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Data availability and indicators

in vulnerability assessment

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Data availability and indicators

Data are rarely available for analyses at all relevant scales. Even where comparable data may be available, rarely research studies explore the relevant causal mechanisms for different processes or phenomena at different scales. Where data are available only for certain scales, the analysis should be made in developing techniques for up-scaling and downscaling information. The main challenge in this approach remain the question in understanding what types of information are scale dependent or scale independent and which is useful or not (Wilbanks, 2003). Methodologically, this is the most serious defy in cross-scale interactions for two reasons. First, most databases are scale specific rather than scale crossing. Second, most analyses and assessments focus on a particular scale of interest rather than on cross-scale linkages and transfers (Berkes et al. 2006). For example, global scientific indicators can characterize global patterns of climate change effectively, but they have serious shortcomings in providing solutions given the site-specific context and constraints in which any solution must be implemented. Because climate change and other natural hazards occur at multiple scales, no single indicator is the “correct” one for analysis. For example, indicators for local assessment tend to be more context dependent than indicators for global analysis. But at the same time, many aspects of local indicators are highly relevant at meso and macro scales. What emerges is a view of highly overlapping features concerning the value, relevance, and utility of indicators at different scales. Since coupling occurs between different levels, indicators must be analyzed simultaneously across scale (Berkes et al. 2006). For example, focusing exclusively at a local scale can lead to explanations in terms of local causes when some important determinants lie in processes at larger regional and global scales. Focusing exclusively on a larger scale can lead to ready generalizations that are just that – much too general (O’brien et al. 2004).

The indicators that are considered important within the context of a vulnerability assessment change with the scale of analysis (Tab. 8). The way in which an assessment could be constructed as a cross-scale assessment is by adapting or modeling the information from other scales (O’Brien, 2004). What constitutes a legitimate indicator? What scale can help the decision maker use the most relevant information and interpretation regarding a particular issue? The choice of the scale for the assessments should derive from distinctive needs, interests, and capacities. In some cases, the process of identifying the appropriate scale and relative indicators for analysis is a research activity in itself (Zermoglio et al. 2005). The most important issue is to extrapolate information across spatial scales by including interactions among micro and mega scale processes with an emphasis on connectivity among scale units and indicators (Peters and al. 2004).

Table 1 Scaling of vulnerability indicators

SCALE	VULNERABILITY INDICATORS	TYPE OF HAZARD
MICRO		
Social	Age, health, psychological and physical strength, education, neighborhood network	Precipitation Flood Windstorm Extreme temperatures Fire Avalanches Ground instabilities Earthquake Volcanic eruption
Physical	Building quality, building layout, materials, age, location, accessibility, hazard mitigation measures, land ownership, fire safety measures, vegetation	
Economic	Income, personal savings, family related insurance, GDP per capita, productivity per capita	
Environmental	Soil quality	
Systemic	Access to information and health care, building use, building density, dependence of utilities	
MESO		
Social	Population structure, disaster preparedness (civil protection means, early warning, emergency plans), access to resources, decision making, autonomy, legal regulations, perception of risk, social participation, stakeholder communication, environmental management	Precipitation Flood Windstorm Extreme temperatures Fire Avalanches Ground instabilities Earthquake Volcanic eruption
Physical	Building code, urban pattern, , urban development period, land use function, disaster protection measures, topography, reinforcement and retrofitting public assets, preventive structures, biodiversity	
Economic	Economic vitality	
Environmental	Environmental degradation, , climate conditions	
Systemic	Transportation, communication networks, energy delivery, emergency services, urban settings (accessibility of various functions and services), urban sustenance (performance, capacity of lifelines)	
MACRO		
Social	Political stability, type of government, national disaster planning, emergency management system and capacities, social equity,	Floods Windstorm Volcanic eruption
Physical	Safety standards and norms, legal regulations, implementation of hazard control and protection techniques, built area density	
Economic	Economic system, economic dependency, insurance services, sustainable growth, capital efficiency, government funds response and loss transfer strategies, mitigation loans, reconstruction loans, assistance to household and private sector	
Environmental	Environmental degradation, natural resources	
Functional	Infrastructure and health care system, energy delivery and storage, nuclear plants, communication, transportation	
MEGA		
Social	International political relations	Windstorm Extreme temperatures Volcanic eruption
Physical	Urbanized areas	
Economic	Trading activities	
Environmental	Climate and geological settings	
Functional	Traffic and energy networks (gas)	

For example, at the national level, vulnerability may be shaped by the macro economic situation, exemplified by indicators such as GDP. At the local level, vulnerability may be tied more closely to entitlements such as crop insurance, savings, and so on. Conclusions derived from impact and vulnerability assessments are valid for the scale of the assessment, and should not be generalized to other scales (Wilbanks and Kates, 1999). Ignoring the scale-dependency of results can be problematic in terms of understanding and addressing climate change, particularly if conclusions are derived from coarse scale assessments (O'brien et al. 2004). Local assessment activities can help to understand the global trends. To the other hand, global syntheses often leave out local details. Often conclusions or indicators clearly diverge from the on-site reality at a specific smaller scale. This situation can arise when the problem is not adequately defined, or when the ''best available' data used for global syntheses are in fact not sufficiently reliable to enable local interpretation (Zermoglio et al. 2005).

The following table proposes an example of possible indicators per vulnerability facets taking into account the different working scale and the pertinence of the data at the given scale.

Vulnerability indicators for floods (MDX)

Table 2 sets out a number of possible, proposed indicators of flood vulnerability, broken down by vulnerability facet. These are derived partly from knowledge of the New Orleans flood risk and the UK Thames Estuary flood risk. The Thames Estuary flood risk management plan (which incorporates London) employs ten principal indicators to monitor changes in flood vulnerability over time and these are incorporated into the table (Environment Agency, 2009). This plan is also based on a number of detailed vulnerability studies, key points from which are also included in Table 2.

As highlighted in tables 1 and 2, natural disasters cause great losses in human lives, property and productive capacity. Entire regions and urban areas become more vulnerable to natural hazards as urbanization expands, population increases and economic activities develop.

For this reason, indicators should not be considered only as scale and assessment dependent. The choice of the indicators depends also on the socio-economic context of the analyzed area. This is particularly evident when studying developing countries with respect to developed countries.

While absolute level of economical loss are great in developed countries due to the larger density and cost of infrastructure and production levels, less-developed countries suffer higher levels of relative loss. As already mentioned in the previous chapters, the destruction of infrastructures and livelihoods are direct outcomes of disasters and can also aggravate other financial, health and environmental aspects destabilizing in this way politics especially in developing countries. Such disaster losses may setback social investments aiming to ameliorate poverty, education, health services, safe housing, drinking water and sanitation infrastructures, or to protect the environment as well as the economic investments that provide employment and income.

Tab. 2 Indicators of flood vulnerability

Vulnerability facet	Proposed indicator
MICRO (taken as individual or household or business entity)	
Physical	Building or installation type, layout, materials, incorporation of resilience measures
Social	Age, disability, personal fitness, health status, health history especially incidence of stress-related illness and depression, level of educational attainment, degree of involvement in, or isolation from, local social networks
Economic	%age by which mean or median annual incomes depart from the national or regional mean, %age of population living below the official poverty line, mean ratio of savings and investments to house value, %age insured for flood loss, mean value of the level of profitability of business entities
Environmental	Soil permeability, typical rainfall-runoff lag times, degree of coverage of permeable natural surfaces with paved impermeable surfaces, degree of absorption of sustainable urban and rural drainage methods at the micro level, extent of erosion, many other physical parameters e.g. flood depth, duration, velocity, sediment load, salt load
Functional	Ease of access to flood risk maps and related flood risk information, ease of access to advice on how to respond to flood warnings, ease of access to advice and information on household/building specific resilience measures
MESO (taken as local or sub-regional or city-wide)	
Physical	Types, ages and condition of flood defence structures, frequency of different building types, layouts and materials, and the degree to which they are flood susceptible, density of buildings, frequency of employment of property level resilience measures (e.g. flood proofing), frequency of employment of community-based resilience measures (e.g. demountable flood defences), location of buildings: number of buildings in rapid inundation zones behind breachable defences and defences which may be overtopped, number of underground rail stations in flood risk zones, lengths of roads, rail lines, airports etc. in flood risk zones, number of road tunnels in flood risk zones, number of fire stations, police stations, hospitals, schools in flood risk zones, number of critical infrastructure installations in flood risk zones (e.g. electricity stations, power stations, major sewage treatment installations, telecoms installations)
Social	**Human capital:** statistical profile of population employing human capital indicators above (mean, variance), presence/absence and degree of development of local leadership **Social capital:** number and quality (i.e. degree of development of) local social networks and support groups, and degree of participation in them, presence/absence of a local flood action group/committee; and local environmental interest groups, degree of engagement of community in owning and managing flood risks, degree of encouragement of flood risk management agencies for local community engagement, presence/absence of riparian and land owner obligations for flood risk management, %age of population who are aware of flood risks and flood warning/evacuation procedures, %age of population with flood experience, %age of population who take at least one measure of flood preparedness, %age of population with a family flood response plan, %age who are able to demonstrate that they know flood warning procedures, presence/absence of local neighbourhood flood wardens, measures of community cohesion Social capital physical aspects: presence/absence of safe havens, presence/absence of designated safe flood evacuation routes, presence/absence of local mechanisms for retaining flood histories and memories (e.g. flood museums)
Economic	Per capita GDP, basic statistical profile of business entities (according to the likely degree of susceptibility of their plant and equipment, raw material and finished goods which are of high, medium and low susceptibility to damage from floodwater), basic statistical profile of business entities according to the likely degree of susceptibility of their business to business interruption (i.e. high, medium and low), %age of business entities with significant parts of their operation outside of the vulnerable area where business may be transferred, %age of business entities which have high, medium and low dependence on other businesses in the vulnerable area which are their significant suppliers, %age of business entities which have high, medium and low dependence on employees who live in the vulnerable area, %age of business entities with business continuity plans, presence/absence of local emergency funds
Environmental	As above for Micro Measures of biodiversity
Functional	As above for Micro. See also Meso physical which incorporates transportation and other functional infrastructure. Frequency of closure of flood gates and barriers
MACRO (taken as region)	
Physical	As above for Meso. %age of region which is in flood risk areas, physical and infrastructure planning mechanisms which recognise constraints on regional development imposed by flood risks
Social	As above for Meso.
Economic	As above for Meso. %age GDP contributed to the region by the locality, measures of the economic vitality of the region, presence/absence of regional flood emergency funds, existence of well rehearsed evacuation and related traffic management plans

Environmental	As above for Meso. Rate of mean sea level rise, rare of rise of peak surge tide levels, rate of land subsidence, increase in fluvial flows, frequency and extent of pluvial flooding
Functional	As above for Meso
MEGA (taken as national)	
Physical	As above for Meso. Existence of a national flood risk management policy and funding strategy which incorporates multi-disciplinary structural and non-structural approaches, existence of a climate change policy linked to reducing flood risks, mechanisms and procedures for regular monitoring of the condition and integrity of flood defences, existence of a robust, state-of-the-art, flood forecasting and warning capability, presence/absence and quality of spatial planning mechanisms and standards which recognise constraints on development posed by flood risks, %age of planning applications for new development in flood risk zones permitted/rejected, building control/compliance and regulation system which incorporates measures to reduce susceptibility to flooding, existence/absence of financial incentives to avoid locating buildings in flood risk zones and to incorporate resilience measures in those that must be located in flood risk zones; also retrofitting incentives and mechanisms
Social	As above for Meso. Public and political attitudes towards flood risk, presence/absence of social equity policies, political stability, type of government, quality of national disaster planning, emergency response capacities
Economic	As above for Meso. %age GDP contributed to the nation by the region or locality, availability of a flood insurance program, existence of government funding programs to manage and respond to flood risks and to economic vulnerabilities, access to social solidarity funds of a larger entity (e.g. European Union) for disaster funds
Environmental	As above for Meso
Functional	As above for Meso

Figure 1 shows economic loss by world region for disaster event triggered by natural hazards between 1991-2000.The unequal distributions of impacts is clear. In Europe and America, losses are shown to be higher than in Africa, but this is a reflection on the value of the infrastructure and assets at risk, not impact of development potential. In less developed regions of the world, low losses reflect a deficit of infrastructure and economic assets rather than a low impact of development. Even a small economic loss may be critically important in the case of countries with very low GDP. Africa's much smaller economic losses may be more significant in terms of slowing process in human development.

There are number of factors that contribute to the configuration of vulnerability in cities. For example, it is important where cities have been built or expanded into hazardous locations. In developing countries, rapid population growth and accelerated urbanization in the region exposed to natural disasters is an example of generating new vulnerabilities. For example, poverty affects urban vulnerability because it forces people to live in the most uncontrolled and unsafe areas. The growth of informal settlements and inner city slums create unstable living environments. They live in poor-quality housing, without clean water, sewage, drain and paved roads. The sanitation system, garbage collection and public health services are also inadequate in those locations.

When population expands faster than the capacity of urban authorities or the private sector to supply housing or basic infrastructure, risk in informal settlements can cumulate quickly. Often, local government may refuse to provide services to informal settlements on the grounds, because that will imply the recognition of the land they have settled and as consequence the obligation of the construction of public facilities with a budget they don't have. However, this makes those people more vulnerable to hazard.

Informal urbanization can also modify hazard patterns. Through process of urban expansion, cities transform their surrounding environment and generate new risk. As an example, the urbanization of watersheds can modify hydraulic regimes and destabilize slopes, increasing flood and landslide hazard. Moreover, ineffective or inappropriate development programs increase vulnerability to hazards, and hence lead to more disasters, great and small.

Figure 1 Total amount of disaster damage between 1991 and 2000
in millions of US dollars (2000 values)