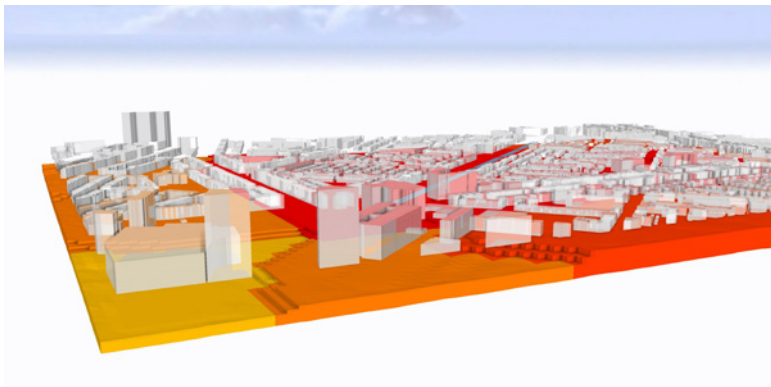
Figure 9

Impervious surface fraction for Greater Kampala: 2001-2016 extracted from Landsat images and simulated for 2021-2036. (Source: ongoing PhD research Eduardo Perez-Molina)

Involuntary displacement and resettlement are already major concerns within DRM and spatial planning. Environmental problems associated with climate change such as increased droughts, more frequent severe storms, sea-level rise and flooding, food and water security are expected to exacerbate the need for resettlement. Building upon recent work on impacts of resettlement in Ahmedabad, India (Patel, Sliuzas, & Mathur, 2015), Alice Nikuze is currently exploring how resettlement processes in Kigali, that are driven by infrastructure development and risk reduction, could be better managed with more attention to social and spatial equity, more transparent and inclusive processes and fairer compensation regimes. Resettlement is a complex issue as it concerns the right to urban land and therefore the right to the city. It has major effects on livelihoods and it incorporates impacts on the displaced as well as on the host communities where displaced households are to be resettled. Where land is at a premium and population densities are already high, social tensions can easily accompany poorly executed resettlement programmes. Alice's work contributes to the agenda of the Netherlands Land Academy (http://www.landgovernance.org) and opportunities for expanding collaboration with LANDac partners around tenure security and fair compensation in involuntary resettlement are high on my short-term agenda. We anticipate developing and testing methods and tools for supporting collaborative

resettlement within the PGM department's group decision room facility to address some of the key concerns around this highly complex issue. This facility is being used in a variety of multi-stakeholder problem settings such as environmental health (Shrestha & Flacke, 2018),

Geo-visualization and 3D/4D urban models are also important to urban risk reduction work. In collaboration with Dr Mila Koeva and others, I will expand research on the use of 3D/4D modelling and visualization techniques for complex urban environments. The pressures on urban systems for more compact, intensive and multi-functional space use, including also the sub-surface, demands 3D/4D modelling capabilities. The recent work of Maryam Ghodsvali (2018) on improving the communication between planners and sub-surface specialists in Rotterdam Municipality with 3D modelling and visualization (figure 10), has provided a basis for further work around the interactions between surface development, networks and the sub-surface in which risk-sensitive urban development is explicitly considered (Admiraal & Cornaro, 2018). In addition to collaborating with visualization experts from the GIP department, it is important to examine how visualizations frame and influence stakeholder's learning processes concerning risk and its components hazard, vulnerability and exposure. In collaborative planning and decision making it is important that the readings of information are properly communicated, well understood, and deliberated before major decisions are taken.

Figure 10
Perspective view of part of Bloemhof, Rotterdam, showing 3D representation of buildings and soil pollution levels (yellow is least polluted, red is most polluted) and depths (Source: Ghodsvali, 2018)

Before closing, I would also like to stress the important role of partnerships and collaborations in the further development of my chair. My collaborations with the Joint Research Centre and others on the GEO Human Planet Initiative, with the Association of European Planning Schools' Resilience and Risks Mitigation Strategies group, and with both UNISDR and UN-HABITAT on the city-disaster nexus and climate change provide much scope for new relations to evolve. With regard to climate change activities, there is currently a big drive to focus more attention on the impact of climate change on slum dwellers globally. A growing amount of work is being carried out to use Earth observation to map slums in support of urban management and for monitoring the Sustainable Development Goals (Kuffer, Pfeffer, & Sliuzas, 2016; Kuffer et al., 2018). This new initiative has my full support and I will be working closely with ITC colleagues from PGM, EOS and ESA, the United Nations (UN) and other partners to have this issue tabled at the UN Global Summit in September 2019. The initiative also coincides very well with some key interests of the ITC's activities within the Integrated Research on Disaster Risk network, whose scientific director, Prof Shuaib Lwasa is also present today. Through these and other avenues I will contribute to the development of methods and tools for grappling with and reducing disaster risk in cities. Should I have tickled your interest to collaborate around the city-disaster nexus I would welcome a chance for further dialogue.

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group. I look forward to another five years of collaborations in various forms and of course our Monday morning Pimp my PLUS sessions and the occasional social capital events at the old market.

Special thanks to my promotors, Henk Ottens from Utrecht University and Volker Kreibich from TU Dortmund who were my supervisors and mentors during my PhD studies. And also to Ian Masser, Brent Hall and Martin van Maarseveen who were all sources of guidance and inspiration. Your combined knowledge and coaching skills were invaluable and have contributed much to my academic and professional development.

I also owe an enormous debt of gratitude to all of my family in Australia. In particular, to my mother, Dorothy, who turned 90 earlier this year and unfortunately cannot be here today. She is a truly remarkable woman who, after the death of my father at a young age, did so much to raise and educate her four children. She is resilience personified, and still a role model for me today.

Despite having now lived in the Netherlands for almost 35 years, I cherish the close ties which still persist with a small group of friends and their families in Australia. Thank you to my friends downunder who have, each in their own ways, contributed to my personal growth and education. Our continuing friendship that endures over such a vast distance is of immeasurable value to me. My sincere thanks and, if you are watching now, sweet dreams.

Moving now closer to home. I wish to express my gratitude to my friends from Enschede and elsewhere in the Netherlands who enrich my life here in so many ways and have adopted me as it re, even without an official "inburgerings certificaat". My thanks too also to all members of the family Grooters; for your friendship and support over the years, and for being here today. Finally, to my wife and life-partner Anita, to our children and their partners and our grandchild, Rosanne, Steven, Tymen, Marianne and Leah, I am immensely grateful for your love and support. Combining my career at ITC with its many missions abroad and family life is not ideal for family affairs. But we have grappled with life's challenges somehow managed, and without you I would not be standing here today. I am proud and happy to be with you.

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