3. Cities and Disaster Risk Reduction

Cities have distinctive physical, environmental and socio-cultural features that may increase hazards, exposure and vulnerability and ultimately disaster occurrence. This section introduces cities as places of complexity, as connectors of multiple domains and scales, as places with particular identities and specialisations. We feel it is important to raise awareness of how urban traits related to the urban fabric, the multiple links at different spatial and temporal scales affect Disaster Risk Reduction, partly drawing on our own EDUCEN experiences. The section is organised as follows. The first subsection presents the main features that make cities so complex, requiring analysts and decision makers to adopt a systemic approach in order to comprehend and manage such complexity. The second subsection describes the key role played by lifelines as critical infrastructures guaranteeing cities' life and functioning. In the last section the implication of cities' and critical infrastructures' complexity for disaster risk management are wrapped up, providing synthetic guidelines for mitigating and reducing risks across the so called disaster cycle.

3.1. Cities: places of complexity

Author: Funda Atun and Scira Menoni

Cities are complex three-dimensional spaces in which social, political and economic organisations interact in different ways and at multiple levels with buildings, infrastructures, production and service facilities, open areas. These interactions reflect the cultural features and the degree of technological development of cities and their inhabitants.

Cities share with complex systems virtually all features that characterize them as such. First, given the nonlinear interrelationships between systems and components, it is impossible to predetermine how the latter will interact in the future or under changed conditions. Second, planning and locational decisions are strongly "path-dependent", particularly those regarding the establishment of new urban functions in a previously not urbanized area. Third, it is extremely difficult to forecast cities' response to external forcing such as that imposed by natural hazards or man made severe accidents. Other important aspects that need to be considered are: the fast evolution of the "urban", particularly in the more recent decades, implying differential development dynamics and multilayered governance, resulting from a deeply transformed geography. In fact, in the new urban landscape fringes tend to blur into rural areas making it very hard to define a clear cut border between what is "city" and what is not. Additional complexity derives from a simple quantitative datum: more than 54% of the world population lives today in cities, 75% in Europe, reversing any prior historic trend and requiring therefore highly skilled managers to keep cities function and able to respond to multiple stresses including natural disasters and man made incidents.

The implications for nowadays risk governance are well depicted in Figure 3.1.2. showing how cities being at the crossroads of different systems are in the meantime physical objects and assets (the urban fabric and the natural systems) and nonmaterial, included in the economic and social systems. The image suggests that environmental sustainability in cities can be achieved only coupling and integrating economic, social development with measures aimed at preserving the natural capital. In general terms it can be held that cities where the link between natural and man-made environments has been addressed in a sustainable manner are also less exposed and vulnerable to natural hazards. On the contrary, cities where such link has been neglected

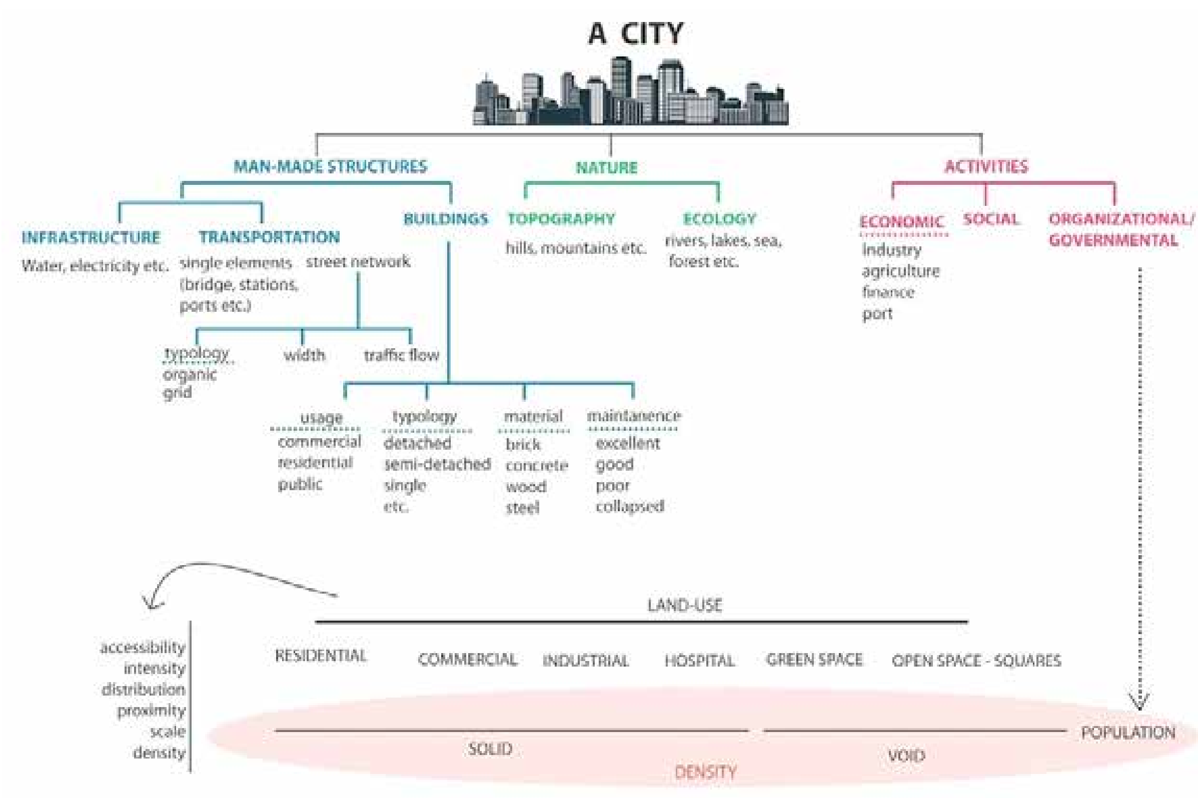


Figure 3.1.1. Cities at the cross-connection between the built and the natural environments, the social and economic systems

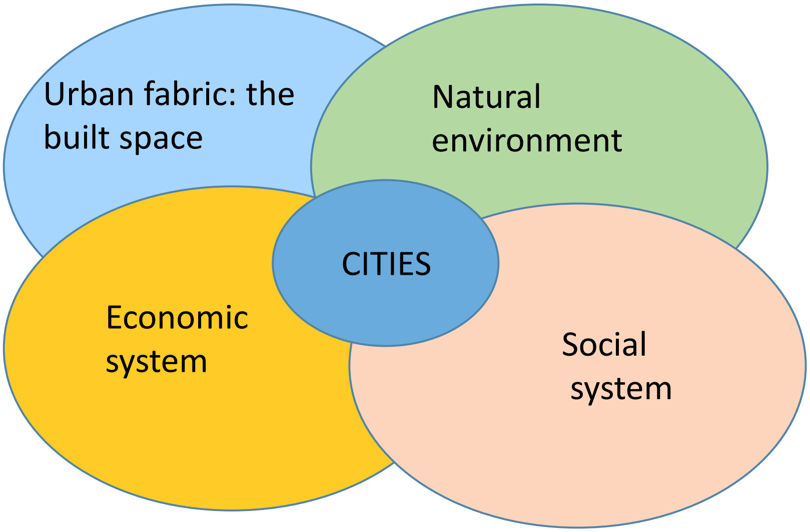


Figure. 3.1.2. Cities at the crossroads of the built environment, social, economic and natural systems

display unsustainable patterns of development that make them also more prone to damage and disruption when stressed by natural extremes.

Contemporary cities need to be comprehended as nodes acting at multiple scales in space and time.

3.1.1. Cities at the crucible of multiple historic and present dynamics

In the past cities used to take decades to build new areas, to transform a city centre, to introduce new infrastructures. Today cities may face much more rapid changes in terms of the pace of construction, creation of new networks and shift from one developmental model, such as industrial, to another, more service oriented. This is the consequence of the many forces that drive change, from increased mobility to, more recently, digital and communication technologies.

Nevertheless, city vulnerability is not only the result of recent changes, even when they occur very rapidly; but also of past decisions, of trends that started long ago. Vulnerabilities in a city have accumulated over the course of time. If this is true for the past, it will be even more so in the future. Future vulnerabilities will be the result of today's decisions mixed with changes in the natural, social, political and economic environments.

Different temporal dynamics unfold in cities: some are the result of long duration processes that accumulate over decades and centuries. They are the result of micro level decisions or lack of decisions, of actions that are prescribed in cities regulations or embedded in the non material culture of inhabitants. For example, how people use places and buildings that depend on their culture may be or become incompatible with the original layout of buildings requiring changes in internal configuration of spaces leading to unpredictable yet dramatic outcomes in case of extreme events forcing. The opening of large shop windows at the first level of buildings, or the elimination of structural components to create parking spaces or laboratories may change the original performance of buildings against horizontal accelerations; the use of basement as residential units or offices clearly puts at risk the life of people and valuable goods in flood prone areas. City managers need to be aware of the fact that not only hard components of cities determine structural features, but also the soft way spaces and artefacts are exploited and change to conform them better to new uses.

Other dynamics reflect abrupt changes, due to the interruption of ordinary life, after a war, a disaster, a dramatic change such as the one that occurred with the industrial revolution, when old schemes were

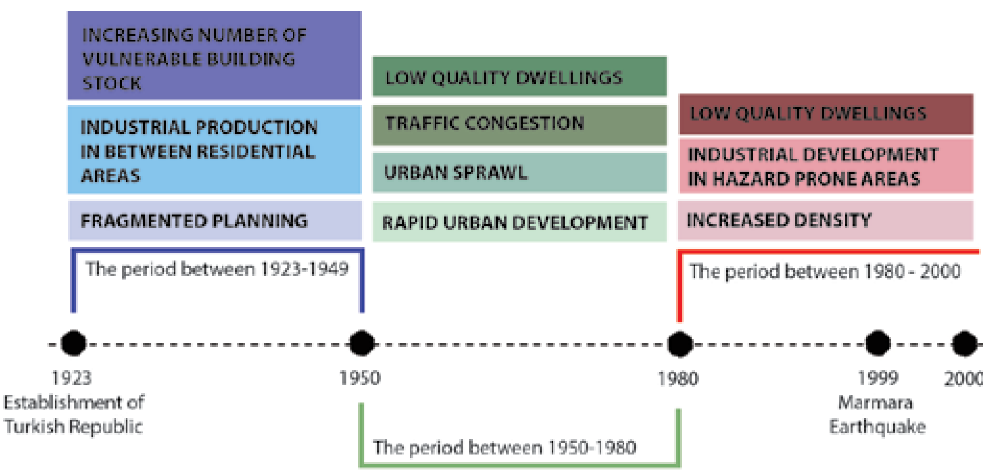


Figure 3.1.3. Vulnerability patterns produced by rapid urbanization: the case of Istanbul. The effect of the rapid urbanization process in Istanbul is provided as an example. After the 80s, newly built large industrial facilities in hazard prone areas, population and buildings density gave tremendously

wiped off, destroying centennial walls to allocate more space for factories and urbanized peasants. Such deliberate changes include modifications in the city layout, patterns, with the introduction of new infrastructures, large palaces, new economic attractive centres.

Whilst the recognition of past dynamics is important to reconstruct the decisions and events that have led to the current situation in terms of vulnerability and resilience, planners and city managers encounter difficulties in imagining future scenarios. Planners are not trained to foresee how the environment they are used to and in which they have prepared to be operational in case of disaster may change suddenly and abruptly. They are not used to recognize in an apparently stable landscape and in the natural features that are part of it the potential for abrupt changes in the future. Also disaster managers must be aware when preparing for an emergency that references that they have placed on their maps may be destroyed and disappear after an extreme events hits a city.

3.1.2. The relevance of spatial scales to cities

Local, regional, national and global levels are interconnected, though in different ways for metropolitan and central areas on the one hand, for small-medium towns and marginal and non-central areas on the other. Actually the situation is much more diversified and complex than the dichotomy between central and peripheral may hint at: cities may be central in a global perspective, but they can also be central to a nation or to a region, given the services and the type of functions they offer to other cities gravitating on them. Cities that are at the margin of global networks can be still central to a region. The different scales are in tension with each other, and this tension owes a lot to the type of existing networks (both physical and nonphysical, hard and soft).

Understanding those complex interrelationships and interlinkages is key to detect the ripple effects a disastrous event may have on social and economic systems. A disaster nowadays is seldom only local: immigrants from South East Asia have become a supportive communities for the countries hit by the tsunami in 2004; the 2011 earthquake affected some economic sectors in the USA depending on specific products that were produced in Japan. The fact that distances count differently in a globalized world means that regions and cities are closer or farther depending on their position and centrality in the various transport routes. This has implications also for the way in which aid and support can be provided once a disaster has hit in a region. Often aid arrives quicker to the airport of a capital city or to the regional central district than it takes from there to be moved to the areas that have been most affected, if the latter are located in detached, sparse and remote locations.

Scales that are relevant for cities may therefore vary from closely local to global, depending on the relative position of such cities, on their role as a service provider and as an economic actor in regional, national and international contexts. This does not necessarily imply that only core central cities must be protected, but rather that differential risk mitigation policies are needed to acknowledge for the diversity and the degree of relevance of cities within and across spatial scales.

Cities' specialization as they position themselves at different spatial scales

Cities' culture, resulting from past trends and present choices, shape the way in which cities position themselves locally and globally, also through designed strategies.

Cities were initially mainly a market place or a political centre, but have become in the modern times a place of production, offering services ranging from basic to high level, such as educational and driving technological and economic innovation. In today's context, some cities have become very specialized, such as trade cities, port cities, finance cities, political and administrative nodes, religious destinations, etc. Every type of specialization entails a different city culture, with important consequences as to how cities interact with each other and in the way they interact with "nature".

Specialization entails prevalence of certain types of patterns, both in the two and three dimensional spaces, reliance on predominant types of infrastructures and services.

The city's specialization should orient decisions on what to protect most and first, on what are viable means of protection, on how they can be implemented without constraining the activities and operations that are mostly needed for the specialized city.

Damage due to business and services interruption may be suffered miles away from the epicenter of the disaster; the network of cities to which the affected area pertains may feel the repercussions of the event in terms of unavailability of goods, lost customers (at least for

Figure. 3.1.4. Volos
The major economic function of a city shapes its structural pattern and physical artefacts. Considering the ex-industrial role of Volos in Greece helps us to understand the huge fabric blocks in the city and the city's functional grid pattern.

some time), lost gateways for their products. Strategic choices will have to be made in order to restart those activities that are crucial for the city's position in the network they pertain to, guaranteeing that it will not loose its role. However the issue must be looked at also at other scales, as what one city can loose may be gained by another, that is already well positioned before the impact of the event. How to account for those shifts is a matter that needs to be considered by national governments. Methods and tools to measure indirect impacts are still in their infancy and there is still much to be unveiled and explained in order to make pertinent analyses at different scales.

Modern cities' culture orient choices towards specializations that can be permanent overtime or confirm the capacity to host for a certain period important events, exhibitions, games. In this respect, mega-events such as Olympic games, Expo exhibitions, universal fairs have become the object of both policies aiming at competing at the global level and of controversies depicting such events as disruptive of citizens' everyday life and well-being. The capacity to host such events, though, is important nowadays as it may boost local economy and generate new networks and exchanges (De Steffani, 2011).

Mega-events, cities and organizational cultures

Mega-events are marketing tools for cities to make them globally significant and attract national and international interest from all over the world. Mega-events are also engines for the structural development of cities, as economic resources gained by mega-events are used to activate urban development. If the mega-events are handled well politically, organizationally and structurally, they provide great advantages to meet social, structural and economic challenges.

Mega-events include the notion of culture in terms of two perspectives; organizational culture and culture in hard infrastructure. The former is about the cooperation of several national and international organizations to achieve a successful mega-event. The latter is about improving the structural condition of a city, as to obtain a mega-event, a well-maintained infrastructure system is a must.

Having good quality infrastructure is not sufficient for being a part of this worldwide competition and hosting a mega-event. Hosting a mega-event brings a major challenge to meet resilience targets, meaning, the increased exposure of the population, including both inhabitants of the city and tourists/visitors coming to the event. Guaranteeing the safety and security of such events has become a critical point, especially after September 11, but also prior to it. That tremendous increase of exposed population from different cultures does not necessarily add new risks, but concentrates the current risks in the city in one place. Therefore, disaster risk reduction (DRR) that considers these cultural diversities must be a part of the investment to increase the resilience of the infrastructure systems, leveraging efforts on the three layers existing in the territory: spatial, organizational (public institutions or private, depending on the owner of the infrastructure system) and social (the users of the system).

3.1.3. Urban patterns result from and shape the relationship among systems and systems' components

Cities' complex interdependences between elements and systems occur in the three dimensional space. An urban pattern is the combination of buildings' density, the prevailing typology of the road network, i.e. ring, grid or linear, and the width of the streets in comparison with the height of the buildings and, finally, the features of the natural envi-

Figure 3.1.5. The street pattern in Lorca
Lorca contains both organic and linear patterns in its street morphology. The city was organized on a human scale, and highly walkable. It provides a low speed of travel within the narrow streets and a high speed of travel in the recently built linear pattern.

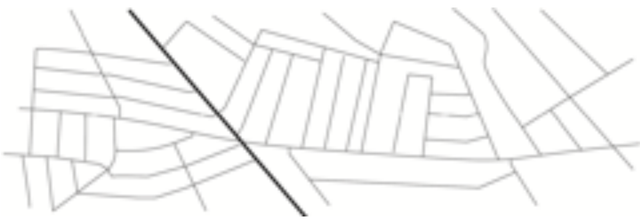


Figure 3.1.6. The street pattern in Istanbul
The pattern is taken from a residential section of Istanbul. The area includes a mono-functional housing development that does not provide functional feasibility. However, the distribution of the streets provides accessibility.

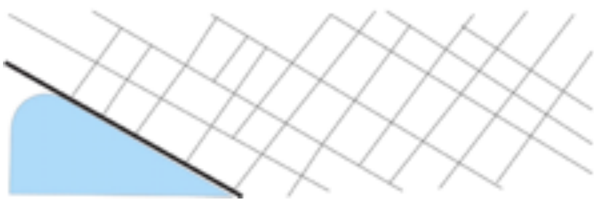


Figure 3.1.7. The street pattern in Volos
Volos has a grid street pattern that provides a rapid connection between distant parts. Highly accessible. Urban blocks are mixed-use, combining residential, touristic and commercial activities.

ronment, that constraints and in the meantime provides opportunities for cities' development.

The type of urban pattern has decisive implications for emergency management, and in particular for all activities related to evacuation, positioning of roadblocks, selection of areas devoted to locate civil protection and rescuers trucks and devices. A regular grid, such as that characterizing the original roman-style settlement can be easily found in colonial cities, in modern expansion areas such as in Volos in Greece and sometimes also in ancient towns such as Tourin in Italy provides redundancy in access ways to almost all point shaped element in cities and fastest in and out travels. Furthermore, the regular grid permits to better define areas pertaining to predetermined emergency centres and to distribute rationally services such as hospitals, fire brigade stations, etc.

Circular, round grids are more complicated to manage: redundancy is still guaranteed but not to all locations, avoiding central nodes is virtually impossible, congestion is more likely in ordinary times and to be expected and therefore carefully managed in emergencies.

Linear cities are those that develop along the coast or important infrastructures such as roads and railways; they are characterized by the general absence of significant alternatives in case of transportation routes failures and by the fact they are easily cut in more parts disconnected from each other that will need to respond a crisis independently from each other. This was certainly the case in Kobe a rather emblematic example of linear city, hit by the earthquake in 1995.

Whilst cities generally present a predominant pattern, there may be also coexistent patterns, particularly in large metropolitan areas that result from the aggregation of pre-existing settlements once autonomous and of newly added development zones.

Different city patterns require city and disaster managers to adopt different strategies in deciding the location of critical infrastructures, in defining self reliant zones and in preparing themselves, other agencies and citizens for contingencies.

However consideration cannot be limited to the plan layout: buildings, transportation networks, services, work activities occur in three-dimensional space. The relation between the latter needs to be considered also vertically.

Figure 3.1.8. The streets of a historical town in Umbria Region versus a main street in Istanbul Metropolitan City (the photo credit: Emre Meltem).

The urban pattern in the third dimension has relevant implications also during emergencies, as it implies the easiness of carrying and using cranes if necessary, of maneuvering firemen tracks, etc. In modern times different interventions can be thought of, provided that such relationships are recognized, for example by adapting emergency cars and means to constrained environments.

3.2. Physical and social networks to guarantee cities' resilience

Authors: Alessandro Pagano and Raffaele Giordano

Disasters cause serious damage on structures and infrastructures, particularly in urban areas. All the lifelines ('hard infrastructures', e.g. water supply, transport, power supply, telecommunication) are impacted by extreme events, and their functionality is limited as a consequence of both physical damages and changes in the operating conditions. Lifelines are vulnerable elements, but also crucial assets to guarantee the safety and well-being of the impacted population.

Lifelines provide a very clear example of assets that work and function at multiple scales due to the internal hierarchy among individual components (typically plants and networks and networks of differential capacity), to the mutual interdependency among infrastructures (the power system is vital for all the others, to pump water and to guarantee communication survival), and to the interconnectedness between lifelines and any other urban function and asset. Such a high level of interdependency cannot be understood only locally, as lifelines are organized regionally, nationally and across borders (for example, large gas and oil pipes connect Africa to Europe and Eastern to Western Europe). In order to guarantee the resilience of hard infrastructures, policies have been set at the European level, however their success depends strongly on how local, regional, national service and networks providers are able to prevent, manage the damage due to natural disaster and to recover, and to what extent they are interacting with emergency managers.

A strong connection exists between the reliability of hard infrastructure and social networks. Community organizations and community-based networks play a key role in disaster preparedness and recovery. Local knowledge, understandings, perceptions, resources, and cooperative strategies are crucial to determine system survival and, particularly, to properly drive recovery conditions. the More specifically, infrastructural systems play a fundamental role in keeping alive the social networks within a community in case of disasters by continuing to provide key services. The process of recovery after extreme events, is also generally supported by the availability of critical services, which significantly contribute to increase the resilience of the whole community.

Thus, the role of hard infrastructures (e.g. water supply infrastructures) at urban level supports the efforts of local communities during the emergency phase, revealing as a key asset to cope with the disaster.

3.2.1. Resilience of hard and soft infrastructures

The concept of resilience tends to be strictly related to both static and dynamic components of disasters across pre and post event context. A static model of resilience identifies and organizes critical variables, whereas a dynamic model represents how and why such variables change across time and space. Resilient systems have a reduced probability of failure, lower consequences from failures and a reduced time for recovery. Referring specifically to urban environments, resilience is related to the capacity of cities to cope with and recover from external shocks. An urban system can be considered resilient if it is sustainable even during the hazard occurrence phase, the most critical period, in which the city suffers the impacts of an extreme event and tries to reconfigure both its physical and social aspects towards a new equilibrium.

The infrastructural system of a city has to be conceived as linked with social and institutional systems, but also with the economic and environmental ones that are all embedded within the urban context and dynamically interacting. Physical (hard) infrastructures involve amendments to the physical surroundings and landscape to serve a given purpose (e.g. transportation, power supply, water supply, management, and treatment). Social (soft) infrastructures refer to the networks and interactions among individuals, groups, and institutions within and outside the community. The link between them is crucial, since the resilience of a system is described by its level of functionality and assuming that it directly represents the level of satisfaction of citizen.

Enhancing resilience means improving the capacity of the whole system to anticipate threats, reduce vulnerability and allow a complete recovery from impacts. Several factors contribute to increase the resilience, which might not necessarily be related to the 'physical' characteristics of the system. They may depend on individual conditions (e.g. well-being and survival skills) and on community characteristics (community connectedness, community infrastructure, participation in disaster response and recovery, engagement in decision making). All these features are found to be highly influential before a disaster strikes, as well as in the event of a disaster and during recovery.

Several extreme events suggested that infrastructural systems play a fundamental role in keeping the social networks alive within a community in case of disaster by continuing to provide key services. The process of recovery after extreme events, is generally supported by the availability of critical services, which significantly contributes to increase the resilience of the whole community.

The Case Study of L'Aquila supported drawing a few key conclusions:

- Physical infrastructure provides vital support to communities during emergency and recovery phases after a disaster. The uninterrupted availability of critical services is a requirement to guarantee the safety and the well-being of a population when a disaster occurs and speeds up the recovery: in this direction, the technical performances of the whole infrastructural system are a key asset to deal effectively with emergencies and contribute to community resilience. On the other hand, the resilience of a community affects the level of service provided by the hard infrastructural system as well: the behaviors of the users (e.g. good practices, flexibility, …), their level of knowledge along with the skills of the authorities managing the emergency and driving decision-making – in a word, their culture - have a direct influence on the response of the hard infrastructural system.

- Infrastructural systems must directly match the needs of a community, and thus should firstly reflect the spatial distribution of the served population. Secondly, the performances of infrastructural systems should be flexible enough to evolve with time, in the aftermath of a disaster and in the recovery phase, since the needs of the whole system change according to the specific path of recovery determined by the specific strategies implemented.

3.2.2. Building back better, the case of l'Aquila

After a disaster strikes, a prompt return to the status quo is needed. Nevertheless, simply rebuilding cities to pre-disaster standards would recreate the vulnerabilities that existed earlier and expose them to future disasters. Reconstruction is generally an opportunity to build back better. It is the restoration and improvement of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

This "build back better" approach advocates for the restoration of communities and assets in a manner that makes them less vulnerable to disasters and strengthens their resilience. Disaster risk reduction measures should be included into post-disaster recovery and rehabilitation processes. Resilient recovery and reconstruction are widely recognized as imperative for sustainable development.

Recovery thus represents much more than a return to the pre-event state. Recovery actions can also promote both physical and economic resilience, and prompt or facilitate investment in infrastructure upgrades and urban revitalization. Resilient recovery and reconstruction can be realized through a variety of strategies: enhancing preparedness; relocating critical facilities to safer areas; integrating disaster risk reduction measures into infrastructure improvements; strengthening governance structures, including the development of institutional mandates for disaster risk management; using the reconstruction process to address urban planning challenges; and establishing predictable contingent financing mechanisms, including disaster risk financing.

The issue of 'Building back better' emerges after major disaster, like the L'Aquila earthquake in 2009. The Italian city of L'Aquila (and its province) was struck by a disastrous Magnitude 6.3 earthquake at 3.32 a.m. on 6 April 2009. As a consequence of the event, 308 people died and 1500 were injured Although the physical event was

Figure 3.2.1. Damaged lifelines in l'Aquila 2009

relatively moderate, its impacts were particularly high mainly due to the very high vulnerability of lives, livelihoods, building stock and institutions in the Apennine Mountains. The physical vulnerability level of its masonry buildings (poorly maintained and not strengthened), mainly located in the historical city center, led to enormous damages. Reinforced concrete structures were affected as well. Surprisingly, more casualties were due to the collapse of reinforced concrete buildings than of the masonry ones, due to their higher vulnerability (Contreras et al. 2014).

As a consequence of the earthquake and of its impacts on the built environment, L'Aquila is still undergoing a complex process of reconstruction. Particularly, on the one hand the extent of damages in the whole urban area limited the functionality of infrastructures and the accessibility for community (see e.g. Fig. 3.2.1); on the other hand, the changes in the population localization due to both temporary sheltering strategies and to the evolution of new permanent areas, forced a radical change of the performances required to the infrastructures. Particularly for the purposes of EDUCEN project, the water supply system represented the key infrastructural system to analyze.

The experience and the knowledge developed during the earthquake and in the aftermath of the disaster, provided crucial information to support the reconstruction phase. Learning from past errors and from the key criticalities encountered was a fundamental step for an innovative, sustainable, effective, safe, 'resilient' design. Just to provide an example, the high uncertainty of the available information and the poor accessibility of some infrastructures often limited the possibility to operate promptly during the emergency; similarly, the need to adapt the whole network to both changes in the urban pattern and specific local needs (e.g. the need to provide some buildings with water using a network with a huge number of breaks) during the reconstruction phase, caused significant stress levels for the system. The urban critical infrastructural systems were thus deeply rethought, and redesigned according to the new needs of the city, and to the experience.

The design of the 'SMART TUNNEL' reflects a basic principle: electricity, gas, water and communication systems are key services supporting daily activities and the well-being of a community (http://www.sottoserviziaq.it/it/home.html). The basic idea behind the smart tunnel is simply to collect and integrate all the critical services in an 'invisible' shell, i.e. an underground concrete gallery, in order to protect them from external threats and make them easily accessible and repairable, both in case of disasters and in ordinary operation.

Providing safe drinking water to a community in case of disasters is one of the main commitments of emergency managers and local authorities. Particularly, the urban water distribution network of L'Aquila city, is being currently rebuilt according to innovative criteria, such as the districtification. The basic idea is to split the whole network into a number of subsystems characterized by spatial and functionality homogeneity in order to facilitate maintenance and management procedures. Distrectification allows: a) controlling leakages and water

Figure 3.2.2. One of the main damages in 2009: Gran Sasso Aqueduct

losses; b) isolating single subsections of the whole network; c) implementing more effective measurements of hydraulic parameters. The distrectification supports flexibility and adaptation capability to the evolution of the urban pattern, and thus is strongly connected to the evolution of the whole city.

The L'Aquila case study is unique and relevant also because it allows the comparative analysis of two different networks operating within the same urban pattern. The urban water distribution system was completely redesigned after the disaster and is currently being built.

The selected measures, according to graph theory computed in an undirected and unweighted version, are summarized in the following Table 3.2.1. (full details can be found on our www.educen.cultureand-

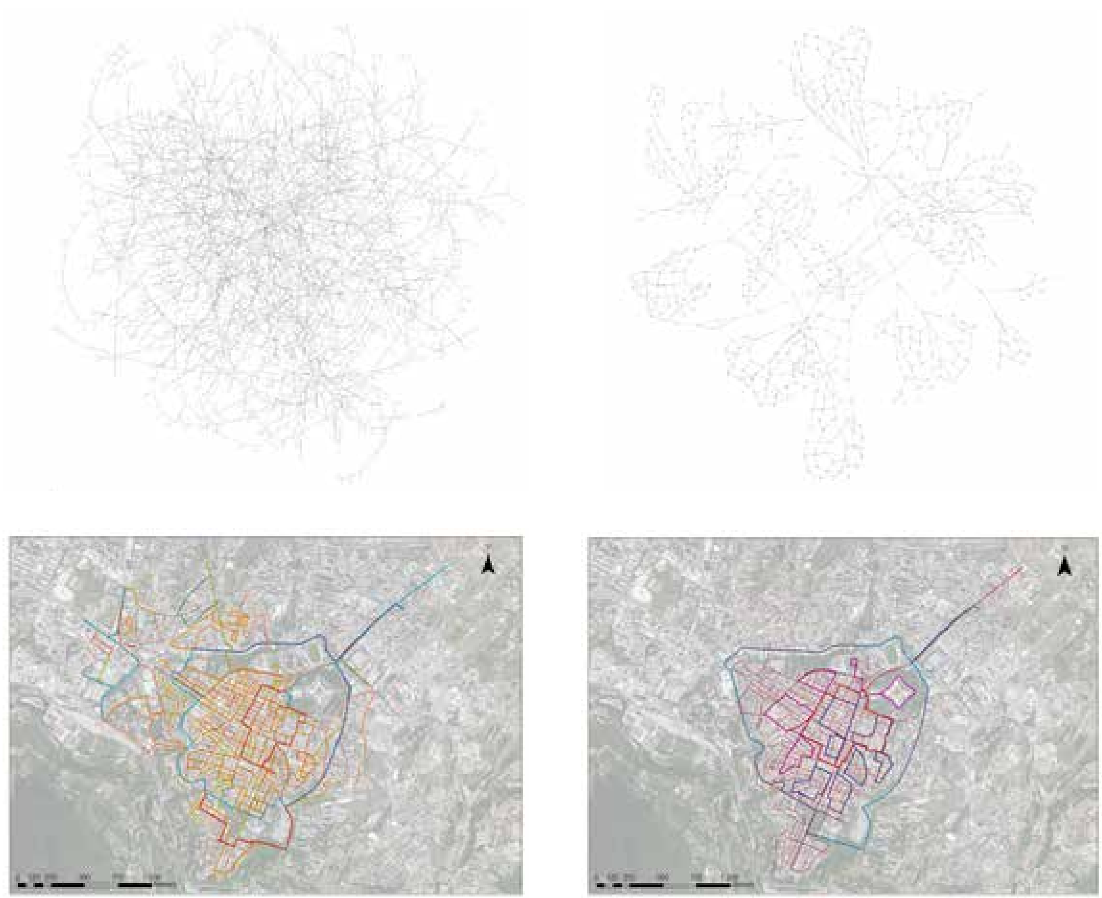


Figure 3.2.3. Representation of the urban water distribution network according to graph theory: OLD and NEW networks.

NETWORK K	q	K	D	I_T	C_C	R_m	C_B	D_{ap}	D_{BR}	λ_2	$\Delta\lambda$	fc
NEW – CS	0.006	3.0 0	26	13.4 3	0.041	0.25 2	0.412	0.1	0.1 1	0.0027	0.386 9	0.500
NEW – ZM	0.013	2.6 3	23	10.7 4	0.02	0.16 2	0.584	0.285	0.5 1	0.004	0.379 8	0.387
OLD	0.0006	2.1 5	97	32.7 6	0.004	037	0.455	0.391		0.00041	1.124 7	0.127

Table 3.2.1. Overview of the results of Graph theory analysis

disaster.eu). It is worth mentioning that the 'NEW' network is made of two independent subnetworks ('CS' – Centro Storico and 'ZM' – Zona Media), and thus the metrics are computed independently. The results generally contribute to suggest a better resilience of the new network, particularly in terms of flexibility, robustness and redundancy. Nevertheless, a comprehensive analysis should also be coupled with hydraulic models and with suitable performance indices.

3.3. How cities are managed matters

Authors: Funda Atun and Scira Menoni

As the trend towards urbanization has been growing fast in the last decade, international organisations such as the World Bank (Kreimer et al., 2003), the OECD (Corfee-Morlot et al, 2009), United Nations have devoted large attention to cities, defining guidelines to support the difficult task of planning and managing cities of the present age.

City mangers are confronted with an ever rising pile of demands for better services, faster communications, greener spaces, and with new obligations set by policies. In the last couple of years a number of important agreements have been signed at the global level such as the Sustainable Development Goals, September 2015; The Sendai Framework for Disaster Risk Reduction, March 2015; the New Urban Agenda decided at Un Habitat III, October 2016; and the Paris Agreement on Climate Change, October 2016. Those agreements will need to be implemented locally at the city's scale, with concrete measures and strategies. Creating a bridge between the indications listed in the agreements is a necessity before being an opportunity favouring knowledge exchange.

Fragmentation and separation of competences scattered among a large number of ministries, agencies, and even at the local scale among uncoordinated bureaus, is often the prevailing style of government, that undermines the benefit of investments and initiatives.

The field of disasters is even more complex, as it is not restricted to the traditional arena of city managers and planners, but must necessarily include those actors that intervene during an emergency, such as the army, fire brigades, police, medical doctors that do not have generally a strong role in cities' governance. They are asked to play a role only limitedly to disaster impact and recovery. In order to better complement and integrate policies, however, it would be recommended to involve such actors more broadly, taking into account their perspective also when deciding about critical infrastructures location, development zones, preservation projects of historic centres. Furthermore, stronger cooperation should be sought also with private organisations such as critical infrastructure providers and insurance companies to work together, exchange data, information and define common strategies to avoid cities' functional disruption during and after an extreme event's impact. In this respect insurers are already collaborating in some countries such as Norway and France to provide their data deprived from sensitive elements in order to inform about past and future potential risks at the city and even at the asset level.

3.3.1. Strategies and intervention across the "disaster cycle"

Figure 3.3.1 highlights the types of capacities that need to be put in place in particular to make cities resilient to disasters. In the 'x' axe the different phases are representing in which different behaviours are required: before the event it is necessary to plan adequately, during the emergency it is necessary to absorb the stress and respond, during recovery fast return to normalcy is required even putting in place temporary repair measures. In the reconstruction it is necessary to learn from the event in order to revise procedures and design that proved to be unsuccessful or unsatisfactory.

The capacities that are necessary are distinguished between: physical, necessary to make infrastructures more redundant, better equipped with safe-fail mechanisms; informational, related to the best use of

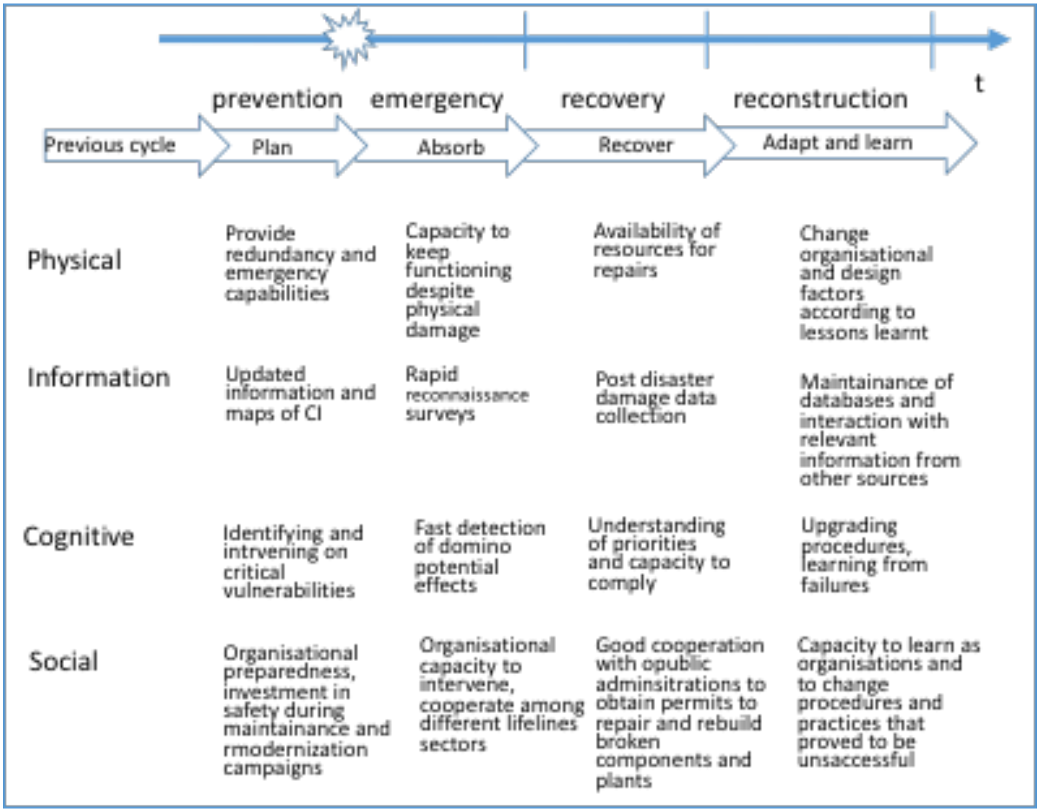
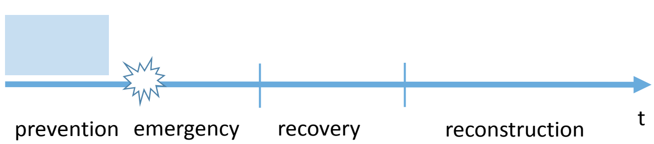


Figure 3.3.1. aspects that need to be considered to make critical infrastructures more resilient to disasters (after Linkov et al., 2013)

data and information to support decision making at each phase; cognitive, related to the understanding and the early detection of critical domino effects potential; and social, mainly related to the organizational capacity to coordinate and intervene in case of need. As it can be easily seen the capacities are both “hard” and “soft”.

At the global scale, the Resilient Cities Campaign carried out by UNISDR has been certainly the most eminent example of large scale initiatives aiming directly at the city level; similar stance has been taken by

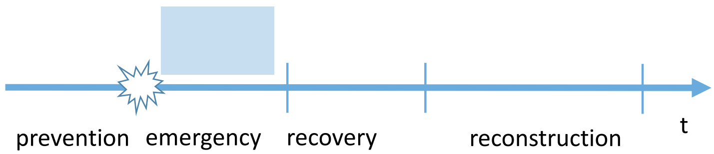
In the prevention phase



the Rockefeller Foundation with the 100 Resilient City project. At present the Sendai Framework for Disaster Risk Reduction is addressing all spatial levels, specifying for each what are the main targets to be achieved in the next fifteen years, starting from March 2015 when it was approved in the World Conference held in Japan.

The main issue with all those initiatives is their very general approach that needs then to be interpreted and applied at the city level, ranging from metropolitan areas, where real intervention has to be carried out going down to the single neighborhoods or districts' level, to medium and small cities.

In the emergency phase



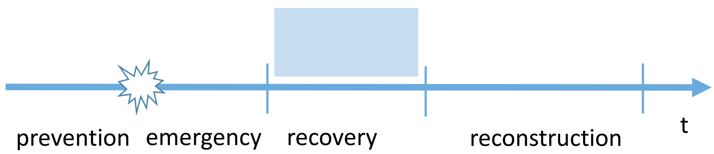
In the prevention phase, a number of decisions can be made to avoid exposure in the most hazardous zones, reduce physical and systemic vulnerabilities to the multiple stresses that may affect the city, and finally define structural measures to reduce the hazards' intensity and/or frequency. A mix of measures is generally more likely to be effective, depending on the specific characteristics of the context and the risks at stake.

Pre-disaster awareness as regards the significance of cultural heritage pays off during the pressing emergency phase and also, having in place a strategy for the preservation of cultural heritage including institutions and legislation, as well as inventories and documentation of historic buildings and their contents.
Depending on the level of destruction, the environment in which city managers and civil protection forces will have to intervene may be significantly disrupted and changed, posing many challenges in order to respond to immediate needs. In the emergency phase the first priority is to search and rescue victims and provide temporary shelters. Enchained events, including na-techs, that are more probable in urban environments due to the interaction of infrastructures and the presence of industrial areas must be prevented and mitigated as much as possible.

The management of emergencies will be carried more or less smoothly depending on the prior preparedness, on the existence and good quality of emergency plans and on the prior integration of the latter with urban and land use plans, for example for accommodating temporary camps and areas for the gathering of emergency means.

Even though immediate needs for life and health get the highest priority, people do care also about the preservation of those values and assets that represent their self-identity and in the meantime may constitute a reason for hope and "rising from ashes" again (Anderson and Woodrow, 1998).

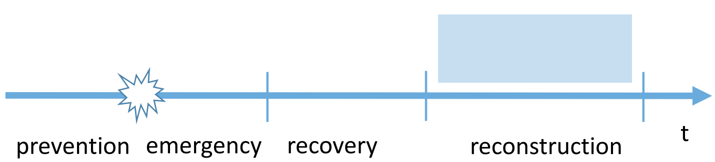
In the recovery phase



In this respect, intervening on cultural heritage to save what has survived complete destruction may be vital for the community. Technical measures include for example shoring structures to safeguard their resistance capacity in case of earthquakes, and moving to safer places movable objects such as ancient books, paintings and sculptures. L'Aquila in Italy was probably one of the cities that has experimented the larger shoring intervention ever after the earthquake in 2009.
The recovery phase is perhaps the most critical for the destiny of a city after a disaster. It is the time when critical decisions are made regarding reconstruction. It is also the time when damage data are collected and analyzed in order to not only to estimate the needs in terms of finance and resources for rebuilding and restoring, but also to learn lessons and decide about intervention modalities that will reduce pre-event vulnerabilities, making cities more resilient.

Post-disaster damage assessment has gained much more attention recently than ever before, making it clear that improved understan-

In the reconstruction



ding of what has been damaged and why is essential to support better decisions about priorities and modality of intervention. The experience carried out in the Umbria Region after the two floods in 2012 and 2013 provides an example of damage assessment that that is attentive to the spatial and the temporal scales at which damage unfolds, regards all sectors relevant in urban life, and matches the damage with the description of the physical phenomena that has provoked it.

In the case of cultural heritage, specific damage assessments, documentation of the building and its condition (photos, drawings, reports etc.) need to be conducted, considering the differences between ordinary buildings and structures and ancient constructions.

Many point at the reconstruction as the phase offering the largest window of opportunities for improving the pre-event situation, as after a disaster some restrictions in the use of land and more stringent building codes may be accepted more easily. It is a time when also relocation of some assets and lifelines can be decided to make future cities more resilient. However such window closes fast, certainly faster than the time needed for the overall reconstruction, and ineffective decision making and implementation may not exploit the opportunities offered by the event. During reconstruction various risk mitigation and climate change adaptation measures can be better integrated than in ordinary conditions. Reconstruction of cultural heritage require very strong competences of the building sector with specialized personnel and knowledge regarding ancient techniques and materials.