Disaster and Crisis Preparedness

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Summary and Keywords

Preparedness involves initiatives designed to mitigate or reduce the impact of major risks and disasters and thus create resilience. It requires foresight and planning. One can distinguish between long-term and short-term preparedness activities. The former can be divided into structural, semi-structural, non-structural and environmental categories. Structural preparedness involves building defences and strengthening buildings and infrastructure against the physical impact of disasters. Although widely used, it is expensive and usually does not provide complete protection against the effects of disaster. Semi-structural measures include flood barriers that can be dismantled and the designation of areas for the storage of floodwaters. Non-structural measures comprise land-use planning (including interdiction on settlement and other uses in areas of high hazard), insurance and emergency planning. The last of these is designed to ensure that resource usage in crisis situations is optimised in favour of responding effectively to the impact. Nature-based or ecological measures involve enhancing the power of natural systems to amortise the impact of disaster. Emergency preparedness configures the 'architecture' of response, including command centres, control systems, hazard monitoring networks, systems designed to warn the public and plans to evacuate people.

In parallel to emergency planning, business continuity management is a form of preparedness that is designed to ensure the continued functionality of organisations. It may include measures to protect their reputation among clients, customers and suppliers, and their market position or stock market quotation. Preparedness for pandemics can be considered as a

special case in which medical and epidemiological preparations are accompanied by preparedness measures to deal with the profound socio-economic changes that a pandemic brings to society.

Preparedness is also important during the phase of recovery from disaster. This period involves a 'window of opportunity' in which official and public sensitivity to the problem can be used to improve safety by reconstructing to higher standards than existed before the disaster and incorporating new safety measures. In terms of resilience, this is a 'bounce-forward' strategy, sometimes known as 'build back better', rather than a 'bounce-back' one that would risk restoring pre-existing vulnerabilities. Disaster risk is particularly dynamic in the modern world, thanks to major changes in the magnitude and frequency of environmental hazards, large increases in the vulnerability of people and assets, and anthropogenic degradation of natural environments. Preparedness is thus a major imperative that is greatly needed if very large losses are to be avoided.

Keywords: disaster, vulnerability, resilience, preparedness, warning, mitigation

Definitions and Overview of Preparedness

Much has been written on the nature and significance of disaster (Richardson, 2005; Perry and Quarantelli, 2005). Nonetheless, there is little consensus on how to define the term. A *disaster* is an out-of-the-ordinary event that has an adverse impact on human lives, activities and safety, and on the environment of human life (UNISDR, 2009). The suddenness and duration of the impact can vary from instantaneous to prolonged (so-called 'creeping' disasters and 'ramped' impacts). Available warning times vary very considerably from one hazard or threat to another. However, beyond this, the limits of what is a disaster are determined more

by the convenience of scholars than any highly defensible rationale. Thus, we tend to exclude warfare, civil conflict and disease epidemics, even though these are disastrous phenomena. We also exclude phenomena such as road accident deaths, as these are distributed, rather than concentrated, in time and space.

Crisis can be defined (*OED*) as "a vitally important or decisive stage in the progress of anything; a turning-point; ...a state of affairs in which a decisive change for better or worse is imminent" (Boin and 't Hart, 2007). Hence, disasters are by definition crises, but not all crises are disasters. Perhaps the point of contact is whether the crisis leads to damage, destruction and possibly casualties. It is nevertheless clear that both phenomena require decisive action in the interests of safety and security.

Disasters can be classified by their causal triggers into *natural* (e.g., earthquakes, hurricanes and floods), *technological* (e.g. transportation crashes, toxic spills and major infrastructure failures), *social* (e.g. riots, crowd crushes and strikes in the provision of essential services), *intentional* (i.e., terrorist incidents) and *compound* (i.e. some combination of the previous categories, including 'na-tech', or natural-technological events). With the demise since the mid-1800s of the concept of disasters as 'acts of God, the term 'natural disasters' has gradually fallen out of favour, as most natural hazard impacts are determined more by human vulnerability than by events in nature (Hewitt, 1983). The concept of 'Acts of God' nevertheless remained extraordinarily persistent and thus continued to function as an excuse for lack of preparedness. Attempts were still being made to debunk it (as a legal and organisational, not a spiritual justification) well into the late 20th century (Wijkman and Timberlake, 1983). Of all categories, compound, composite or cascading events are probably the most common, such are the complexities of modern society and the impacts of disaster upon it (Pescaroli and Alexander, 2018).

In the context of disaster or crisis, *preparedness* consists of actions taken to ensure readiness (He and Zhuang, 2016). As far as is technically possible, *readiness* means being able to anticipate developments and ensure that resources are efficiently and effectively deployed, and protection is adequate. It implies that the problem of disaster impacts has been thought through in a practical manner and measures have been adopted to combat it. *Disaster risk reduction* (DRR) has come to signify the overall process of preparing for, responding to and recovering from disasters and major crises (Weichselgartner and Pigeon, 2015). *Resilience* involves the ability to resist and adapt to disaster forces by both hardening defences and learning to co-exist safely with risk (Paton and Johnston, 2017).

One of the great problems of DRR is society's perennial inability to change the balance of effort and expenditure from response to preparedness. Critics might see this as evidence of humanity's fecklessness, but there are various reasons for it. One is that responding to disasters once they happen is very expensive and it is an imperative that cannot be avoided. Although it has often been demonstrated that preparedness saves money by reducing needs associated with the response phase, it is often difficult politically to justify expenditure on events that have not yet occurred. Moreover, for most administrations capital expenditure is easier to procure than revenue expenditure, as it involves a one-off cost rather than a continuing financial commitment. Disaster response is akin to capital expenditure, whereas there are elements of revenue expenditure in most forms of preparedness, because they involve continuing activities such as monitoring, training and maintenance of structures (Birkland and Waterman, 2009).

Since the mid-1990s the USA has sought to limit its expenditure on responding to disasters and encourage states and local authorities to reduce their risks (Mileti, 1998, p. 50). Nonetheless, the expenditure on disaster relief has risen relentlessly, despite all efforts to put

curbs upon it (Painter, 2019) and from time to time the Federal Government has been accused of financing undue risk-taking (Platt, 1999). Hence, it remains persistently true more is spent on response than preparedness, and the shift of emphasis from the former to the latter has been severely limited (Bea, 2010). In part, this reflects the difficulties experienced by a federal government in seeking to impose regulations on states that have a degree of legal and administrative autonomy and decide for themselves whether or not they will use it to impose regulations designed to reduce disaster risk.

Preparedness depends on the ability to foresee events and to organise defences against them. The various forms of preparedness can be divided broadly into long-term and short-term kinds. The former include structural (i.e., physical) and non-structural (i.e., organisational) measures. The latter include emergency planning and evacuation. Business continuity planning and management are specialised forms of preparedness that involve the defence of an organisation's commercial reputation, as well as the ability to bring a crisis under control. Pandemics are among the most important topics in emergency preparedness and so require specific consideration. Short-term preparedness requires a structure, the 'architecture' of emergency response, which can be planned and created in advance of a crisis or disaster impact. When disaster has struck, emergency preparedness can take advantage of the special conditions that prevail in disaster recovery, notably in awareness and the salience of disaster risks, and hence it has a distinctive role in the aftermath period.

Long-Term Preparedness

Foresight involves perception gained by looking forward into the future. Most natural hazards follow a magnitude-frequency rule, in which the size of event is inversely proportional to its mean recurrence interval. Although records may be inadequate to construct accurate

distributions of events, and actual recurrence may be somewhat irregular, the rule gives some basis for preparedness (Hewitt, 1970). With regard to anthropogenic hazards, including terrorism, the basis for preparedness is usually the world-wide incidence of similar events, as tempered by risk factors, as assessed locally. In the modern era, mean values tend not to be stable, and so it is necessary to anticipate events on the basis of monitoring global changes, for example in the incidence of climatic extremes and the events they cause, such as storms, floods, droughts, heatwaves and cold snaps (Birkmann and von Teichman, 2010).

Broadly, long-term preparedness can be classified into structural defences, semi-structural works, non-structural measures and physical modification or stewardship of the natural environment.

Examples of structural defences against natural hazard impacts are floodgates, floodwater impoundment dams, levees, berms, sea walls, debris collection basins, snow fences (to prevent avalanches), sediment check dams, antiseismic reinforcements, rockfall nets, and slope reinforcements (see Table 1). The purpose of a structural measure may be to 'harden' some element or section of the built environment so that it resists the physical impact, to divert the impact into a less harmful path, to prevent the impact from occurring and thus protect the structure and its immediate environment, or to reduce the kinetic energy inherent in the impact. Sea walls, for example, are designed to protect a coast against erosion, storm surge or tsunami. Debris containment basins are intended to attenuate mudflows and debris flows, providing the basin is periodically excavated so that it is not full when the mass movement arrives. 'Hurricane straps' are simple metal fixtures which can be used in wood-framed houses to anchor the roof to the rest of the structure. It is commonly found that such buildings tend to be destroyed if the roof becomes detached and the wind gets inside. In the field of anthropogenic hazards, structural defences might include blast walls as a defence

against the effect of bombs, or containment vessels to stop the spontaneous venting of toxic chemicals from reactions that have become exothermic and are thus out of control.

Table 1. Selected examples of structural defences against hazards.

Type of structural defence	**Hazard(s)**	**Intended effect**
Floodgate	River flood	Prevent impact
Levee	River flood	Prevent impact
Relief channel or dredging	River flood	Divert and reduce impact
Flood impoundment dams and basin	River flood	Reduce impact
Sea wall	Storm surge, tsunami	Prevent impact
Berm, groyne	Coastal erosion	Reduce impact
Retaining wall	Mass movement (landslide)	Divert or prevent impact
Slope drainage system	Mass movement	Prevent or reduce impact
Sediment check dam	Debris flow or mudflow	Prevent or reduce impact
Debris collection basin	Debris flow or mudflow	Prevent or reduce impact
Rockfall net, slope anchor	Mass movement	Prevent impact
Snow tunnel, snow fence	Snow/ice avalanche	Prevent, reduce or divert impact
Sharp 'prow-like' upslope wall of building	Snow/ice avalanche	Divert impact
Antiseismic reinforcements (retrofit)	Earthquake	Prevent or reduce impact
'Hurricane straps' for roof	Windstorm	Prevent impact
Containment vessel	Exothermic chemical reaction	Attenuate or prevent impact
Blast wall	Terrorist bomb	Reduce impact

The first problem with structural defences is to assess or calculate the magnitude and frequency of forces that they will be expected to resist. Most natural hazards obey a rule that the larger they are, the less frequently they occur. Various mathematical formulae have been fitted to different classes of hazard, and they mainly conform to symmetrical distributions with a more or less strong central tendency and two diminishing outliers referring respectively to increasingly small and large events (Hewitt, 1970). However, the problem of what size of event to expect during the planned life of the structure is very difficult to resolve. Likewise, such is the pace of environmental modification that it may be difficult to find a rationale for

assuming that it is possible to provide protection for any particular length of time. Moreover, most calculations of this kind have to assume that the distribution of magnitudes and frequencies is static. For meteorological events, climate change may invalidate such an assumption by increasing the frequency or magnitude of extreme events. This is sometimes known as the 'fat-tailed' distribution problem. It belies the assumption that the typical curve of events is Gaussian (or similar) and instead the distribution is skewed towards more high-end, or large magnitude, events (Weitzman, 2011). Hence, there are no clear rules concerning how to determine the maximum size of event to plan for. On occasion, reference is made to the "maximum credible event", but this is often a subjective concept (Davies, 2015). A maximum credible event (MCE), known in safety science as the 'top event', is the worst case to arise out of a range of possible outcomes for a given hazard or threat in a defined area (Sokolov, 2017). Simple logic and common sense are used to determine what is 'credible', and timespans need to be human ones, not the protracted periods of geological time. Hence, one rule of thumb that is often used is to focus on the event that is likely to occur about once in 100 years. In any case, a trade-off has to take place between the desire for protection and the cost and disruption of measures taken against very large impacts.

Virtually no structural defences are entirely proof against hazard impacts. Levees and dams can be overtopped, seismic bracing may fail, or sea walls may be eroded by wave action until they collapse (Collenteur et al., 2015). The physical forces unleashed during the impact may simply be too large for the structure to bear. The result may be worse than it would have been without the defences. This is particularly the case where floods are concerned. Urban and infrastructural development tend to be stimulated by the assumption that structural protection is adequate for all occasions. Hence, behind levees that keep rivers in check, urbanisation occurs under the assumption that the area is fully protected. This is rarely if ever

the case and when the defences fail damage can be extensive. A good example is the record flood that for six weeks or more affected the Mississippi-Missouri river basin in the summer of 1993. It was preceded by 97 years of engineering works to tame the two rivers, but also by major increases in the extent of urbanised land on the floodplains. About 78,000 sq. km were flooded in nine states (Changnon, 2019).

In the early part of the 20th century most natural hazard preparedness in the United States involved structural protection. The eminent geographer Gilbert Fowler White advocated a mixed approach to floods (White, 1945 which changed national policy in the USA and also in many other countries. He did not decry the construction of defences against flooding, but he was also a champion of land-use control, insurance, emergency preparedness, education and other non-structural approaches, as well as the semi-structural measure of setting aside areas that could contain floodwater without damage and thus reduce peak flood flow (White, 1974).

The term 'semi-structural' is often applied to measures that involve enhancement of natural defences or portable structures that can be dismantled when they are not in use (or at least that do not profoundly modify the built environment). Examples of the latter are moveable flood barriers and means of sealing the lower levels of houses against the incursion of shallow floodwaters (Poussin et al., 2012). For other forms of semi-structural preparedness, the term 'nature-based' or ecosystem-based' solutions is increasingly used (Renaud et al., 2016). For example, forests and natural vegetation can trap and reduce the flow of floodwaters, thus attenuating the peak of the flood hydrograph. Mangroves can trap sediment and reduce coastal erosion. Wetlands can purify water and lend stability to low-lying landscapes. Groves of trees can provide a natural barrier which reduces the force of tsunami waves. By and large, natural landscapes are homeostatic, which means that when disturbed

they will endeavour to return to equilibrium (although not necessarily the same equilibrium as that which prevailed before the disturbance). Nature-based solutions seek to encourage homeostasis and stability in landscapes without excessive loss of their biological productivity (Lafortezza et al., 2018). In contrast, structural measures such as seawalls and river levees require considerable maintenance to stop them from being worn down by natural forces to the point of destruction.

Non-structural preparedness involves forms of organisation designed to promote safety. One of these is land-use control (Burby et al., 1999). One of the principles of urban and regional planning is to separate incompatible functions, such as housing and heavy industry, in order to ensure that each functions without disturbing other forms of land use. Through conservation, urban or rural landscapes of high value can be protected by law or ordinance so that they do not lose their value by being over-developed. Obviously, land-use planning has a very strong spatial dimension. So, in fact, does emergency planning (Alexander, 2016, p. 50). It is remarkable how much scope there is to combine the two, and how little it is exploited in the modern world. Nonetheless, by mapping hazard, exposure and vulnerability, it is possible to create a picture of the spatial distribution of risk. Hazardous areas can be subject to limitations in the uses to which they are subjected. Thus, land that is frequently flooded, unstable slopes, areas of potential seismic liquefaction, and the runout tracks of snow avalanches should, as far as is possible, be prevented from being developed. In such places, infrastructure will require expensive protection and reinforcement. Development can even be removed by buy-out processes (McCarty et al., 2005). For example, in this manner, the central business district of Hilo, Hawaii, was relocated away from the coast after it had suffered extensive damage in the 1960 Pacific tsunami (Atwater et al., 1999).

Unfortunately, in 1983 and thereafter it was shown to be susceptible to lava flows from Mauna Loa volcano. Safe land for development is evidently at a premium on Hawaii Island.

Land use control has proved to be an effective tool for preparing to reduce hazard risk. However, it is not a universal palliative. First, it requires strong and effective laws and enforcement, both of which may be lacking. Secondly, land that is interdicted may become more attractive as a result. In some developing countries, through lack of other options, the poor are constrained to live on unsafe land, for example on steep, unstable slopes or on the floors of valleys that periodically flood. The drift to the cities and world-wide process of urbanisation exacerbates this tendency. In cities such as La Paz (Bolivia), Caracas (Venezuela), Recife (Brazil) and Port-au-Prince (Haiti), not only is there dense settlement of unsafe land, but the forms of housing that the poor are able to construct are not hazard-proof either (Sarmiento et al., 2019). Thus, failure of land-use control (and the ability to provide safe alternative areas to build upon) and failure or inability to enforce building codes contribute greatly to the relentless rise of vulnerability (Marks, 2018).

Another form of non-structural preparedness is major hazard insurance. The principle of insurance is to create a pool of monetary resources which can be used to compensate those subscribers who suffer losses (Kunreuther, 2019). Actuarial calculations determine the premiums to be paid as membership of the scheme, any exclusions from policies and the likely scale of losses to be compensated. The price of the premium signals the level of risk and it communicate to actual or prospective policy holders the need to to reduce their risk. Insurance is remarkably effective in providing resilience against the effects of damage and destruction, although perhaps less so in terms of lives lost. In this respect, the beneficial effects of insurance are experienced in the aggregate, in that not all insured parties will recover their losses, assets and livelihoods after disaster has struck. Moreover, there are

various problems with insurance against major hazards that cause disasters. One is that the losses may be overwhelmingly large, on the scale of tens of billions of US dollars. In the 1930s, early attempts at flood insurance in the United States bankrupted insurers, as major floods can cluster in time, whatever their average recurrence interval might be. The problem was repeated with hurricanes 60 years later (Mileti, 1999). As a result, all US natural hazard insurance is underwritten by the Federal Government. Purely private insurance is stymied by *adverse selection*, the tendency for buyers to purchase policies with a strong likelihood that they will collect on them.

To be strictly fair, insurance programmes would require all subscribers to bear an equal risk of loss. In practice, with disaster risks there are elements of 'moral hazard' and 'charity hazard' (Raschkya and Weck-Hannemann, 2007). Moral hazard involves the inadvertent subsidy of some subscribers by others. For example, those who do not live on or near dangerous slopes need not insure their homes against landslides, but if this is an element of their insurance package, they may be paying for it unnecessarily. On the other hand, the residents of slopes may not be at risk of floods, and the same problem arises. There is also a risk that the purchase of insurance may discourage property owners from participating in efforts to reduce vulnerability, exposure or hazard as compensation for any losses they may sustain is presumably assured. For long, one of the main problems with the US National Flood Insurance Program has been high payments to insured parties who suffer frequently repeated losses. Hence, much effort has been devoted to devising measures to make vulnerability reduction or hazard mitigation a condition of purchasing insurance (Knowles and Kunreuther, 2014).

Charity hazard is partly a function of the inability of poor residents to afford insurance. In Italy, for example, 70 per cent of the national population lives in areas of

significant earthquake risk. To rely fully on insurance for post-disaster compensation would require homeowners to pay annual premiums of an average of 4,000 euros, which is well beyond the means of the average family and would be wildly unpopular if it were a compulsory tax on home ownership (Gizzi et al., 2016). In such cases, the government becomes the "insurer of last resort". Political pressure associated with popularity among voters may induce it to compensate widely, which distorts the insurance market and may result in critics labelling disbursements as "forgiveness money", a form of subsidy for taking risks of living in hazardous areas without adequate structural protection. Micro-insurance is spreading in developing countries following the diffusion of micro-credit, and is thus providing relief to poor householders who are forced to live with risk. However, there are questions about the financial viability of the model, especially in the light of major and increasing levels of hazard impact and human vulnerability.

Conventional insurance has slowly increased its role in loss compensation, but nevertheless it still only covers between one fifth and one third of financial losses in disasters. National schemes underwritten by governments have become increasingly important (McAneney et al., 2016) and they may involve compulsory elements. However, some are at risk of insolvency, or forcing governments to bail out schemes. Others are not adequately linked with functioning risk reduction schemes and, in any case, there is no standard model that is valid for all countries (Paleari, 2019). Despite all of the issues with it, insurance is a popular element of disaster preparedness and is destined to play an every greater role in that process.

Relationship Between Preparedness, Prediction, Forecasting and Warning

Short-term preparedness encompasses readiness for impending events. The causative agents of disaster vary considerably in their predictability. Earthquakes, for example, are predictable in terms of broad seismicity and magnitude-frequency relationships, but it is difficult or impossible to predict an impending seismic disaster. Crustal stress fields can be assessed, measured and monitored, but the timing and magnitude of tremors are hard to forecast. The same is true of volcanic eruptions, where there are usually abundant precursors but there will probably be little indication of the exact timing of the paroxysmal phase of an eruption. On the other hand, tropical cyclones can be tracked by satellites and reasonably accurate predictions of landfall can be issued in a window of time that extends over 36-48 hours. Tsunamis can also be detected potentially hours in advance of landfall, although the biggest problems are posed by near-field tsunamis, in which the lead time is measured in minutes, not hours (Wood and Schmidtlein, 2013). Anthropogenic disasters generally cannot be predicted in the same way as natural hazards, which is why terrorism is anticipated by a generalised 'threat level', based upon an assessment of terrorist activity coupled with any specific intelligence that the authorities may receive.

A forecast is an operational form of prediction that usually offers specific information on what is likely to happen in the future. Most forecasts are expressed in terms of probabilities (often expressed as percentages), which allows them to take account of the error function of the model of hazard mechanisms on which they are based. A forecast will state, in probabilistic terms, what is likely to happen, where impacts are likely to occur, how serious they are likely to be, and in what window of time the impact is likely to take place. A warning is a recommendation for action based on a forecast. Public warnings aim to stimulate an appropriate reaction from the general public, for example, by recommending or requiring

prompt evacuation of the area of an impending hazard impact. Warnings to the emergency services are usually alerts that require readiness for action. Warnings can involve several levels of authoritativeness, from a 'hazard watch' situation, in which conditions favour the possible development of an impact, to an 'impending impact' warning, in which an emergency situation is either about to occur or is highly likely to do so in the immediate future (Zschau and Küppers, 2003).

In general terms, a warning system is composed of three subsystems: technical, administrative and social (Foster, 1980). Absence or inefficiency of any of these subsystems renders the whole warning system ineffective. The technical subsystem, with its scientific underpinnings, provides the information about an impending impact. The administrative subsystem encompasses evaluation of incoming information and the decision on who to warn, how and with what message content. The social subsystem embraces the response to the warning, including how it is perceived and what decisions are made. There are, of course, further technical issues concerning how to transmit warning messages.

By and large, warning systems are only as good as the preparedness that underpins them. Knowledge of impeding adverse events may be excellent, but actions based on such understanding cannot be efficient unless there is a degree of prior human organisation. For example, mass dissemination of warnings requires an infrastructure to make it function. According to varying circumstances, there are arguments for and against different means of warning people, from sirens to radio messages, SMS messages, television, telephone and Internet-based methods (Wenzel and Zschau, 2014). Much depends on the logistics of warning, and on aggregate patterns of human activity at the time the warning is issues (and reissued), but there also needs to be an underlying level of organisation (Foster, 1980).

Training in what to do, and familiarity with warnings, the consequence of hazard impacts, and the need for action are all necessary.

One of the elements of emergency organisation that is most effective in the short term is pre-impact evacuation. It requires adequate monitoring and warning of an impending impact, and a good idea of where the disaster is likely to strike. Evacuation can only be accomplished safely if there is enough time to carry it out before the hazard arrives. In principle, it should also direct evacuees into progressively safer zones. Generally, people are safer sheltering in situ than they are evacuating if there is a likelihood that they may fail to arrive in safe zones in time. Planned evacuation requires a well-designed warning system that fully informs evacuees of what they need to do and where they need to go. Adequate transportation and route planning are needed. Reception centres located out of harm's way need to be designated and prepared. Special arrangements need to be made for the elderly, people with disabilities and institutions such as hospitals, nursing homes and prisons. Arrangements need to be made for continuity of care, for example in the supply of vital medicines (Alexander, 2016, p. 101).

For example, if excessive rain or a major storm is forecast, and flooding is an expected consequence, evacuation of the floodable area may be mandated. Prior organisation coupled with emergency planning is intended to ensure that the means of evacuation are present, that routes and traffic flows can be managed, and that evacuees can be accommodated in reception centres where they will be fed and cared for throughout the emergency phase. Evacuation is designed to lead people out of hazardous zones into areas of safety. Scenario construction and simulation can be used to model the process and anticipate blockages and other problems associated with it (Assavapokee et al., 2010).

Preparedness Through Emergency Planning

Emergency situations need to be tackled by a mixture of procedures, plans and improvisation. Although the ability to improvise stimulates creativity, and perhaps also flexibility, improvisation needs to be minimised because it is inefficient and it lacks foresight. For example, if it is suddenly discovered that specialised equipment is needed to conduct search-and-rescue operations under a collapsed building, then it is usually too late to procure the equipment within an appropriate span of time. It is far better to anticipate such needs in preparedness.

Emergency planning is an art and a science. In some respects it is nothing more than "organised common sense", but experience and learning are required in order to know what to include and how to configure a plan. Most organisations have procedures, and generally the emergency services have standard operating procedures that may be written up in a comprehensive manual. Planning and procedures are not quite the same thing. If we consider emergency operations to resemble an orchestra, each musician has his or her own music to play (the procedures), while the conductor has the score (the plan), which is designed to ensure that they all play in harmony. The main goals of emergency planning is to apportion responsibilities for key tasks; to anticipate needs generated by an emergency situation and ensure that, as far as is possible, they are met; and to guarantee communication, information sharing and coordinated, cooperative emergency activities (Perry and Lindell, 2007).

Remarkably few emergency and disaster situations are completely unprecedented. For these, generic procedures are the only solution. For most impacts, indications of what will happen can be gained from the examination and analysis of past events. For this reason, it is important to base emergency plans as far as possible on scenarios (Alexander, 2016, Ch. 6).

A scenario should not be regarded as a prediction of any future event. Instead, it can be treated as an exploratory tool that leads to a range of possible outcomes. In emergency planning, it helps to base scenario methodology on a systems approach. The inputs start with a reference event, which is usually the largest or most significant disaster of a certain kind to have affected the area covered by the plan in the past. Other inputs include the starting conditions, such as time of day and the aggregate patterns of human behaviour that prevail at the time. In a sudden-impact disaster such as an earthquake, these may include population density, predominant behaviour (sleeping, travelling to work, presence at work or school, etc.). Historical analysis can be combined with an assessment of current conditions, which will show changes in the geography of the affected area and its vulnerability. The impact is carried forward from time zero with the ability to extract 'time-slices' of developments as they evolve. Interactions of hazard impact, exposure and vulnerability determine the likely consequences in terms of loss of life, physical injury, psychological harm, destruction and damage of buildings, infrastructure and other assets, and interruption of productive and recreational activities (Peduzzi et al., 2009).

The planning scenario may be considered in terms of risk, impact and response. It enables planners to estimate the probable nature and magnitude of needs generated by the impact. These can then be matched with available resources and the scenario can be extended to show how best to deploy the resources, and what supplies, equipment and personnel may be needed in addition to those that are easily available.

A city in which damaging earthquakes occur periodically has no excuse not to have an emergency plan that deals with seismic contingencies, although it is essential that the plan embrace other hazards as well and be adaptable to most or all contingencies. Adequate knowledge of how to manage an earthquake disaster in the local context can only be gained

by a scenario-based assessment of what is likely to happen and what needs the impact will generate. This is achieved by investigating the magnitude, reach and scope of local earthquake disasters in the past, with particular reference to its interaction with vulnerability states, and the ability to respond to whatever needs arise in a future recurrence of the impact (Zegras and Rayle 2012).

Emergency plans need to be constructed at all levels, from that of critical facilities such as airports and hospitals, to that of an entire country. Humanitarian operations and mutual assistance may need international plans. For a nested set of plans (perhaps local, regional and national), compatibility can be assured by comparative reading in order to ensure that none of the provisions clash and that all foreseeable responsibilities are fully assigned to managers, team leaders and operatives.

Emergency plans are often assumed to be static instruments, but this need not be the case. In the first place, a permanent written plan can be a living document. It needs to be reviewed and updated at frequent and regular intervals. All potential users of the plan should be made aware of both its provisions and any changes made when it is updated (Stallings and Faust, 2009). Secondly, the process of planning usually continues into the emergency. In practical terms, plans need to be adapted to the changing dynamics of emergencies as they evolve. The essence of the plan is to seek to match urgent needs with available resources. Both of these are likely to change rapidly and substantially during an on-going emergency. It is important to create a common operating picture and share it among the response forces in the field and the decision makers in the emergency operations centre. This will create situational awareness, which is a vital means of anticipating developments and preparing to meet them in the very short term (Rawls and Turnquist, 2012).

As a form of disaster preparedness, emergency planning takes place in a context defined by the architecture of emergency response.

Preparedness and the Architecture of Emergency Response

Much as emergency plans cannot adequately be improvised at the height of a crisis, so the support structures that they require also need to be thought out and set up before the event. Many countries now have basic laws to govern the way in which emergencies are dealt with. In the United States, the federal response is governed by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (1997-2007; Bea, 2010). In the United Kingdom, the Civil Contingencies Act of 2004 prevails. In Italy, Law no. 225 of 1992 establishes, defines and regulates the civil protection system. In India, the Disaster Management Act (2005-2010) is the basic law. With respect to India, the USA, Germany and other federal countries, that the division of responsibilities may mean that the national law is somewhat subordinate to provisions made by constituent states. Unless the integrity of the nation is threatened, in civil emergencies, the role of the federal government may be to support the lower levels of public administration rather than to command them.

In most cases, either by design or default, there is a lead agency, which is usually one of the emergency services, and which has some degree of precedence over the other response organisations. In Italy it is the National Fire and Rescue Service, as the primary need in disasters is to stabilise the scene. In the UK disasters are seen, rightly or wrongly, as primarily a matter of public order and protection, so the lead agency is the Police. In Iran, where major earthquakes can produce mass casualties in large numbers, it is the Red Crescent Society.

Emergency operations centres (EOCs) are a necessary focus for the coordination of emergencies when they arise (Bergeron and Cooren, 2012). A typical EOC is essentially

bicameral, consisting of a situation room for quiet discussion and decision making, and an operations room for communicating decisions and collecting information. In the operations room the common operating picture is compiled and shared with decision makers in field operations and in other centres. EOCs are needed at all levels of government and at major sites such as hospitals, airports and large factories. Thus, they can form a network connected by robust and resilient telecommunications. The EOC is the natural home for an emergency plan, the best place to develop and maintain it. Many EOCs also have a training function, which involves preparedness through ensuring that participants in emergency response are fully aware of their roles, responsibilities and position in the system.

Emergency response systems vary from those that are strongly hierarchical to those that depend on a more level form of collaboration. The former tend to be organised according to strategic, tactical and operational levels, with the policy formulation level sitting above these three, but not usually active during crisis situations. Broadly, 'strategic' means guidance of the whole emergency effort and procurement of the necessary resources. 'Tactical' refers to the allocation of resources, and 'operational' to their use in the field (Phelan, 2008). To avoid mistakes, inefficiencies and duplicated effort, it is necessary to compile and widely share the common operating picture, which is a synoptic view of the dynamically evolving situation in the disaster area. The use of this picture is termed 'situational awareness' (Danielsson et al., 2014). In the United Kingdom, the three levels are designated 'gold' (strategic command), 'silver' (tactical command) and 'bronze' (operational command). This is a command and control approach, which has military origins, but it is not the only way to manage an emergency (Arbuthnot, 2008).

An alternative to the hierarchical approach is to develop the response on sectoral lines. Here, the main collaborations are between decision makers and operatives working in sectors

such as telecommunications, search and rescue, transportation logistics, shelter and so on. In general there are about 16 different sectors, including one that deals with the coordination of the whole and one that covers accounting for the cost of emergency procurement and deployment. The sectors, known in United Nations parlance as 'clusters', are groupings of all the managers of organisations, agencies and enterprises in a particular field, such as water and sanitation, or housing and shelter. The main channels of communication are between the decision makers and directors who are responsible for activities in each particular sector, and the overall coordinators of intersectoral work (Danielsson 2016).

Preparedness and Business Continuity

Business continuity planning is a parallel process to emergency planning, with which it needs to interact. The goals of business continuity management, and the plans that it requires, are to ensure, as far as possible, that an organisation can continue its activities in times of crisis, that it can recover its productivity and its reputation (including its market position and share values if the organisation is in the private sector), and that it can bring the crisis under control (Hiles, 2010). In the private sector, failure to plan for business continuity can lead a company to bankruptcy if disaster strikes. Inertia during a crisis can seriously damage a company's reputation and thus its sales. However, although reputation management is an important business continuity activity, it cannot save an organisation on its own. It needs to be backed up by concrete actions to face the crisis and its consequences. Hence, business continuity requires that the material elements of the crisis be managed as well as the perceptual component associated with reputation. This means that emergency planning and business continuity planning are effectively parallel and linked processes that have a significant degree of mutual dependency (Paton and Johnston, 2017).

To prepare adequately for a business interruption requires a number of set activities. One is to understand exactly how an organisation functions during normal times, and how it would function under duress. Another is to know its core activities and its vulnerabilities. Besides disasters of natural hazard origin, businesses may be at risk of cyber-attack, sabotage of products or equipment, or the creation of products with faulty components. Major crises require a response from the whole organisation, including its heads and governing body. This ought not to be delegated, although there also needs to be a crisis management unit that coordinates activities, including public relations, communication with suppliers and customers, and the evaluation of legal obligations (Elliott et al., 2010).

Organisational resilience is a well-developed field which stems from the fact that organisations socialise risk, decision making and activities in such a way that individual contributions to the process are not quite the same as their total. Organisations thus learn differently from individuals (Toft and Reynolds, 2005). If an organisation encourages its employees to assume collective responsibility for risk and crisis management, then that is fertile ground for planning responses to emergency situations (Zhou et al., 2018). In favour of preparedness, organisations can encourage specific activities, such as prompt issuance of communiques, thorough knowledge of developing situations, flexible working methods, alternative methods and sites of production, robust supply chains, well organised emergency response, and strong internal communication. In many cases, a major element of this is redundancy, or the ability to substitute alternative means of production, supply, delivery, communication and so on, for those that have failed due to the crisis. This can be expensive and hard to justify in these days of 'lean' production methods. However, redundancy is not entirely about investing in equipment that lies unused until there is a crisis. It is also about developing alternative means of thinking through a crisis and alternative survival strategies

(McEntire, 1999). Generally, large multi-national corporations are well attuned to business continuity methods and have enough resources to support well developed programmes. The problem mainly lies with small and medium-sized enterprises many of which are short of resources, including the training required to appreciate the need for business continuity preparedness. These are the companies and organisations that are most likely to be put out of business when crisis or disaster strikes, as they have few alternative resources to fall back upon.

Preparedness for Pandemics

While disease outbreaks in general are, purely by convention, generally excluded from consideration in disaster risk reduction, this is not true of pandemics. This is because of the fact that they can cause severe social and economic disruption, as well as their health effects. A pandemic is a disease epidemic with major international connotations. Pandemics require international health measures in order to bring them under control. Global or large regional pandemics of non-seasonal influenza occur with a recurrence interval of about 35-40 years (Basili and Franzini, 2006).

Pandemics are worthy of special consideration because they are not merely medical problems. In fact, it is possible that the socio-economic effects of a pandemic could be as profound as its health effects, something that seems to be the case with the SARS virus Covid-19. Humans have no natural defences against pandemic viruses and it is not possible to manufacture vaccines in advance of the event. The potential consequence is rapid spread of infection and widespread sickness with a lethality that can rise to more than 10 per cent of hospitalised patients. A major pandemic could last for as long as two years, with varying impacts during that time as successive waves of infection occur. (Taubenberger and Morens,

2010). The socio-economic consequences stem from sickness and the desire of healthy people to limit social contacts in order to avoid infection, so-called 'social distancing'. Absenteeism from key services may be a problem, and economic sectors, such as entertainment and education, which involve people gathering together, are badly affected by changes in people's habitual behaviour (Bedford et al., 2020). Telecommunications assume paramount importance in place of face-to-face meetings (Bisset et al., 2011).

Preparedness for pandemics takes place along several different lines. Vaccines will be mass produced based on the strain of disease that evolves. This will take time. Meanwhile, medical resources are likely to be overwhelmed, or at least put under strain. Before the event, antiviral medicines can be stockpiled ready for distribution. However, critics have argued that their effectiveness is limited and they may reach their expiry date before they can be used. Other measures involve planning to keep essential services running, look after the sick, dispose of the dead, maintain public order, control infection (as far as possible), organise quarantine, and provide support to sectors of the economy that are deeply affected by the situation (Fineberg, 2014). The reactions of the general public would need to be monitored and information issued according to need. Essentially, preparedness plans need to take account of possibly radical changes in socio-economic conditions (Bisset et al., 2011).

Preparedness During Recovery from Disasters and Crises

On the face of it, post-disaster recovery is the antithesis of preparation. It is nevertheless a period in which preparedness can be built into the reconstruction process. This is the 'bounce forward' philosophy of resilience (Manyena et al., 2011), rather than the 'bounce back' kind that merely recreates pre-existing vulnerability. Hence, disaster often presents a major opportunity to improve safety and security by both structural and non-structural means. In

new and revised emergency plans, the disaster forms a major 'reference event' for scenarios of future impacts, answering the question "exactly what will occur, and what can be done, if and when it happens again?" Repairing buildings can incorporate safety measures as a means of retrofitting them. New buildings need to be built to higher standards with greater resistance to the forces inherent in hazards and disasters. Most hazard impacts increase our knowledge of future contingencies: in short, they teach a lesson. They thus contribute to the basis of preparedness and forewarning (Manyena et al., 2011).

Preparedness against disaster is a social activity that depends on certain forms of decision making. These in turn depend on perception, which is conditioned by direct experience of adverse events and by human cultures. Most disasters and civil contingencies are recurrent events, whether or not they occur on regular cycles. Where the intervals between significant impacts span human generations, knowledge and the impetus to act may be lost. It is thus common to experience a burst of activity after disaster strikes, but with declining commitment as the event recedes into an ever more distant past. Most societies have a problem with how to keep the memory alive with people who have no direct experience of disaster, but are nevertheless at risk and how to convince people to prepare for events that are, so far, hypothetical to their own experience. For this reason, although preparedness is usually given a high priority in the aftermath of disaster, after decades of quiescence, it tends to lose its salience (Tidball et al., 2010).

Conclusion

In *Leviathan*, Thomas Hobbes (1588-1679) argued that 'Prudence is a Praesumption of the Future, contracted from Experience of time Past. (Vanden Houten, 2002, p. 267). In the

610 modern world, few disasters are without precedent and thus they offer a historical basis for foresight and preparedness.

As this article has endeavoured to show, the process of preparing for civil contingencies embraces a wide variety of temporal and spatial scales, from short to long term, from family emergency plans to national ones, and from individual buildings to major
615 networks of infrastructure. Early attempts to deal with disaster were largely confined to reaction rather than prescription. Hence, emergency management developed before preparedness. Only since the start of the present millennium has the field become redefined as 'disaster risk reduction', embracing both preparation and reaction.

It is very difficult to estimate the value of preparedness, because this depends on
620 forecasts of the number of casualties and amount of damage and destruction that can be avoided by prior adoption of specific measures. However, virtually all estimates that have been provided give positive cost-benefit ratios of at least 1:2, many of them substantially larger than that (Shreve and Kelman, 2014). This begs the question of why preparedness is not more widespread and popular. One reason for this in democratic countries is that the time-
625 spans involved do not often coincide with the political cycle, in which results need to be achieved well within the five years or less that may elapse between elections. Another is the pervasive human tendency to gamble, and thus to defer or ignore the necessary preparedness measures. A third reason is the fact that vulnerability may be created by one party but suffered by another. Marginalisation occurs when poverty and lack of adequate representation
630 deprive groups of people of self-determination, power over their own destinies and basic rights, including the right to information. Thus, basic human rights are key elements of preparedness, as they underpin the ability to know about risks and act to reduce them.

Despite widespread restrictions on human rights, growing wealth divergence and increasing settlement of highly hazardous areas, preparedness against disaster is growing steadily in the modern world. In the 'top-down' mode it is coordinated by United Nations agencies, notably the UN Office for Disaster Risk Reduction (UNDRR, formerly the UN International Strategy for Disaster Reduction, UNISDR). Much of the problem now exists at the local level which is poorly served by the top-down approach (GNCSODR, 2011). Formidable challenges lie ahead. One hopes, for instance, that in the future disaster preparedness does is not overly dominated by social control, rather than autonomous organisation (Baker and Ludwig, 2018). Climate change is intensifying extreme meteorological events (drought, floods and storms) and wildfires. Very large earthquakes, tsunamis and volcanic eruptions are always possible. Toxic contamination and environmental destruction are ever-present risks. However, with more than a century of concentrated research on the causes, impacts and effects of disasters, we have the knowledge needed for adequate preparedness. The main challenge is thus to overcome the political and economic obstacles to putting that preparedness into practice.

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