1. Blessing in disguise: long-run benefits of urban disasters

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1.1 CITIES IN MOTION

The Saint-Elisabeth's Flood (19 November 1421) was one of the most devastating flood disasters in Dutch history. Dozens of cities and villages in the south-western part of the country were swept away due to an unprecedented heavy storm, with a death toll of thousands of people. It is noteworthy that several cities which were completely destroyed (e.g., Dordrecht) later on played an important role as economic, cultural and political centres in the Netherlands. Apparently, urban recovery after disaster is by no means an exception and may even be a more universal phenomenon.

It is a well-known fact from ecology that forest fires may strengthen the long-run stability and diversity of woods and ecosystems. Apparently, an environmental disaster may lead to a better and more sustainable outcome for an ecosystem in the long term. Similar positive findings may be recorded on external shocks in human-made or social systems. For example, the large influx of refugees (Huguenots, Jews) to the Low Countries in the sixteenth and seventeenth centuries prompted the rise of flourishing cities (e.g., Antwerp, Amsterdam). Countries in a war may sometimes be better off in the long run than countries without a war, as witnessed by the post-World War II *Wirtschaftswunder* of Germany. Social systems apparently comprise an abundance of responsive or creative talent which makes these systems highly resilient and adaptive. In human history it appears that disasters may create challenges or threats which may be turned into new opportunities. This 'challenge and response' mechanism of human societies (see Toynbee 1934–61) provides an unprecedented degree of learning and adaptation behaviour which may lead to relatively stable social systems. Economies and societies in motion may be more resilient and robust than others in a static standstill position. Coping with dynamics is also the core message of a Schumpeterian 'creative destruction' conceptualization of the evolution of human-made systems.

Dynamics not only refers to a simple time-varying trajectory, but may

also encapsulate non-linear dynamic behaviour in space and time (see for an exposition Reggiani and Nijkamp 2006). This phenomenon has prompted an avalanche of studies on non-linear dynamics in complex spaces (see Reggiani and Nijkamp 2009), which may exhibit various dynamic evolutionary pathways (e.g., a cusp catastrophe), depending on initial conditions and transition dynamics. Sometimes, very complicated – even fractal – movements in spatial systems may occur in complex multi-agent systems (see, e.g., Banaszak et al. 2015). Clearly, both natural and human-made systems may exhibit a wealth of dynamic behaviour, especially in those cases where human responses intervene with natural systems (e.g., in the case of climate change). This observation has prompted a great variety of studies on resilient spatial systems and adaptive behaviour of agents (see Reggiani et al. 2015). For example, in the literature on flood management the notions of flood hazard (the probability of the occurrence of extreme events) and flood effects or damage in catastrophic events often show up. Such damage is contingent on the range of exposure (people, resources) and the areal vulnerability (or lack of resistance in case of a flood) in the area concerned. For more details and applications in the domain of climate change we refer to van der Pol (2015).

Clearly, besides flood disasters, there are many other types of disasters which may adversely and dramatically affect a spatial system. For example, an urban system may be exposed to a great variety of external shocks, such as fires (e.g., Lisbon), earthquakes (e.g., Kobe), wars (e.g., Mombasa), famine (e.g., Calcutta), social unrest (e.g., Tripoli), environmental disasters (e.g., Bhopal), volcanos (e.g., Pompei/Napoli), economic collapse (e.g., Detroit), or several planning disasters (see, e.g., Hall 1982). A prominent question is of course whether human response (e.g., adaptation, abatement measures) may lead to a more favourable and stable long-run outcome, and if so, under which conditions.

In this context, various policy responses may be distinguished, such as anticipatory adaptation, mitigation measures, or *ex ante* control or preventive measures, which all aim to transform a system out of equilibrium back into a stable – sometimes initial – state. Disaster management is usually geared towards achieving the original equilibrium situation. In all such cases, solid empirical and scientific information is needed. Van der Pol (2015) makes a distinction here into three sources: scientific information for policy, evidence-based learning, and incident-based learning. Clearly, information, learning and adjustment are critical parameters in uncertainty management. It is increasingly recognized that governing a balanced future of urban systems is an unprecedented challenge that requires novel, contemporaneous decision support tools (e.g., imagineering methods, dashboard techniques, scenario experiments) (see Kourtit 2015).

The main proposition put forward and tested in the present study is whether, how and why an organized type of dynamic spatial system, that is, a city, once it is dramatically affected by an external shock or disaster, is able to recover. In particular, we want to investigate whether – as a result of dedicated recovery and rehabilitation strategies after a shock or disaster has occurred – the city concerned may operate at a higher achievement level compared to the ‘without’ effect (‘dead weight’). Our study is organized as follows. Section 1.2 provides a concise description on the dynamics of urban systems and outlines the problems addressed in the chapter in greater detail. Section 1.3 gives a review of the database used to collect information about various types of disasters. Section 1.4 provides a comprehensive overview of the world evidence of natural disasters, including distribution of different types of natural disasters across the world and a comparison of the total number of disasters and the total number of deaths and people affected by natural disasters between 1974 and 2003. In the second part of this section we discuss the resilience of countries all over the world against natural disasters by using the inspirational example of Japan and its cities. Section 1.5 is devoted to the implications for urban disaster management based on statistical evidence. The chapter concludes with general policy lessons.

1.2 THE DYNAMICS OF CITIES

Cities – and urban agglomerations – are complex and interrelated spatial entities that include a wide variety of dynamic trajectories over time (see, e.g., Taylor 2007; Kourtiti et al. 2014; Kourtiti 2015). Despite the worldwide urbanization mega-trend, not all cities have the same growth pace; some may show an unprecedented growth rate, while others may even exhibit a decline (see Haase 2015). Urban growth and urban shrinkage in the world are often taking place at the same time. Urban areas are usually showing a life cycle pattern with upturns and downturns, sometimes similar to business life cycles in industry. There is a wealth of studies that document these dynamic urban trajectories (see, e.g., an early seminal study on the life course of cities by van den Berg et al. 1982). In recent years, we have witnessed an avalanche of studies on urban growth and decline under different economic and political regimes (see, e.g., Couch et al. 2005; Nuijsl and Rink 2005; Cheshire 2006; Haase et al. 2009; Kabisch et al. 2010, 2012). An interesting overview of various trends in urban dynamics can be found in Haase (2015).

Interesting contributions to a further understanding of resilience mechanisms and vulnerability analysis can be found *inter alia* in Alexander

(2000), Richardson et al. (2008) and Rose (2007). Urban evolution is the result of a complex internal, external and policy force field. In contrast to a regular life cycle pattern of urban agglomerations caused by endogenous forces of a city or urban system (as studied in the earlier urban dynamic systems literature; see Forrester 1969), our chapter aims to focus attention on the external shocks that impact the urban economy and that lead to disequilibrating forces, without any prior guarantee of a stable outcome or a return to the original position.

The analysis of external shocks to an urban system prompts two types of methodological research challenges:

- What are the intermediate and long-term effects of such a shock on the urban economy? Such effects may show up in various urban sectors, such as tourism, the retail sector, public services or the business sector at large. This leads to the need for a systematic and comprehensive urban disaster impact assessment (UDIA).
- Under which conditions is the urban system able to return to its initial position or to a new equilibrium? This question is often addressed in the context of resilience and vulnerability analysis. The conceptual framework and operational meaning of resilience and vulnerability – with a distinct reference to the transportation sector – have been presented in recent articles by Kim and Marcouiller (2015) and Reggiani et al. (2015).

Resilience refers in general to the ability of actors to develop and implement adaptation mechanisms to external perturbations that mitigate the long-run effects of such shocks and that might lead to a restoration of the original equilibrium or to the realization of a new equilibrium state. Resilience may thus be considered as ‘the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks’ (Walker et al. 2004, p. 8). Vulnerability is related to the robustness of a man-made system to cope with the emergence of external shocks and to combat their negative consequences; it is a shock absorption ability that reflects to some extent a risk-persistence of a system in a timely and effective manner. Reduction of vulnerability through deliberate actions may increase the resilience of the system concerned.

In the past decades, there has also been a permanent interest in a related phenomenon, viz. hysteresis. This is a particular type of systematic singularity that leads to out-of-equilibrium situations as a result of a delayed response to shocks. Depending on initial conditions, different types of asymmetric behaviour of a complex system may be observed (known as a cusp in

the catastrophe theory literature). Such inert response mechanisms may find their origin in historical and cultural attitudes in some regions or cities or in ineffective and low-responsive management and policy systems in cities. In other words, even though disasters or shocks are often not forecastable, the response system (in terms of local attitudes and effective counter-measures) is critical in coping with jumps in a system and hence in paving a road to a new balance (also see for a recent study Tubadji et al. 2016).

In recent years, much interest has arisen in disaster impact assessment. Methods employed in such an assessment comprise inter alia: input-output analyses, shift-share analysis, general equilibrium modelling and so forth (see, e.g., Rodriguez et al. 2007; Cuaresma et al. 2008; Cavallo et al. 2013; Okuyama and Santos 2014). The geographical scale level of a disaster impact assessment may range from a macro perspective (see, e.g., Skidmore and Toya 2002) to a local (regional and urban) angle (see, e.g., Baade et al. 2007; Chang 2010; Coffman and Noy 2011; Okuyama 2015). It is also noteworthy that a need for a more systematic impact assessment has emerged, as reflected in some recent meta-analytical studies (see, e.g., Lazzaroni and van Bergeijk 2014; van Bergeijk and Lazzaroni 2015).

The history of spatial and urban dynamics over many centuries prompts intriguing questions on the ‘why’ and ‘how’ of urban evolution. In this context, Tellier (2009) adopts a long-run perspective on urban development patterns and concludes that the force field of the spatial development of our world has to be found in hyper-dynamic corridors in our urban world which spur economic development in these areas. Cities on these corridors have more favourable seedbed conditions and are able to recover more swiftly from decay and destruction. The broader literature on regional resilience, especially the literature on resilience to natural disasters, offers new insights that may be relevant to a better understanding of regional-economic resilience. A common finding in this literature is that access to economic resources promotes regional or community resilience in the face of natural disasters (Morrow 2008; Pastor and Benner 2008). This observation suggests that regions with higher average incomes or wages (independent of human capital) may recover more quickly from external shocks (Hill et al. 2012). Consequently, urban resilience may be income-dependent.

In the current age of local and global uncertainty, we are continually facing new and unforeseen threats at all levels – international, national, regional and local. Natural disasters, technological catastrophes and terrorist attacks beset the world of today. Cities and their urban structures are positioned in the first line of attack, while they have to be able to satisfy the needs and expectations of society in the event of disasters – and to cope with the fear of future disasters.

1.3 DATA AND METHODOLOGY

There is a great deal of evidence on urban disasters, but often on an anecdotal basis, so that a systematic comparison is often problematic. For our purposes we have resorted to an extensive disaster database. Data inspection and mining have been undertaken through the Emergency Events Database (EM-DAT).¹ EM-DAT uses a classification that was initiated by the Centre for Research on the Epidemiology of Disasters (CRED) with the aim to create – and agree – on a common hierarchy and terminology for all global and regional databases on natural disasters and to establish a common and agreed upon definition of sub-events that is simple and self-explanatory. In this context, CRED defines a disaster as ‘a situation or event that overwhelms local capacity, necessitating a request at the national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering’ (Guha-Sapir et al. 2016, p. 7). For a disaster to be entered into the database, at least one of the following criteria should be fulfilled:

- ten or more people reported killed
- 100 or more people reported affected
- declaration of a state of emergency
- call for international assistance.

CRED distinguishes two generic categories for disasters, natural disasters and technological catastrophes.

The natural disasters category is divided into five sub-groups, which in turn cover 12 disaster types and more than 32 sub-types. The five sub-groups and 12 types are:

- biological disasters (insect infestations, epidemics and animal attacks – the last two categories are not included in the dataset)
- geophysical disasters (earthquakes and tsunamis, volcanic eruptions, dry mass movements)
- climatological disasters (droughts with associated food insecurities, extreme temperatures and wildfires)

¹ Since 1988, the Centre for Research on the Epidemiology of Disasters, located in the School of Public Health at the Université catholique de Louvain, has been developing and maintaining an Emergency Events Database, EM-DAT. EM-DAT was created with the initial support of the World Health Organization (WHO) and the Belgian government. The main objective of the database is to serve the purposes of humanitarian action at national and international levels. It is an initiative aimed to rationalize decision-making for disaster preparedness and prevention, as well as to provide an objective base for vulnerability assessment and priority setting.

- hydrological disasters (floods including waves and surges, wet mass movements)
- meteorological disasters (storms divided into nine sub-categories).

The technological catastrophes comprise three groups:

- industrial accidents (chemical spills, collapse of industrial infrastructure, explosions, fires, gas leaks, poisoning, radiation)
- transport accidents (transportation by air, rail, road or water)
- miscellaneous accidents (collapse of domestic/non-industrial structures, explosions, fires).

EM-DAT contains essential core data on the occurrence and effects of over 18,000 mass disasters in the world from the year 1900 to the present. The database is compiled from various sources, including United Nations (UN) agencies, non-governmental organizations (NGOs), insurance companies, research institutes and press agencies. EM-DAT provides an objective base for vulnerability assessment and rational decision-making in disaster situations. For example, it helps policy- and decision-makers identify disaster types that are the most common in a given country and have had significant historical impacts on a specific human population.

The following three figures summarize, compile and show the development of the occurrence of disasters from 1900 to 2015 in relation to death tolls caused by disasters, total affected people by disasters and total economic damage.

Figure 1.1 shows the total death toll caused by disasters from 1900 to 2015 and the occurrence of disasters from 1900 to 2015. While the disaster occurrence has an increasing trend, the number of deaths is decreasing. Figure 1.2 demonstrates total affected people by disasters.

Source: http://www.emdat.be/advanced_search/index.html

Figure 1.1 Total deaths caused by disasters from 1900 to 2015

Source: http://www.emdat.be/advanced_search/index.html

Figure 1.2 Total affected people by disasters from 1900 to 2015

Source: http://www.emdat.be/advanced_search/index.html

Figure 1.3 Total economic damage caused by disasters from 1900 to 2015 in thousands of US\$

The data show an increasing trend of people affected by disasters from 1900 to 2015. They correspond to the trend of the increasing world population. Figure 1.3 provides an overview of the total economic damage caused by the disasters.

Figure 1.3 shows that the economic damage caused by disasters has a similar trajectory as the occurrence of disasters during the period concerned. The total economic damage as well as the total affected number of people essentially mirrors the increasing occurrence of disasters. The occurrence of disasters forms a clear contrast with the total number of deaths (Figure 1.1), which is decreasing during the reporting period.

As reported by EM-DAT, it turns out that from 1993 to 2014, 56.27 per cent of all disasters occurred in high-income and upper-middle-income countries, where the share in the number of deaths is 32.17 per cent, in contrast to lower-middle-income and low-income countries with 67.83 per cent of total deaths, corresponding to 43.73 per cent of the total number

of disasters. While the economic losses from disasters tend to be greater in high-income countries due to higher value of properties, infrastructure and assets, low- and middle-income countries tend to face higher fatalities and disruptions to hard-earned development gains. On average, around 82,000 people are killed annually by disasters, with most fatalities concentrated in low- and middle-income countries (Dickson et al. 2012).

1.4 SUCCESS AND FAILURE IN CASE OF DISASTERS

Success and failure of cities and countries exposed to and coping with disasters depend on many place-based ‘specific features’. In the distant past, disasters usually had far-reaching consequences. Historical evidence can, for instance, be found in devastating fires common in big cities, *inter alia*, London in 1666, Chicago in 1871 and Thessaloniki in 1917. Large fires are nowadays no longer devastating major cities in high-income nations.

In high-income nations, the concentration of people, buildings, motor vehicles and industries (and their wastes) in cities is not generally associated with higher disaster risks because this same concentration also means many economies of scale and proximity for the comprehensive web of infrastructure and services that reduce disaster risks and disaster impacts. Urban populations in these nations take it for granted that they will be protected from disasters, including extreme weather, floods, fires and technological accidents. (World Disaster Report 2010, p. 16)

It is noteworthy that several high-income countries are very often facing natural disasters. Let us take a look at the distribution of different types of natural disasters across the world. In Figure 1.4, there are four maps of the world with occurrences of different types of natural disasters from 1974 to 2003. Severity of disasters reported on maps is evaluated according to the CRED methodology as indicated in Section 1.3. Of course, we may assume that a large country (by area) will tend to have a higher number of occurrences than a small country. But as seen from the maps, this is not always the case. Very often, the location in areas where tectonic plates are meeting (Japan, Italy) or in hurricane areas (Caribbean) is a crucial factor for the higher occurrence of disasters.

Map 1 shows the number of occurrences of earthquake disasters in the world from 1974 to 2003. A light colour means occurrence of an earthquake frequency from 0 to 5, the grey colour represents the occurrence from 5 to 10, and the black colour means more than 10 earthquakes during the investigation period. Map 2 shows the number of occurrences

Source: <http://www.emdat.be/world-maps>

Figure 1.4 Occurrence of different types of natural disasters in the world from 1974 to 2003

of windstorm disasters in the world from 1974 to 2003. The light colour means a frequency from 0 to 10 windstorms, the grey colour represents the interval from 11 to 30 windstorms and the black colour means more than 30 windstorms. Map 3 shows the number of occurrences of flood disasters in the world from 1974 to 2003. The light colour means a frequency of occurrence from 0 to 15, the grey colour represents an interval from 15 to 60 floods and the black colour means countries are affected by more than 60 floods within the relevant period. Finally, map 4 shows the number of occurrences of volcano disasters in the world from 1974 to 2003. The light colour means countries have a zero number of volcano disasters, the grey colour indicates countries have 1 to 2 occurrences of volcano disasters, and the black colour means countries have more than 2 occurrences of volcano disasters in the period concerned.

It is evident that some geographical localities in the world are more affected by the occurrence of disasters than others. As mentioned before, higher occurrence of different types of disasters (e.g., earthquakes or hurricanes) is often place-specific. Different countries have different severities of natural disasters. This can also be caused by a higher density of population (e.g., India) or a well-built and complicated infrastructure (e.g., United States, Japan). Countries most affected by the occurrence of all types of natural disasters are Japan, the United States, Mexico and the Philippines that are fighting with the high occurrence of all types of disasters, followed by China, India, Indonesia and Italy.

Source: <http://www.emdat.be/world-maps>

Figure 1.5 The total number of disasters occurrence (map no. 1) and the total number of deaths and people affected (map no. 2) by natural disasters between 1974 and 2003

Figure 1.5 provides a comparison of the total number of disasters occurring (countries shown in light colour represent 0 to 30 natural disasters occurrence, countries shown in grey represent the interval from 31 to 120 natural disasters, and countries shown in black represent 121 to 506 natural disasters) and the total number of deaths and people affected by natural disasters (countries in light colour from 0 to 1 million, countries in grey colour from 1 million to 5 million, and countries in black from 5 million) between 1974 and 2003.²

Figure 1.5 evidences that several countries, despite the enormous occurrence of natural disasters, are able to deal better with catastrophes and to develop more preventive measures for the protection of their inhabitants. Countries in the group with the highest occurrence of natural disasters that belong to the group of countries with the lowest number of people affected or the lowest death tolls are the United States, Mexico, Japan and Indonesia. In contrast, there are several other countries, especially in the African continent, that despite the lower occurrence of natural disasters belong to the most affected countries in the world. The worst situation is in the Islamic Republic of Mauritania with an occurrence of less than 31 natural disasters, while the total number of deaths or people affected by natural disasters within the investigated period is more than 5 million. With the current population of 3.6 million people this number is more than alarming.

The world evidence of natural disasters brings us to the question, why and how some countries and cities are able to cope with natural disasters, to protect inhabitants and to rise from the ashes like a phoenix relatively fast and to return in an even more favourable position than before?

² Occurrences of disasters are in total numbers, not standardized for the size of the country.

According to the World Disaster Report (2010), the reason for this is found in the solid built environment and urban management:

in a well-governed city, much of the disaster risk in terms of death and serious injury is enormously reduced by good-quality buildings and infrastructure. If these interventions do not prevent disasters, they can dramatically cut the death and injury tolls and should limit the economic impacts. This applies not just in cases of extreme weather or earthquakes but also for industrial accidents and fires. (p. 140)

To support the evidence of this statement, we will use here the example of Japan and its cities. Japan with more than 120 million inhabitants is one of the most densely populated countries in the world. The census in 2010 shows that more than 90 per cent of the Japanese population lives in cities (Ministry of Internal Affairs and Communications Statistics Bureau 2015). Table 1.1 shows the occurrence of all types of natural disaster in

Table 1.1 Occurrence of natural disasters and its consequences in Japan from 1900 to 2016

Disaster type	Disaster sub-type	Events count	Total deaths	Total affected	Total damage (thousands of US\$)
Earthquake	Ground movement	47	161 835	963 619	146 841 400
Earthquake	Tsunami	14	32 576	436 947	212 821 000
Epidemic	Viral disease	1	0	2 000 000	0
Epidemic	Bacterial disease	2	1	534	0
Extreme temperature	Heat wave	7	675	122 487	0
Extreme temperature	Cold wave	1	6	0	0
Flood	Flash flood	1	21	25 807	1 950 000
Flood	–	56	14 685	7 210 152	721 800
Flood	Coastal flood	2	34	384 143	7 440 000
Flood	Riverine flood	15	253	196 080	4 614 000
Landslide	Landslide	21	1 071	25 773	248 000
Landslide	Avalanche	1	13	0	0
Storm	Convective storm	17	280	118 517	6 670 200
Storm	Tropical cyclone	128	32 673	7 713 297	56 356 100
Volcanic activity	Ash fall	15	515	99 979	132 000
Wildfire	Forest fire	1	0	222	0
Total		329	244 638	19 297 557	437 794 500

Source: http://www.emdat.be/country_profile/index.html

Japan from 1900 to 2016 including total deaths, total people affected and total economic damage.

Table 1.1 shows that in Japan from 1900 to 2016 a total of 329 different types of natural disasters occurred, with a total death toll of 244,638 people. Although this number is high, in comparison with the total number of almost 20 million people affected, as noticed by Davis and Weinstein (2002), evidence from Japan has shown that temporary shocks, even of a frightening magnitude, appear to have little long-run impact on the spatial structure of the economy. In addition, empirical results from Japan strongly confirm that there is a great deal of persistence across time, especially in the densely settled regions.

The data in the table show that natural disasters caused gigantic economic damage over time. It is noteworthy however, that despite all the destructive consequences of natural disasters in Japan, the country is still one of the most competitive countries in the world and obtained the 6th highest ranking according to the Global Competitiveness Index in 2015–16. Similarly, Japanese cities are among the most beautiful and flourishing ones in the world, with the highest standards of living, even though several of them are located in an area with a high seismic activity.

1.5 THE URBAN DIMENSION OF DISASTERS

As shown in the previous sections of the chapter, disaster occurrence impacts all parts of our world, and all countries in the world have experienced some kind of natural disasters. When we look at the spatial dimension of natural disasters, cities and urban areas concentrate higher disaster risk than rural areas due to the density of people, infrastructure and assets. Clearly, uncontrolled urban explosion and inefficient urban management may affect the level of disaster impact on urban development.

Extremely stressful experiences regarding natural disasters are mainly associated with significant physical damage and human suffering. In the short run, there is obviously an expectation of a significant negative impact of natural disasters on economic growth and activity in the area concerned. However, as mentioned by Cole et al. (2016), the results of the existing empirical studies on such areas are mixed among authors finding negative, positive or no effect at all of a natural disaster on economic growth. The absence of a consensus on the average effects of natural disasters is illustrated by the results of two recent studies by Cuaresma et al. (2008) and Cavallo and Noy (2010) who argue that on average natural disasters have a positive and negative impact, respectively. Negative effects of disasters are undisputable and are often very devastating in terms of

death tolls, economic damage and total number of people affected by disasters.

The UN reports a steady increase of disasters across the globe (UNISDR 2004). If comparing disasters in developed and developing countries, it becomes evident that the effects of disaster are not uniform. Developing countries affected by natural disasters have usually experienced the highest numbers of people both affected and killed. Mileti et al. (1995) and Aleskerov et al. (2005) perceived this as a consequence of unsustainable development, lack of land use planning, and absence of interest and resources to solve issues concerning disaster preparedness. Developing countries mostly deal with disasters after they are hit. Disaster prevention is often weakly developed. Loayza et al. (2009) support this argument and conclude that developing countries are more sensitive to natural disasters. Expectedly, negative effects of natural disasters have been researched and highlighted in many books, articles and reports. Despite the considerable economic damage caused by natural disasters, only little research has been undertaken on the long-range effect of such disasters on economic activity. Several studies are dealing with short-term impacts of natural disasters (Cole et al. 2016). Noy (2009) finds a significant short-run effect of natural disasters, concentrated in developing countries only, but almost no long-term impact. In growth models with increasing returns to technology in production, theory says any destruction of capital can lead to a longer-term negative impact. Likewise, the destruction of infrastructure lowers returns to all factors of production (Cole et al. 2016). A similar result is provided by Rasmussen (2004) who finds that natural disasters lead to a reduction in same-year growth of more than 2 per cent and an increase in the current account deficit and public debt, while Fisker (2012) finds that an earthquake does have a negative impact on five-year growth at the local level. In this context, Ahlerup (2013) argues that if the only negative effects are found for disasters, then the intuitive assumption of a negative impact lacks robustness. Cole et al. (2016, p. 5) conclude then that the

type of disaster has an important influence on the magnitude and sign of the growth effect. The main negative impact tends to come from damage to essential intermediates such as the effect of drought on agriculture. The positive impact is more prevalent in those cases where there is a physical damage to buildings and infrastructure and the reconstruction leads to positive returns.

In this context, Davis and Weinstein (2002, p. 1271) argue:

the pure random growth theory predicts that growth follows a random walk – all shocks have permanent effects. By contrast, the locational fundamentals story holds that so long as the shock is purely temporary, even strong shocks should

shortly be reversed, as the advantages of the particular locations reassert themselves in relatively rapid growth rates on the path to recovery.

Beside many negative effects of natural disasters, there are several reasons why we might expect natural disasters to have a positive economic impact on the short-run or long-run growth path. Several empirical studies deal with short-run positive effects of natural disasters on economic growth. The most visible one is an endogenous reaction of an affected country or city (or an international organization) to the disaster in the form of a fiscal stimulus (multiplier effect) and related foreign (financial and non-financial) aid stimulating the locally affected area (Albala-Bertrand 1993; Cole et al. 2016). Generally, we can say the gross domestic product (GDP) is increasing in periods immediately following a natural disaster (Dacy and Kunreuther 1969; Albala-Bertrand 1993; Otero and Marti 1995). This is often caused by the increased direct production and activities connected with repairing of infrastructure or its overall rebuilding or revitalization of cities, very often in a more efficient form. The same effect can be observed on employment. Leiter et al. (2009) focused on the impact of selected natural disasters on employment in developed countries. He examined European firms that have been affected by floods and found that employment growth is higher in regions that experienced major floods.

A positive long-run effect of natural disasters on growth can be found in the work of Skidmore and Toya (2002) based on the Schumpeterian notion of creative destruction. Disaster risk may reduce tangible asset investments, but at the same time disasters provide an opportunity to update the capital stock through invention or adoption of new technologies. While adopting endogenous growth theory, disaster risk could potentially lead to higher rates of growth. Individuals and institutions invest in physical but also human capital which prompts and supports positive externality associated with human capital accumulation. If disasters reduce the expected return to tangible assets, then there is a correspondingly higher relative return to intangible assets, which may have a positive effect on growth.

While disasters are considered to be external shocks that may destroy urban development gains, disaster risk is internal to the development process of cities. The rapid and often unplanned expansion of cities is exposing a greater number of people and economic assets to the risk of disasters and related risks, such as the effects of climate change. For city governments, increased climate variability imposes additional challenges to effective urban management and the delivery of key services, while for residents it increasingly affects their lives and livelihoods due to a greater frequency of natural disasters. There is an urgent need for cities to consider the issues of disaster and climate change by streamlining assessments of

related risks in their planning and management processes and delivery of services (Dickson et al. 2012).

A disaster response can result in the development of more effective infrastructure and increased productive effort in affected – but also in unaffected – areas of a country. Likewise, when more capital is destroyed than labour, the return to capital increases resulting in short-term growth, while local workers may also be incentivized to work harder so as to compensate for inter-temporal losses (Melecky and Raddatz 2011). According to the World Disaster Report (2010),

the quality and capacity of local government in a city have an enormous influence on the level of risk that its population faces from disasters and, in particular, on whether risk-reducing infrastructure serves everyone including those living in low-income areas. Local or municipal governments also influence whether provision has been made to remove or reduce disaster risk from events such as floods and large-scale fires or to build into the city the capacity to withstand potential disaster events such as earthquakes. The quality and capacity of local government also have an enormous influence on the levels of risk from everyday hazards that can contribute much to mortality, injury or illness but that are not considered disasters, such as vector-borne diseases and traffic accidents. These risks are not an inherent characteristic of cities but the result of the limitations of their governments in meeting their responsibilities and, more broadly, of limitations of governance including the quality of their relations with the inhabitants and civil society organizations. (p. 139)

According to the World Bank (Guigale 2017), one source of disaster risk management usually remains under-exploited: insurance. Data from Geo Risks Research for 2006 indicate that very few developing countries have appropriate property insurance in comparison to developed countries (Wirtz 2008). The seriousness of the post-disaster capital gap and the emergence of novel insurance instruments for pricing and transferring catastrophe risks to global financial markets have motivated many developing country governments, as well as development institutions, NGOs and other donor organizations, to consider pre-disaster financial instruments as a component of disaster risk management (Linnerooth-Bayer et al. 2005). Insurance instruments are only one of many options in managing risks of natural hazards (Linnerooth-Bayer et al. 2007), but they can significantly influence the path of recovery.

Ahlerup (2013), who pays attention to controlling carefully the endogenous nature of natural disaster losses and controlling for unobserved heterogeneity, finds a clearly positive effect on the subsequent economic performance in the short, medium and long term.

Urban agglomerations have an expensive and vulnerable infrastructure and a massive concentration of humans, businesses, houses and offices.

Figure 1.6 Urban resilience trajectory after an external shock

Consequently, any disaster will have a dramatic effect on the socioeconomic position of an agglomeration, if affected by an external shock. The long-run consequences are likely also determined by local cultural attitudes and effective policy responses. But it is also important to realize that the contribution of a modern and up-to-date urban infrastructure – in combination with external economies of density, proximity and connectivity – may reinforce the long-range socioeconomic progress potential of a city. We may therefore, hypothesize that the urban resilience trajectory – after an external shock – may have the following shape outlined in Figure 1.6, which is influenced by various moderator variables, viz.: (i) current level of high welfare and appropriate public facilities; (ii) inert local cultural attitudes on urban management; (iii) ineffective or delayed policy response after a shock.

Testing the validity of the constituents of the urban resilience curve would need extensive panel data – on a cross-comparative base – over a long time period. This may be difficult to achieve, although in several cases basic data (such as population numbers, migrants, infrastructure, public expenditure, employment, houses, buildings and so on) may exist, which might be suitable for a solid validation of our propositions. If not, we have to resort to case study research, which may be insightful regarding the drivers and effects of urban catastrophic events, but often offer only anecdotal evidence.

Cities can plan and respond better if the location and nature of risk is known and clearly mapped out, and also if risk assessment and management is mainstreamed in urban development and management programmes. Therefore, the database like that for UDIA mentioned above should contain at least the following information ingredients:

- institutional assessment
- hazard impact assessment
- social assessment.

According to the methodology of the World Bank (Dickson et al. 2012, pp.24–61), the assessment should be based upon three principal assessment pillars (institutional, hazard impact and socioeconomic), each of them associated with three levels of complexity (primary, secondary and tertiary). This framework is built around a central pillar for assessing the impact of hazards, aimed at identifying the type, intensity and locations of potential changes and losses resulting from future hazards and climate change scenarios. Given that risk is a function of hazards, the relative vulnerability of people and economic assets, and the capacity to respond, an operational urban risk assessment should take into account the role of institutions and the socioeconomic conditions of city residents in order to understand and enhance the competence of agencies that are responsible for managing the risks arising from disasters and climate change, and identify the most vulnerable populations likely to be adversely affected, as well as understanding their adaptive capacity. We briefly summarize here the most important lessons.

1.5.1 Institutional Assessment

The bases for institutional assessment are: legal foundations, national and regional frameworks. At the primary level, institutional assessment is oriented towards an institutional mapping of disaster risks and climate change. The first step in institutional assessment is the identification of institutions and organizations explicitly responsible for addressing climate change and natural hazards, and those that have a more indirect impact. It is followed by undertaking an institutional mapping exercise that includes government agencies within the city and a description of their specific competences before, during and after disasters. At the secondary level, interventional analysis is realized with the aim to identify key resources, policies, tools, programmes and coordination tools and approaches. It creates an inventory of relevant planning instruments, including existing policies, programmes, plans and projects. The secondary and tertiary

levels overlap with intervention gap analysis. This identifies shortcomings in current city management tools and policy programmes, and provides preliminary recommendations to mainstream risk reduction including adaptive capacity assessment and identification of possible fiscal transfers for risk financing.

1.5.2 Hazard Impact Assessment

The main pillar of urban disaster impact assessment is oriented towards understanding hazard trends, identifying relevant populations and tangible assets at risk of hazards and climate change in a city, and quantifying potential impacts of future hazards. The primary level assessment is focused on geospatial analysis of historical incidence through secondary data collection and stakeholder consultations to develop simple maps of hazard impacts showing where hazards have historically affected a city. At a secondary level, hazard mapping, exposure mapping and vulnerability studies are the basis for development of more detailed risk maps. Risk modelling for natural hazards and climate changes, scenarios of economic and social loss are defined based on impact modelling. The tertiary level involves modelling probabilistic risk through using different hazard scenarios to approximate economic loss for exposed tangible assets. Modern approaches and tools are used through the design of concrete and specific probabilistic risk assessment tools. Well-developed planning tools can enhance the capacity of city managers or project developers to understand and integrate climate change into future planning. The most effective risk planning tools encourage users to focus on the conditions, assumptions and uncertainties underlying the results of climate models to enable them to estimate the robustness of the information, make an informed assessment of current and future risks, and evaluate the appropriateness of response options.

1.5.3 Social Assessment

Social assessment is mainly based on demographic information that is very important for efficient and robust risk assessment. Socioeconomic assessment focuses on identification of demographic, housing, welfare, human development and investment variables. It develops a comparative ranking of specific areas based on simple qualitative codification. The primary level of social assessment is based on a socioeconomic analysis of city residents. Understanding urban risk at this level can contribute to reducing vulnerability at the level of citizens or households. The secondary level of social assessment is focused on the identification of vulnerable areas and community profiles and slum mapping, while the tertiary level of

social assessment focuses on household hazards and vulnerability surveys. Socioeconomic assessment incorporates community-based approaches. Combination of bottom-up and top-down approaches creates more robust tools for urban risk assessment but also for disaster response. Community participation can empower local residents, build social capital and establish a common foundation for neighbourhood level risk assessments. Participatory approaches enable communities to have greater control over information and interventions, thereby enhancing their resilience.

One of the most important responses after disaster is to support people affected to meet, network and often share their grief and, in their own time, begin to participate in creating solutions. This means involving local people from the start in any discussion of rebuilding and in managing the shift from relief to reconstruction. Well organized, representative, community organizations are also valuable allies for agencies supporting reconstructions as they can provide much of the information base for rebuilding, contribute to the rebuilding and supervise local builders and contractors. (World Disaster Report 2010, p. 55)

In developed countries, there is a strong effort of citizens, different organizations (NGOs, community centres, alliances and so on), but also local municipalities and authorities to empower community life in urban areas. Thus, community participation has a positive impact due to elimination of the consequences of natural disasters as well as prevention and assessment of natural hazards.

The same positive effect can be observed in developing countries. As an example we mention here the work of Shelter Associates (SA) from Pune in India using very high resolution images for slum surveys and poverty mapping at the city level. Their work in close collaboration with residents of slum communities helped them to achieve information about households, their dwellings and the overall site characteristics. Slum settlements were mapped by professional agencies using plane table methods to produce large-scale slum maps showing plot and building boundaries, while residents engaged in household surveys, gaining knowledge and skills on data collection and a better understanding of their community's problems, their opportunities and the planning process. The spatial and socioeconomic data are entered into a geographic information system (GIS) database and analysed for direct use by the communities to prepare upgrading plans and to negotiate with local government authorities on policy and developmental issues. The process therefore contributes to community empowerment by enabling them to be full partners in settlement upgrading and in the subsequent management of their community. As a result of these community-based approaches, many slums have been mapped, while plans for their improvement have been produced (UN-HABITAT

2008). All these data and surveys are at the same time usable for urban risk assessment and disaster response. Engaging urban poor in a direct dialogue regarding risk and vulnerability and having them involved in risk mapping have led to favourable experiences. This is in addition to creating critical spatial data about low-income urban areas that would assist in more inclusive city planning and analysing urban risk. It is important that city governments recognize the value of raising public awareness of climate change and the need for disaster mitigation. Engagement of community groups and NGOs provides necessary inputs to urban risk assessment and has significant importance not only for the data and maps used for risk assessment, but also for the support provided in identifying and acting on risk and vulnerability (Dickson et al. 2012).

There is a clear need for a systematic urban disaster/resilience impact assessment, in which the most crucial aspects of decline and recovery are mapped out in a relevant time frame. Figure 1.7 presents a cascade model from urban downturn back to urban upturn. It comprises a suitable and focused combination of various urban community assessment tools:

- a well-working urban risk assessment mechanism
- well-prepared disaster response tools and policies

Figure 1.7 A cascade presentation of the urban 'phoenix' mechanism

- a deliberate attitude of competent urban authorities
- a smart engagement of local communities.

It should be noted that testing this cascade model requires panel data on several relevant variables over a long time period, from the first shock to final recovery and beyond.

1.6 CHALLENGES IN URBAN RISK ASSESSMENT AND DISASTER RESPONSE

Urban resilience after an external shock is influenced by many factors, including geographic location, the social and economic situation, level of infrastructure, density of population, culture habits, environmental conditions and many others. Although there may be different levels of suffering from and impacts by the natural disasters in different countries and parts of the world, it is clear that the issue is global. The solution of this issue, including decreasing the risk of natural disasters and their impact on urban areas, takes place at national, mostly regional, or even local scales. So far, there is no generally valid mechanism for disaster and hazard assessment as well as no well-functioning tool or system for revitalization and restoration of urban areas. On the other hand, there is an infinite creativity, smartness and ingenuity of humans that bring much hope regarding disaster prevention and abatement.

Urban risk assessment and appropriate disaster response are real challenges of the world today. One of the biggest challenges is to enhance the quality of urban risk assessment and to mitigate the impact of natural disasters worldwide. Our overview shows that mitigation of disaster impact on cities in low- and middle-income countries and their disaster response urgently need improvement. In Figure 1.8 we present a comprehensive approach for risk assessment, identification and management leading to a desirable urban resilience pattern based on methodology for the risk assessment produced by the World Bank (see Dickson et al. 2012), the adaptive capacity index approach (for more information see Pelling and Zaidi 2013; Zaidi and Pelling 2015) and the risk management methodology based on the adaptive capacity approach (for more information see Paterson et al. 2017).

Urban risk assessment is mainly based on accessible and operational data to be used by competent authorities. Furthermore, the collection of needed data, their integrity and the capacity of exploitation and interpretation of data in different formats seem to be problematic in many cities. The collection of information relevant to urban planning and management

Source: Own processing based on Dickson et al. (2012), Paterson et al. (2017), Pelling and Zaidi (2013) and Zaidi and Pelling (2015).

Figure 1.8 Urban resilience based on urban risk assessment, identification and management

is one of the core tasks of the urban public sector. This involves producing credible information on hazard risk and making it easily available to all stakeholders (Deichmann et al. 2011). Better data leads to better tools and analytics and thus to better decisions (World Bank 2012).

The crucial issues for urban risk assessment are shown in Figure 1.8.

Specialized technical skills are a first challenge. Although existing technical capacity can be used for undertaking a primary level of urban risk assessment (with adequate training), specialized technical skills are required for elements of higher level risk assessments such as flood or seismic risk assessment. A proper financial allocation for risk assessments is needed. While the primary level of urban risk assessment would require modest financial resources, the associated costs of the tertiary level may exceed a city's budget for developing urban management tools. Specific resources will have to be generated to initiate and sustain efforts towards risk assessment and risk reduction. Data collection and interpretation are also necessary. Collecting reliable, accurate and timely data remains a daunting task in many cities. Even if the data are available, problems

may arise due to different organizations or agencies using different data formats. The extent to which assessment methodologies represent the actual situation needs attention. Community consultation-based assessment (primary level risk assessment) is important, but while more cost-effective may not be accurate enough to plan for structural reduction of disaster risk. Available risk modelling and climate change projections also have large uncertainties associated with them. Gaining and maintaining political support is another task. It may be difficult to gain necessary political support to initiate and mainstream urban risk assessment. Priorities may change with a change of leadership, leaders may focus more on other pressing issues or there may be vested interests in delaying dissemination of the results of a risk assessment to a city's population (Dickson et al. 2012, p. 34).

Risk management needs adaptive governance which might be understood as an ability to reflect on practical outcomes, flexibility in organizational structures and management and support for practical experiments. Risk management needs to reflect local knowledge (Aitsi-Selmi et al. 2016) and requires relevant knowledge and training in terms of risk reduction training, identification of barriers to adaptation and incremental improvement mechanisms. Consequently, risk reduction should be based on risk consideration and land use planning, policy and financial support for alleviating risk, public education on risk reductions and ability to access and influence risk knowledge (Pelling and Zaidi 2013; Zaidi and Pelling 2015; Paterson et al. 2017). Involvement of communities and all relevant stakeholders is a crucial issue in urban risk assessment. Communities and relevant stakeholders may fill the gap in data gathering. They should be involved through the preparation of plans for urban risk assessment and reduction as well as in scenario building. Communities also play a very important role in terms of disaster response.

Appropriate and smart disaster response mechanisms – and not disasters themselves – may be a blessing in disguise and may result in long-term urban resilience. A suitable and focused combination of well-working urban risk assessment mechanisms, well-prepared disaster response tools and policies, a deliberate proactive attitude of competent urban authorities, and a smart engagement of local communities may lead to a rebirth of cities and urban areas from the dust of disasters – like the phoenix – in a new and brighter shape. The comprehensive approach to risk assessment, identification and management proposed in the chapter serves to depict a desirable urban resilience pattern after an external shock.

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