TOOLS FOR MAINSTREAMING DISASTER RISK REDUCTION

Collecting and Using Information on Natural Hazards

Guidance Note 2

Tools for Mainstreaming Disaster Risk Reduction *is a series of 14 guidance notes for use by development organisations in adapting programming, project appraisal and evaluation tools to mainstream disaster risk reduction into their development work in hazard-prone countries. The series is also of relevance to stakeholders involved in climate change adaptation.*

Collection and use of information on hazards is part of many project and programme planning tools. This guidance note focuses on the basic processes of acquiring and using such information. It covers key elements of natural hazards information, its place in the project planning/management cycle, tools for gathering information, providers of information and issues to be considered when collecting and analysing data. Owing to the diversity of natural hazards and the types of information and data collection methods relating to each, this note can be no more than an introduction (see Further reading).

1. Introduction

A range of natural hazards threatens lives and development (see Table 1). By understanding and anticipating future hazard events, communities, public authorities and development organisations can minimise the risk of disasters. Failure to do so can be highly damaging to development programmes and projects (see Box 1). Yet development planners often fail to consider the threat of natural hazards sufficiently, and hazard and disaster risk management is often carried out independently of development activity. Even where hazards are taken into account, proper assessments are often thought to be too costly and time-consuming.

Programme and project planners and managers should understand the characteristics, location, frequency and magnitude of hazards and their potential impact on property and people. They should understand which hazards present a risk in the places where they work and the main characteristics of those hazards. They do not need to be hazards specialists, though they may need to work alongside them and, therefore, should know how to identify and contact experts in this field.

Table 1 Types of natural hazard

Type	*Description*	*Examples*
Hydro-meteorological	Natural processes or phenomena of atmospheric, hydrological, oceanographic or climatological nature	■ Floods, debris and mudflows ■ Tropical cyclones, storm surges, wind, rain and other severe storms, blizzards, lightning ■ Drought, desertification, wild fires, temperature extremes, sand or dust storms ■ Snow avalanches

Geological	Natural earth processes or phenomena	■ Earthquakes, tsunamis ■ Volcanic activity and emissions ■ Mass movements, landslides, rockslides, liquefaction, submarine slides ■ Surface collapse, geological fault activity
Biological	Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances	■ Outbreaks of epidemic diseases, plant or animal contagion and extensive infestations

Source: Modified from UN/ISDR (2004), p.39.

Box 1 **Some consequences of using, and neglecting, hazards information in development planning**

A study in 2003 examined factors influencing coastal erosion along a 60-kilometre coastline in La Union in the Philippines. Extensive data were collected on wave and wind action (including typhoons), slope angles, earthquakes and associated subsidence, shoreline substrates, presence and absence of natural buffers such as mangroves and coral reefs, shifts in the position of a river mouth, mining and other land uses, and coastal protection structures. As a result of the study's findings, municipal authorities decided to relocate settlements and schools, redesign seafront structures and rehabilitate mangroves.

In 1987 a report to the government of the Caribbean island of Montserrat highlighted the risks from the Soufrière Hills volcano to the capital, Plymouth, and many other facilities in the southern part of the island. The report was ignored and development continued regardless, even though the extensive damage to buildings caused by Hurricane Hugo in 1989 provided an opportunity for change. In a series of eruptions beginning in 1995, large areas in the south of the island were affected. Much of the capital was destroyed and many other facilities, including the airport, were made unusable. Three-quarters of the remaining population, and most of the critical facilities, had to be relocated permanently. More than 60 per cent of the land area is now officially designated as unsafe for human habitation or activity.

Sources: Berdin, R. et al. 'Coastal erosion vulnerability mapping along the Southern coast of La Union, Philippines'. In ProVention Consortium, *Applied Research Grants for Disaster Risk Reduction: Global Symposium for Hazard Risk Reduction, July 26–28, 2004*. Geneva: ProVention Consortium, 2004, pp 51–68. Available at: http://www.proventionconsortium.org/themes/default/pdfs/AG/berdin.pdf; Siringan, F.P. et al. 'A challenge for coastal management: large and rapid shoreline movements in the Philippines'. In UN/ISDR, *Know Risk*. Geneva: United Nations International Strategy for Disaster Reduction, 2005, pp. 218–19; Clay, E. et al. *An Evaluation of HMG's Response to the Montserrat Volcanic Emergency.* 2 vols. London: Department of International Development (UK), 1999.

2. Natural hazards information: key elements

Natural hazards information helps project planners to:
- recognise and understand natural hazards in the project area;
- identify knowledge gaps;
- identify risks to the project from natural hazards, now and in the future; and
- make decisions about how to deal with those risks.

Information on the following key features of natural hazards is needed to identify past, present and potential hazards and their effects:
- *Location and extent*. Is the programme or project area affected by one or more natural hazards, what types of hazard, and where?
- *Frequency and probability of occurrence*. How often are hazard events likely to occur (in both the short and the long term)?

- *Intensity/severity*. How severe are the events likely to be (e.g., flood levels; speed of winds and volume/rate of rainfall during hurricanes; magnitude and intensity of an earthquake)?
- *Duration*. How long will the hazard event last (from a few seconds or minutes in the case of an earthquake to months or even years in the case of drought)?
- *Predictability*. How reliably can we predict when and where events will happen?

Information about the speed of onset of a hazard event is principally relevant to disaster preparedness and early warning systems but may also have a bearing on planning decisions (e.g., planning secure evacuation routes).

Project planners should also be aware of:

- secondary hazards resulting from a hazard event (e.g., landslides triggered by an earthquake or heavy rainfall; fires in buildings set off by earthquakes; dam failure due to floodwaters);
- hazards outside the project area that could affect it (e.g., by cutting off supplies of power or raw materials, displacing communities); and
- how hazard events occur, including not only natural physical processes but also the impact of human activities that create or exacerbate hazards (e.g., deforestation causing slope instability and hence landslides).

The potential impact of the project itself on existing or potential hazards is normally dealt with through environmental impact and social impact assessments (**see Guidance Notes 7 and 11**), but it is a significant issue that must be assessed during project planning, with appropriate mitigation measures incorporated into project design.

Hazards are not static phenomena and hazard risk exposure will change over time. Ideally, therefore, one should understand future changes in hazard risk over given periods: a 'probabilistic' hazards assessment, rather than a 'normative' one based on current conditions. This is particularly relevant to climate change, which may have a significant effect on the patterns and trends of natural hazards and disasters. Note, too, that hazards can have positive as well as negative effects (e.g., floods deposit fertile sediments).

Hazards information should be used to support decision-making about how the project will manage any hazard threats that are identified. If the threat is not regarded as significant, changes to project design may be unnecessary. If it is severe, planners may decide not to go ahead in that location. In between these extremes, a variety of structural and non-structural mitigation measures may be introduced to protect the project or programme and its target groups.

The project appraisal (or preparation) process involves weighing up a number of different factors (environmental, social, economic, etc.), as well as hazards. Projects may have competing objectives that have to be balanced. Planners must, therefore, agree explicitly and openly in each case how much weight to give to particular hazards in their design decisions.

3. Use of hazards information in the project cycle

Hazards data collection and analysis should begin at the earliest possible stage in the project cycle and continue throughout the planning process, generating progressively more detailed information (for more information on the project cycle, **see Guidance Note 5**).

Significant[1] hazards should be identified early in the cycle, during the project identification phase. If significant threats are identified, further information gathering and analysis will be required.

In the identification and appraisal phases, collection and interpretation of hazards information usually form part of (or feed into) other essential project appraisal activities, especially risk analysis, vulnerability assessment and environmental appraisal (**see Guidance Notes 6, 7 and 9**). They can also be incorporated into various economic and social appraisal methods (**see Guidance Notes 8, 10 and 11**) and into decisions on construction design and site selection (**see Guidance Note 12**). It is important that hazards information and assessment do not stand alone but are fully integrated into these other planning tools.

1 It is not only large-scale hazard events (e.g., major earthquakes) that may be significant as far as an individual project is concerned. Small-scale, localised hazards (e.g., floods, landslides) may also be important if they are numerous and widespread in the project area.

The amount of information required and its form (including the level of accuracy, speed of data collection and scale) will vary according to the nature of the hazards and the type of project, as well as the phase of planning and the type of appraisal tool being used (see Section 4).

Table 2 presents a model for incorporating hazards questions and decisions into the project cycle (note that hazards monitoring and updating information continue after project implementation has begun).

Table 2 Incorporation of hazards information in the project cycle

Project cycle phase	*Key activities*	*Incorporation of natural hazards information*	*Knowledge outcomes and decisions*
Programming	Establish general guidelines and principles; agree sectoral and thematic focus; outline broad ideas	Guidelines and principles identify need for natural hazards information and outline approach to obtaining and using it	Guidance to planning team on approach to collecting and using natural hazards information
Identification	■ Carry out stakeholder analysis ■ Identify and screen ideas for projects ■ Decide which options should be developed further	■ Identify target areas and their environmental characteristics ■ Collect basic information including natural hazards data ■ Determine general significance of natural hazards in and affecting project areas	■ Awareness of significant natural hazards in project area ■ Understanding of information gaps and needs ■ Provision made for obtaining such information
Appraisal/ preparation/ formulation	■ Study all significant aspects of the idea ■ Develop logical or results-based planning frameworks ■ Draw up activity and implementation schedules ■ Calculate required inputs ■ Decide to take the project forward, or not	■ Detailed information on hazard, vulnerability and risk ■ Preparation of hazard, vulnerability and risk assessments ■ Production of hazard and land use maps ■ Reviews of technical, social and economic viability	■ Knowledge of location, severity, probability of occurrence and other key features of natural hazards within specific time frame in project area ■ Identification of vulnerable locations: human settlements; production facilities; critical facilities ■ Identification of critical hazards-related issues and constraints likely to affect project ■ Determination of expected damage to people, property/facilities, economic activities and disruption to implementation plans ■ Selection of best project options ■ Development of mitigation strategies
Implementation	Implementation of planned development project activities	Ongoing monitoring of natural hazards' impact on project and its beneficiaries	■ Adoption of risk mitigation and vulnerability reduction measures (including emergency preparedness and response plans) ■ Modifications to design and implementation arrangements where appropriate
Evaluation	Assessment of achievements and impact	Review planning assumptions relating to likely impact of natural hazards on project	■ Decision to continue, change or stop project ■ Conclusions taken into account when planning and implementing similar projects

Adapted and developed from: OAS (1991), pp 1/17–1/22.

4. Hazards information: needs, types and sources

Information needs and types

Planners draw on a variety of hazards data, depending on the nature of the project and the hazards concerned, as well as the data's accessibility and applicability.[2] Much of this information is likely to be scientific, comprising spatial and numerical data relating to the hazard, particularly in the form of maps (see Box 2), ongoing monitoring, scientific studies and field survey reports. New technologies such as remote sensing and geographical information systems (GIS) are revolutionising capacity to analyse hazards. Such data can also be used to model potential hazard events.

Box 2 Hazard maps

Mapping is a central tool in hazard identification and assessment. Maps can accurately record the location, probable severity and likelihood of occurrence of hazards and display this information clearly and conveniently. They can be to any appropriate scale or level of detail, making them equally useful for national- and local-level planning.[3]

The type of information recorded varies according to the hazard under investigation. In the case of earthquakes, for instance, it might include geological fault lines, areas of recorded seismic activity and types of soil and bedrock; for floods, topography, geomorphology and previous areas of inundation.

Mapping may be based on a range of data sources (e.g., existing maps, remote sensing, surveying). Additional information from photography, field surveys and other sources can be overlaid onto base maps – geographical information systems are making this much easier. Community hazard mapping exercises can also be undertaken. Communities are often knowledgeable about the location and nature of local hazards and their causal factors. Such information is particularly valuable in identifying and appraising localised hazards but community-level outputs can also feed into higher-level mapping and planning.

Maps are a good medium for communicating hazards information to decision-makers but often need interpreting – to both non-specialists, who may not be used to seeing information in this form, and educated users, who may be unfamiliar with the particular formats and symbols being used. In all cases the meaning of the data presented should be thoroughly discussed and understood.

Table 3, which focuses on the main geological and hydro-meteorological hazards worldwide, outlines the information needs of development planners and the main data types, or methods of acquiring data, in each case. The method(s) selected will depend upon the availability of resources and the intended application of the data collected.

Table 3 Hazard information: Types, sources, assessment methods

Type of hazard	*Information needed by development planners*	*Data types/sources/assessment methods*
Hydro-meteorological		
Floods (river and coastal)	■ Extent and location of flooded or flood-prone area ■ Depth and duration of flood ■ Velocity of water flow ■ Rate of rise in water level and discharge ■ Amount of mud deposited or held in suspension ■ Frequency and timing of occurrence (including seasonality)	■ Historical records of frequency, location, characteristics and impact of past events ■ Meteorological data: rainfall (and snowmelt) records and monitoring (e.g., rain gauges) ■ Topographic mapping and height contouring around coastlines, river systems and catchment areas; geomorphological mapping; sequential inundation stages mapping

2 For example, the study of coastal erosion in the Philippines (Box 1) drew on documentation (especially maps) of shoreline and bathymetric (water depth) changes, new bathymetric and GPS (global positioning system) surveys, interviews with local residents and aerial photographs.
3 Three-dimensional mapping is also possible, using software for digital elevation modelling; so is four-dimensional mapping, with computerised animations incorporating a time component.

Type of hazard	Information needed by development planners	Data types/sources/assessment methods
	■ Rainfall (and snowmelt) volumes and intensities in flood-prone areas and their surroundings ■ Natural or man-made obstructions to flows and flood-control structures ■ Warning period ■ In coastal areas: tidal ranges and patterns of on-shore winds; height of sea-surges induced by cyclones	■ Natural resources and land use mapping ■ Estimates of capacity of hydrology system and catchment area ■ Hydrological data on flows, magnitude (including flood peak discharges) and frequency of floods, river morphology, infiltration properties of soil ■ Hydrological estimates of future flood discharges, flows and associated characteristics; flood frequency analysis ■ In coastal areas: tidal and sea-level records, meteorological data on windspeeds and directions ■ Long-term and seasonal weather forecasts; climate change models
Windstorms (including hurricanes/tropical cyclones and tornados)	■ Locations and extent of areas likely to be affected ■ Frequency of occurrence (including seasonality) and directional patterns ■ Velocity and direction of wind; wind and gale severity scales (e.g., Beaufort); local hurricane/typhoon scales ■ Associated pressure conditions, rainfall and sea/storm surges ■ Warning period	■ Historical and climatological records of frequency, location, characteristics (including cyclone and tornado paths) and impact of past events on the project area and neighbouring areas (or countries) facing similar conditions ■ Meteorological records of wind speeds and direction at weather stations ■ Long-term and seasonal weather forecasts; climate change models ■ Topography and geomorphology of affected land areas (where there is risk of flooding from heavy rainfall or sea surges; see also flood data)
Drought[4]	■ Rainfall levels, deficits ■ Frequency and timing of rainfall and drought occurrence (including seasonality); length of drought periods ■ Water levels (groundwater, rivers, lakes, etc.) ■ Water retention qualities of soils ■ Warning period ■ Associated biological features (e.g., pest infestation, invasive plants)	■ Rainfall and snowmelt monitoring (e.g., rainfall gauges) and mapping ■ Soil type and moisture content surveys/analysis ■ Water source surveys and monitoring ■ Vegetation surveys (including mapping, aerial photographs) and crop production monitoring ■ Historical records of frequency, location, characteristics and impact of past events (including long-term records of rainfall fluctuations) ■ Long-term and seasonal weather forecasts; climate change modelling
Geological		
Earthquakes	■ Location and extent of known seismic hazard zones, epicentres, faults, fault systems, etc. ■ Magnitude (energy release at epicentre) and intensity (severity of ground shaking) of earthquakes in the area ■ Other geological, geomorphological, hydrological features that influence ground shaking and deformation	■ Zoning and micro-zoning (mapping/recording all seismological, geological, hydrogeological parameters needed for project planning in a given area, based on sources below) ■ Maps of seismic sources (faults, fault systems) ■ Geological, geomorphological maps and surveys (see also landslides)

4 The focus here is on meteorological drought (i.e., when rainfall drops below a certain level) and hydrological drought (reduction in water resources), that is to say on the hazard itself, rather than agricultural drought (impact of the other two kinds of drought on crop yields).

Type of hazard	Information needed by development planners	Data types/sources/assessment methods
	■ Potential secondary effects: landslides, mudslides, avalanches; floods resulting from dam failures or tsunamis; fires; pollution from damage to industrial plants ■ Frequency of events	■ Data on past occurrence of earthquakes, their location, characteristics (magnitude, intensity, etc.) and effects ■ Calculations of maximum ground accelerations
Volcanoes	■ Location of volcanoes and current state of volcanic activity (active, dormant, extinct) ■ History, frequency and character of each volcano's eruptions and the processes that produce them ■ Areas at risk from eruptions; radius of fall-out or direction of flow of eruptive materials ■ Volume and type of material ejected (e.g., ash falls, pyroclastic flows, lava flows, lahars, gas emissions) ■ Explosiveness and duration of eruption ■ Warning period	■ Geological studies and maps, based on geological survey evidence of frequency, extent, nature of previous eruptions ■ Hazard/zoning maps (based on geological data) ■ Historical records of frequency, location, characteristics and impact of past events ■ Monitoring and observation/recording of precursory phenomena (including seismicity, ground deformation, hydrothermal phenomena, gas emissions)
Landslides	■ Volume and type of material dislodged, area buried or affected, velocity ■ Natural conditions affecting slope stability (composition and structure of rock and soil, inclination of slopes, groundwater levels) ■ Other external triggers: seismicity, rainfall ■ Vegetation and other land use (including building activities, landfill, man-made mounds, garbage pits, slag heaps, etc.)	■ Identification of location and extent of previous landslides or ground failures by surveys, mapping, aerial photography ■ Mapping/surveys of rock formations and characteristics, surface geology (soil types), geomorphology (slope steepness and aspect), hydrology (esp. groundwater and drainage) ■ Historical records of frequency, location, characteristics and impact of past events ■ Identification of probability of triggering events such as earthquakes, cyclones, volcanic eruptions ■ Vegetation and land use mapping and surveys ■ Zoning maps, based on the above

Sources: Adapted from: Borton, J. and Nicholds, N. *Drought and Famine*. New York: United Nations Development Programme, Department of Humanitarian Affairs (UNDP/DHA), Disaster Mitigation Training Programme module, 1994. Available at: http://www.undmtp.org/english/drought andfamine_guide/drought_guide.pdf; Coburn, A.W., Spence, R.J.S. and Pomonis, A. *Disaster Mitigation*. New York: UNDP/DHA Disaster Mitigation Training Programme module, 1994. Available at: http://www.undmtp.org/english/Disaster_mitigation/disaster_mitigation.pdf; UNDRO. *Mitigating Natural Disasters: Phenomena, Effects and Options. A Manual for Policy Makers and Planners*. New York: Office of the United Nations Disaster Relief Co-ordinator, 1991.

Information providers

The following list outlines the main types of hazard information provider:

- Vulnerable communities and other local stakeholders, whose environmental knowledge can be obtained through surveys and participatory appraisal.
- State disaster management agencies, planning organisations, other ministries and departments,[5] and public utilities (which generate hazard, risk, vulnerability and disaster impact data sets and maps). The military often have good hazards data, although it may not be easy to obtain (see Access to information in section 5).
- National and international scientific research and monitoring institutions such as meteorological offices, volcano observatories, geological surveys (which produce maps showing hazards and hazard-prone zones, install and operate monitoring systems and maintain the data sets collected, and carry out surveying, research and modelling) and space investigation agencies (which collect remote observation data).
- International development and disaster management organisations, notably regional management disaster agencies and documentation centres, and United Nations (UN) operational agencies (which produce diverse information materials including maps, disaster impact data, research studies and field reports).

5 Many different government departments may collect this kind of data, for instance, agriculture, health, transport and defence departments, and national organisations responsible for building codes and standards.

- Other non-state organisations, such as libraries, archives, the media, universities, research institutes, insurance companies and non-governmental organisations (also with varied information products).

Information gathering and dissemination initiatives are expanding at all levels, particularly the international (often with the support of UN and other international agencies) or bilateral donors. Hydro-meteorological hazards are particularly well served (see Box 3). The media and the Internet are also becoming increasingly important channels for dissemination. There are now a number of online databases containing high-quality information on hazards and disasters. The UN International Strategy for Disaster Reduction's publication *Living with Risk* (2004) lists many global, regional and national providers of hazards information, much of it available online.

Box 3 **Collecting and disseminating hydro-meteorological information**

The World Meteorological Organization (WMO) coordinates a global network of national meteorological and hydrological services from 187 member countries, which collect and share weather, water and climate data. Information is collected from 18 satellites, hundreds of ocean buoys, ships, aircraft and nearly 10,000 land stations. More than 50,000 weather reports and several thousand charts and digital products are disseminated each day through the WMO's global telecommunications system. This information is used for analysis of atmospheric and climatological conditions to produce forecasts and warnings, particularly for extreme events. At the national level, these agencies maintain data archives and databases providing historical data that can be used to assess future events and trends.

Source: World Meteorological Organization. 'Reducing risks of weather, climate and water-related hazards'. In UN/ISDR, *Know Risk*. Geneva: United Nations International Strategy for Disaster Reduction, 2005, pp 74-5.

5. Critical factors in data collection and use

Information on hazards should be accurate, reliable and comprehensible to planners (or at least capable of being explained easily, where it has been produced for other users or purposes). It must also cover all significant hazards.

Access to information

At an early stage, project and programme planners should consider where relevant and reliable hazards information is located and the potential ease or difficulty of obtaining it (including the likely time and resource implications).

Much of the information may be in the public domain (see section 4, Information providers). But in some countries it may remain restricted. Maps, for instance, are sometimes considered too militarily, politically or commercially sensitive to share. Most information from official sources is subject to regulations governing access and disclosure. Considerable time and effort may be necessary to obtain even open-access information from slow-moving bureaucracies. Project planners should encourage transparency and knowledge building by sharing their own findings with other organisations.

Box 4 **Challenges in access to information**

Following the 2001 earthquake, the Gujarat State Disaster Management Authority in India commissioned the Delhi-based consultancy TARU to produce a comprehensive hazard risk and vulnerability atlas covering the 25 districts and 226 sub-districts that make up the state. Completed in 2005, the atlas covers risks from six natural and man-made hazards and the physical, social and economic vulnerability of the population, buildings, infrastructure and economy.

One of the main challenges to this ambitious undertaking was the collation and validation of public data from over 20 departments and agencies at state and national levels, all of which had to be digitised and incorporated into a common spatial database. Demographic data and information on settlements, industries and commercial establishments were relatively easy to obtain. However, obtaining map data was more difficult because of the Indian government's security restrictions on public access to maps of areas bordering Pakistan, which includes much of Gujarat. To overcome this problem, extensive use had to be made of remote sensing to construct thematic maps and locate roads, bridges and settlements; this was costly. In addition, no topographical or bathymetric data for Gujarat are in the public domain, although this was crucial to assessing risk of flood and storm surge inundation; here, the project had to use NASA data.

Collating and validating large hazard event time series and geographically precise risk data was a major challenge. Multiple sources were drawn upon to enable triangulation and consistent data series, especially for drought (precipitation), earthquakes and cyclone tracks to produce statistically acceptable sample sizes to fit extreme value distributions. The availability of data from only one public source on flooding and chemical accidents was a particular challenge, as cross-validation was not possible.

No systemic vulnerability or fragility functions exist for India or Gujarat's physical infrastructure, economy, populations and communities. These had to be painstakingly estimated using past disaster loss studies and stratified sample surveys across the state. In some areas, especially in the case of infrastructure vulnerability, international cases and research were used to benchmark fragility functions, as an adequate record of local loss was not available. A mixed sample of events across India was used to estimate the fragility functions for post-disaster loss of life.

Source: Information provided by A. Revi, Director, TARU, Delhi, India.

Data quality

Planners will seek to obtain as much existing hazard information (processed or raw data) as possible for their assessments, drawing upon a variety of information providers (see section 4, Information providers). A high level of accuracy and detail is often possible in hazard assessment, for example, visually through maps, remote sensing and GIS, and in prediction such as complex flood models that model rainfall to run-off, the movement of floodwaters through waterways and flood plains, and inundation areas. (Simulations and scenarios can also be useful in assessing how the proposed project might exacerbate or mitigate hazards and how future development might affect the predominant hazard patterns in the project area.)

However, in many situations it will be necessary to work with incomplete or outdated data sets. Not all countries have extensive hazards data; many find it difficult to collect and maintain comprehensive data sets because of cost and skills shortages. Early consultation with technical experts will help to identify and overcome such problems.

Carrying out new studies is costly and time-consuming but field surveys (e.g., mapping topography and vegetation, taking soil samples) may be required where recorded information is limited, to verify data from other sources or to resolve uncertainties.

It may not be necessary to rely on sophisticated technologies and outside specialists in surveying. Visual surveys by experienced people can identify areas at risk from landslides; simple stream gauges or flood marks can be used to monitor water levels and identify areas likely to be flooded; and local people's knowledge of hazards is often more accurate and extensive than outsiders appreciate. Many community projects carry out participatory surveys (e.g., transect walks, community mapping, timelines and seasonal calendars) that complement or compensate for more formal scientific data.

Hazards information is often not collected or presented consistently, and so is to be found in a variety of formats (e.g., mapping to different scales). Project planners should be clear from the start about the formats they wish to work in, bearing in mind their compatibility with other information systems in use by the organisation concerned, and the types and formats in which existing data are most likely to be available. This has time and resource implications, which have to be factored into the planning process. Consistency in recording data is equally essential and is not always straightforward (e.g., cataloguing hazards can be complicated where a primary hazard such as a cyclone triggers secondary hazards such as floods and landslides).

A great deal of valuable evidence about the location, impact and frequency of hazard events may be obtained from historical records (written and oral), archaeological findings, professional reports or research studies of various kinds, local observation, damage reports, and newspaper and magazine articles. On the Internet, the volume of open-access geospatial information such as maps and satellite images is growing rapidly. Planners commonly use quantitative and qualitative evidence from such sources, particularly where other data are missing or difficult to obtain. Online disaster data sets and national risk indices provide additional information for country-level programming (**see Guidance Note 4**).

In all cases, planners must make their own judgements about the quality and relevance of the information that is available.

Capacity to collect and use data

Information is collected for a purpose: to guide decision-making. Adequate time and resources should be allocated to the assessment of hazards based on the data gathered. Planners often overemphasise data collection compared to analysis. As noted above, hazards information is usually collected to feed into other project appraisal activities, particularly risk analysis.

Information collection and analysis systems should be as simple and practical as possible, based on planning teams' human, technical and material capacities. The cost and time needed for assessments must also be taken into account.

Assessments using existing or less detailed data, or focusing on selected key hazard characteristics, may be deemed sufficient in some cases,[6] but in many instances additional scientific or technical expertise will be needed. Adoption of new technologies (e.g., GIS, remote sensing) may place considerable demands on human and system capacities.

Highly technical information generated by scientists or engineers may need explaining to non-scientific users. It is advisable to bring different technical specialists (including natural and social scientists, and planners) together at the earliest possible stage to facilitate mutual understanding and communication.

Uncertainty and decision-making

Understanding hazards can be a complex process because it is often based on a combination of data sets. For example, in assessing landslide hazards at a particular site, scientists will look at past history, slope steepness and orientation, bedrock, rainfall, groundwater and vegetation, because specific combinations of these factors are associated with different types of landslide. A planner would add land use to this list, as development activities can increase landslide hazard risk, even in areas not previously affected. Where there are multiple hazards the challenge becomes more complex, because different assessment techniques and results have to be brought together.

It may not be possible to assess some features of the hazard owing to limitations in the current state of scientific knowledge. Evidence may not be clear-cut, even to experts. Probabilistic calculations of hazard risk are often problematic. For example, it is difficult to predict the location and timing of landslides precisely, although there is sufficient understanding of landslide processes for estimates of potential hazards. Similarly, estimates of frequency often have to be derived from records of previous events. Experts may disagree over interpretations of evidence.

It is important to define clearly what information is needed for decision-making, and the level of detail required, before starting data collection. This should be reviewed from time to time as the planning and appraisal process progresses, and the information needs and availability become clearer. It is also essential to identify explicitly gaps and ambiguities in the evidence and areas where the analysis is contested. In all cases, clear procedures for reaching planning decisions are required, which should be laid down in advance.

6 For example, the recent Kathmandu Valley Earthquake Risk Management Project (KVERMP), where the emphasis was on informing and mobilising local institutions to protect existing urban developments, chose to use the available geological and seismological data, allied to an imported methodology for developing damage scenarios, rather than undertake new seismic micro-zoning and soil amplification studies. Dixit, A.M. et al. 'Hazard mapping and risk assessment: experiences of KVERMP' in ADPC (2004).

Box 5 Hazard and disaster terminology

It is widely acknowledged within the disaster community that hazard and disaster terminology are used inconsistently across the sector, reflecting the involvement of practitioners and researchers from a wide range of disciplines. Key terms are used as follows for the purpose of this guidance note series:

A *natural hazard* is a geophysical, atmospheric or hydrological event (e.g., earthquake, landslide, tsunami, windstorm, wave or surge, flood or drought) that has the potential to cause harm or loss.

Vulnerability is the potential to suffer harm or loss, related to the capacity to anticipate a hazard, cope with it, resist it and recover from its impact. Both vulnerability and its antithesis, *resilience*, are determined by physical, environmental, social, economic, political, cultural and institutional factors.

A *disaster* is the occurrence of an extreme hazard event that impacts on vulnerable communities causing substantial damage, disruption and possible casualties, and leaving the affected communities unable to function normally without outside assistance.

Disaster risk is a function of the characteristics and frequency of hazards experienced in a specified location, the nature of the elements at risk, and their inherent degree of vulnerability or resilience.[7]

Mitigation is any structural (physical) or non-structural (e.g., land use planning, public education) measure undertaken to minimise the adverse impact of potential natural hazard events.

Preparedness is activities and measures taken before hazard events occur to forecast and warn against them, evacuate people and property when they threaten and ensure effective response (e.g., stockpiling food supplies).

Relief, rehabilitation and *reconstruction* are any measures undertaken in the aftermath of a disaster to, respectively, save lives and address immediate humanitarian needs, restore normal activities and restore physical infrastructure and services.

Climate change is a statistically significant change in measurements of either the mean state or variability of the climate for a place or region over an extended period of time, either directly or indirectly due to the impact of human activity on the composition of the global atmosphere or due to natural variability.

7 The term 'disaster risk' is used in place of the more accurate term 'hazard risk' in this series of guidance notes because 'disaster risk' is the term favoured by the disaster reduction community.

Further reading

ADPC. *Proceedings: Regional Workshop on Best Practices in Disaster Mitigation – Lessons Learned from the Asian Urban Disaster Mitigation Program and Other Initiatives, 24–26 September 2002, Bali, Indonesia.* Bangkok: Asian Disaster Preparedness Center, 2004. Available at: http://www.adpc.net/audmp/rllw/default.html

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Organization of American States Caribbean Disaster Mitigation Project website contains reports, studies and other documents illustrating the application of hazards information in mitigating the impact of natural disasters on development: http://www.oas.org/cdmp

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Tools for Mainstreaming Disaster Risk Reduction is a series of 14 guidance notes produced by the ProVention Consortium for use by development organisations in adapting project appraisal and evaluation tools to mainstream disaster risk reduction into their development work in hazard-prone countries. The series covers the following subjects: (1) Introduction; (2) Collecting and using information on natural hazards; (3) Poverty reduction strategies; (4) Country programming; (5) Project cycle management; (6) Logical and results-based frameworks; (7) Environmental assessment; (8) Economic analysis; (9) Vulnerability and capacity analysis; (10) Sustainable livelihoods approaches; (11) Social impact assessment; (12) Construction design, building standards and site selection; (13) Evaluating disaster risk reduction initiatives; and (14) Budget support. The full series, together with a background scoping study by Charlotte Benson and John Twigg on *Measuring Mitigation: Methodologies for assessing natural hazard risks and the net benefits of mitigation*, is available at http://www.proventionconsortium.org/mainstreaming_tools

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