CROSS-CUTTING SECTOR

ENVIRONMENT

PDNA GUIDELINES VOLUME B

GFDRR
Global Facility for Disaster Reduction and Recovery

WORLD BANK GROUP

CONTENTS

INTRODUCTION

The main objective of PDNA–Environment is to prepare a recovery strategy that guides the restoration of environment and natural resources damaged due to a disaster. This should also enable environmentally friendly rebuilding in all sectors. The recovery plan also supports the restoration of environment and natural resources as a disaster risk reduction (DRR) strategy.

ASSESSMENT PROCESS

Environment affects all sectors of economic and social activity. Hence the strategy used in this guideline is to consider only those aspects of post-disaster effects and impacts not covered in other sub-sectors.

Due to the cross-cutting nature of the environment, the Environment PDNA team (ENA) needs to work closely with other sector teams, and also possibly participate in (or learn from) key consultations. The coordination with other sector teams is also important to avoid repetition in calculating the effects and impacts.

This guideline contributes to the methodology for post-disaster assessment by strengthening the estimation of needs for human development recovery; governance and institutional capacity; disaster risk reduction as it relates to the environment; and access issues associated with a post-disaster situation.

The first action to be undertaken, after a decision has been made to conduct a PDNA for the environmental sector in case of a specific disaster in a country, is a scoping exercise. In the base case scenario, this should be done in the country after a preliminary evaluation of the available data on the disaster.

The following information should be gathered during the scoping exercise:

1. Type of disaster, intensity and geographical scope;
2. Population impacted by disaster, disaggregated by age and sex in each geographical territory (like state or district);
3. Key environmental segments impacted and typical services each provides;
4. Key institutions (national, local) involved in environmental governance;
5. Key stakeholders involved in the rescue and relief operations;
6. Overall scope and timeline for the PDNA; and
7. Possible sources of required data.

In case of major disasters, it would be useful for the team leader to have made at least an initial reconnaissance trip of the site ahead of finalising the scope of work so that s/he might be able to advise members of the team about the overall situation. Visual aids such as photographs should be taken to familiarise people; these are also an excellent additional reference source and should, if possible, be taken with referenced metadata. Maps should be consulted and annotated as required.

DATA COLLECTION IN THE FIELD

The fieldwork should have four components:

- Collecting information from the field;
- Institutional capacity assessment;
- Stakeholder consultation, including a good representation of population subgroups such as youth, men, women, ethnic groups; and
- Exchanges with other sectoral teams undertaking field work to triangulate information and minimise duplication.

Building on information obtained from the pre-disaster analysis (which is described in the next section) and with some knowledge already of the scale and extent of the disaster, an attempt should be made to map the situation to identify areas at risk (such as specific communities or vulnerable ecosystems) and begin to identify possible hazards in each. Possible steps to follow include:

1. Obtain or create a base map of the area using available information, satellite images, local knowledge, etc.;
2. Identify where the impacts of the disaster have been most severe, also noting relevant changes to infrastructure, housing, and so forth;
3. Pinpoint areas that may be at further risk (from secondary disaster-related impacts or those which might be affected by unsustainable exploitation of natural resources);
4. Identify which measure might be needed—and whom to consult—in order to help mitigate further impact on the environment;
5. Identify the key institutions and stakeholders who are impacted and/or need to be consulted; and
6. Identify the typical services provided by the environment.

DATA GATHERING

Existing Data Sources: Data gathering is always a challenge. This is all the more true immediately after a disaster when people who have access to the data have other pressing commitments to attend to. The assessment teams should be aware of this fact and be strategic in their data gathering, trying to maximise data sharing between teams. Teams should also be prepared to work with the available less than ideal data and supplement data gaps with primary data gathering, remote sensing and expert judgment.

The following information and the steps to collect primary data , which is primarilly the government's responsibility, are suggested:

1. Prepare a plan, and guide for field studies of affected areas and, if possible, also of unaffected and/or pristine areas;
2. Establish a plan of personal interviews (see the following step), in coordination with relevant and appointed national contacts;

3. Meet with people in positions of responsibility, appointed technical specialists and other figures with knowledge and responsibilities or information relevant to the case in question;
4. Conduct field interviews with university researchers, officials, government spokespersons and community leaders while appraising other on-site studies or existing assessments; and
5. Meet with local community-based organisations (CBOs), women, men, indigenous communities where applicable, who might local knowledge of impacted areas as well as the resulting impacts on people's livelihoods.

Based on the available information regarding the nature of disaster, and the primary data gathered, each specialist as part of the ENA team may prepare a list of the relevant information desired for the detailed analysis of the effects and also for the identification of needs. Then the possible secondary sources of data can be identified. The following generic sources of information are to be searched:

a. Published and confidential information from UN and other international agencies, including from other assessments of the disaster;
b. Information available with the agencies of the national governments;
c. Information available with international and local NGOs;
d. Information available in published literature in general;
e. Consultation with officials of other UN agencies and national/regional governments;
f. Information collected (and surveys conducted) by other UN/national agencies in this specific context after the disaster (It is likely that there are other post-disaster assessments in the area before the ENA): and
g. Consultation with the affected population. (If possible, some parts of this consultation can be carried out in the form of primary surveys.)

Many available sources of information within national/regional governments of the disaster-affected country may be useful to ENA. These may include:

1. Government ministries such as those for the environment or natural resources (if different), forestry, water, livestock, agriculture, and so forth;
2. National or regional disaster preparedness plans;
3. Geographical, geomorphologic and climatic maps of the country/region;
4. Community structures, including women's groups, that may have a role in managing natural resources;
5. State of the environment reports; and
6. National level databases such as Census, National Health Surveys, etc.

The degree of data which can be collected during a PDNA exercise depends on the geographical extent of the disaster-impacted area, the time available to undertake the PDNA and funding. Detailed primary data gathering

may be difficult and one has to depend on a combination of approaches (some of which are mentioned below) to provide the team with the necessary data:

1. Satellite image analyses to capture the big picture elements;
2. Compiled data from government sources;
3. Data collected by chamber of commerce, farmer bodies and other agencies;
4. Data collected through field agents employed collectively for the PDNA process; and
5. Data collected by other sectors, directly or from other sources.

The PDNA team makes every effort to verify data collected on the most critical environmental issues and to secure additional data to fill data gaps. In addition to this, efforts must be made to sift information collected from satellite image and triangulate secondary sources. The checklist in Appendix II may be used as a tool for collecting primary data. However, please keep in mind that this is a generic checklist and it needs to be expanded and adapted based on the specific disaster situation.

EXPECTED OUTPUT

The needs assessment should lead to a detailed report on the effects and impact on the environment due to disaster, and to the sector's recovery plan. It includes the damage and changes in economic flows (or losses) wherever possible to estimate such values; and also the needs and costs of rebuilding the environment. A standard outline for the PDNA sectoral report has been suggested and this should be complied with, subject to any specific country agreement made with the overall PDNA team.

A combined PDNA document is produced at the end of the PDNA exercise, which will factor in the key recommendations and cost estimations made in the Environmental Sector report. However, the Environmental Sector report will have much more information that will be useful to national actors. It is therefore recommended that all efforts be made to publish the Environmental Sector PDNA document either as an annex or supplement to the main report.

TEAM FOR PDNA-ENVIRONMENT

Undertaking a full PDNA of an environmental sector issue needs a small team of environmental experts, under the coordination of a team leader. Members of such a team should have specialised domain knowledge based on the key environmental segments impacted, identified from the original scoping exercise. The team leader should have a clear understanding of the overall PDNA process and how the environmental issues dovetail with the exercise.

An ideal PDNA team may have experts, especially on environmental economics, who provide technical support to the team. During the assessment itself, all team members should hold meetings at least daily to share information, identify any problems or gaps, and plan for the next day's activities.

PRE-DISASTER INFORMATION/SECTOR OVERVIEW

Gathering as much reliable information as possible on the actual situation immediately before the disaster is an essential step for the ENA. Many different sources of information need to be consulted. Even then, however, many gaps must be expected, to be addressed in subsequent steps through specific and directed lines of enquiry.

Key sources of pre-disaster baseline information are likely to include, but not be restricted to the following:

1. Environmental profiles for the country/region;
2. Satellite images and maps;
3. Project reports from national and international environmental agencies;
4. Local knowledge on natural resources' management;
5. Previous environment-related assessments;
6. Specific databases, for example, if a national park or marine reserve is within the affected area, specific reports will likely be available;
7. Wildlife and fisheries management plans;
8. Housing and related development plans;
9. Land tenure records; and
10. Population of men and women living in and around national natural resources.

To guide the initial data gathering process, questions to consider include, but again are not restricted to:

1. Who were the main actors (government, non-governmental and communities [including women and men]) responsible for managing natural resources before the disaster?
2. What is the current situation regarding the status of these organisations and structures?
3. Who might be the most useful people to contact for further information regarding the pre-disaster situation?
4. What were some of the key environmental features in that region before the disaster? Examples might include productive coastal fisheries, ecotourism, endemic species, a source of drinking water, and so forth.
5. What was the land ownership system? Who had access to natural resources?
6. Were there obvious links with or dependencies upon natural resources or critical ecosystem services, such as fisheries or freshwater provisioning which might have been impacted by the disaster or further impacted after disasters due to overexploitation?
7. Are there sites of ecological interest or value in the immediate region? If so, what was their pre-disaster status?

Particular attention needs to be given to identifying the presence and pre-disaster status of protected areas and the presence of ecosystems that may provide particular services, such as water provisioning, spawning grounds for offshore fisheries or sites of exception biological diversity. Such sites include:

1. National parks;
2. Nature reserves and hunting reserves;
3. UNESCO World Heritage Sites;
4. Marine reserves;
5. Ramsar sites (wetlands of international importance);
6. Wildlife corridors; and
7. Watersheds and other ecosystems providing vital services.

Analysis of such information will also help plan for subsequent steps, e.g. by identifying who needs to be consulted, how the members of the ENA team might allocate individual responsibilities for certain tasks, how the field work will be conducted, and so forth. Additional information coming from the emergency phase may also prove helpful in piecing together an overview of the pre-disaster situation.

The pre-disaster information should enable the team to describe the status of infrastructure and other assets (relevant for environment), environmental goods and services, governance mechanisms, and risks and vulnerabilities. These are briefly mentioned in the following sections.

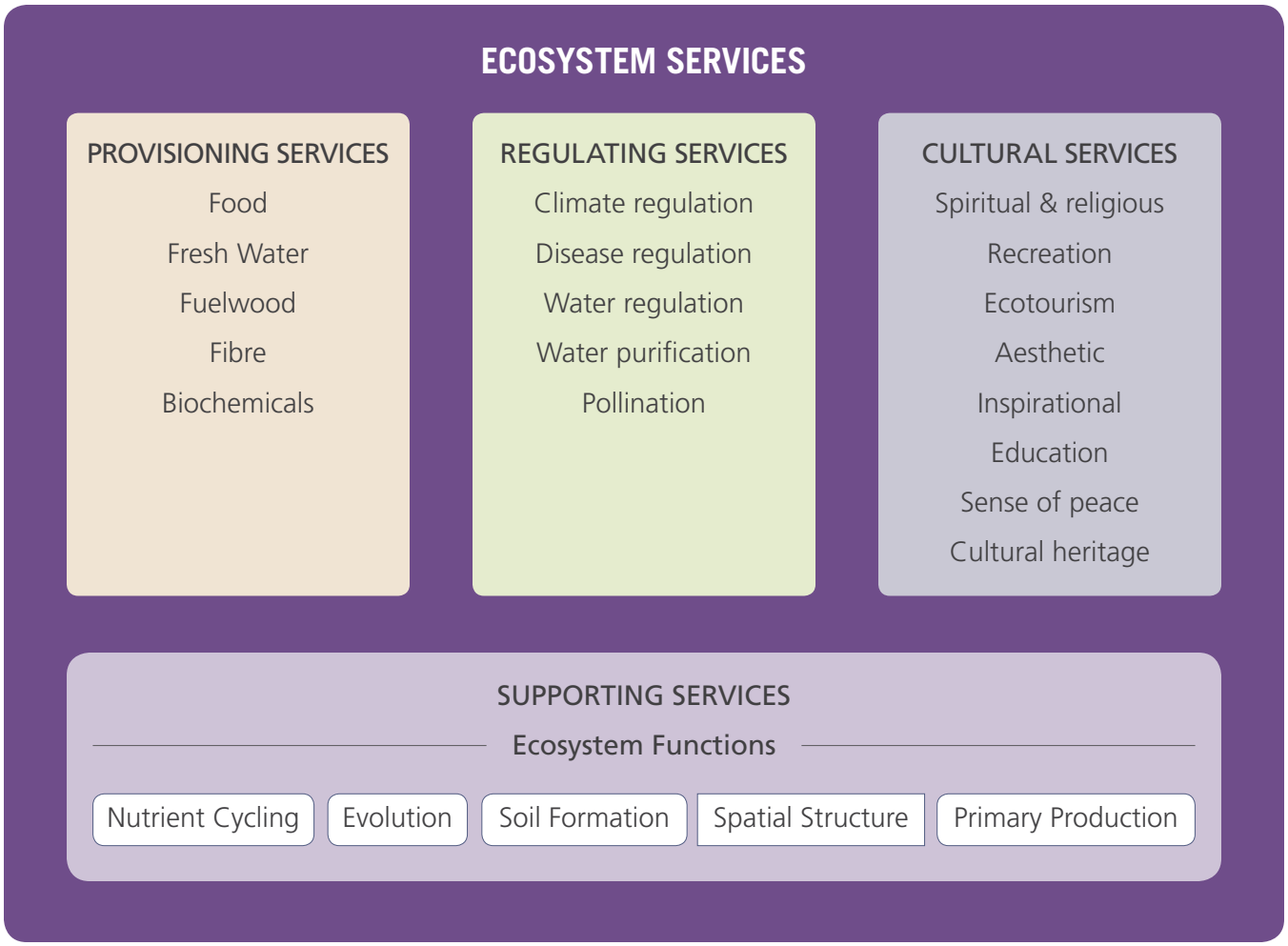
DESCRIPTION OF KEY ASSETS

This may include pre-disaster status of the extent of relevant natural resources (e.g. forests) which existed before the disaster. A description of the extent (quantity) and quality of these natural assets can be part of the sector overview. Similarly, there could be certain man-made assets relevant for environment (like the environmental monitoring systems) and the nature of these assets before the disaster could also be part of sector overview.

The economic uses to which the environment is put is a critical aspect of the description.

DESCRIPTION OF THE PRODUCTION AND DELIVERY OF GOODS AND SERVICES, AND ACCESS TO GOODS AND ENVIRONMENTAL ASSETS AND SERVICES

Disasters can impact environmental segments and access to environmental goods and services. Ecosystems provide a range of services to humanity and the conceptual framework of these services, as identified in ''The Economics of Ecosystems and Biodiversity'', is presented in Figure 1: Ecosystem Services.



(Reference: Baltimore Ecosystem Study, Urban Lexicon)

Not all environmental systems offer every ecosystem service mentioned above. However, every damaged environmental segment needs to be assessed within the above framework to ensure that not just the provisioning services are factored in while assessing damage and loss.

DESCRIPTION OF GOVERNANCE AND DECISION-MAKING PROCESSES

The state of environmental resources depends not only on the natural factors but also on the institutions and governance systems. These may include formal and informal factors, and those instituted by the communities and the states. A description of these and other formal governance structures for managing natural resources existing in the territory should also be part of the pre-disaster sector overview.

RISKS AND VULNERABILITIES INCLUDING EXISTING PREPAREDNESS PLANS

The country (and the communities within it) may have already perceived certain risks associated with the potential negative impact on environment and natural resources, and may have created plans for mitigating such risks. An understanding of such perceived risks and their level of preparedness could also be part of the pre-disaster sector overview.

ASSESSMENT OF DISASTER EFFECTS

Multiple linkages between environment and disasters are of interest while undertaking a PDNA after a disaster. These linkages are as follows:

1. Disasters have environmental and economic effects, which in turn affect people;
2. Recovery efforts after a disaster may also leave an environmental footprint;
3. Environmental degradation increases disaster risk;
4. Disasters disrupt access to environmental goods and services;
5. Disasters increase strain on environmental governance; and
6. Healthy ecosystems can play an important role in disaster risk reduction and hence could be part of future strategies for DRR in the country.

Some environmental effects may occur immediately after the disaster, like the washing away of forests due to landslides, or the land and water pollution caused by breaking down of sewage systems. These are called immediate effects. Effects that take some time to manifest after the disaster may be referred to as additional effects and may not be able to be captured as part of the assessment as the assessment has a specific start and end time. This could be eutrophication in a lake a few months after a flooding or forest fires a few months after a drought. It is not realistic to predict every possible environmental impact in a disaster situation due to the large permutations of disasters and ecosystems in the world. Some of the major disasters and their environmental effects are listed in the Annex. The following are the key elements to assess the disaster effects on environment:

1. Environmental effects caused by the disaster and relief operations as well as potential environmental pressures from recovery;
2. Response-related activities or coping mechanisms resulting from the disaster that can impact the environment or create new environmental risks;
3. Factors which may have impacted the access of stakeholders to environmental resources, particularly vulnerable groups such as women, indigenous people, and ethnic minorities with high dependence on natural resources for livelihoods;
4. Impact of the disaster on institutional capacities for environmental governance;
5. Underlying environmental drivers, such as environmental degradation that may precipitate or aggravate a future disaster; and
6. Opportunities to build back greener.

These effects must be presented according to the country's geographical divisions as presented in the census and by other key sociological characteristics where relevant (sex, age, ethnicity, religion, ability, disability of the given population). The effects can be expressed in quantitative or qualitative terms under the following headings.

Introduction: general description of the disaster event, its geographical scope, population affected and evolution till date, etc.;

Effects on natural assets–these include the full or partial destruction of natural or environmental assets such as forests, mangroves, or atmospheric quality. The description may include not only quantitative changes but also those related to quality; and

Effects on access to environmental goods and services,

The possible causes for the disruption of environmental services and access to these are:

1. Damage to goods and services: Environmental goods or services may have been totally or partially destroyed as a result of the disaster. For example, if forest has suffered a severe fire, women and men will no longer be able to access it and benefit from the multiple services offered by it. In some cases, secondary environmental goods and services might also be affected, such as fish processing and cottage industries usually done by women;

2. Disruption to physical access: If a community had to relocate after a disaster, men and women will not be able to access the environmental goods or services even if the environmental goods are unharmed;

3. Economic barriers to access: Disasters reduce the purchasing power of men and women in a community. For example, if the community had access to the waste management at a certain unit cost, after the disaster, the community may not have the resources at its disposal to pay for such services. So even though the environmental service is undamaged and there are no physical barriers to access, the service is no longer accessible to the community. In addition to reduction in purchasing power, disasters may also push into further poverty certain sub-groups such as forest and indigenous people who derive a larger part of their livelihoods from the natural resources.

EFFECTS ON ENVIRONMENTAL GOVERNANCE AND DECISION-MAKING PROCESSES

Disasters can also affect institutions of environmental governance. This may be manifested in their ability to plan and implement an environmental recovery program. Some relevant examples in this context are as follows:

1. Damage to physical resources including infrastructure, vehicles, equipment, data gathering systems, data records of the institutions, such as Ministry of Environment, National Parks Authority and Waste Management Department and other government institutions dealing with environment;

2. Staff capacity at the institutions of environmental governance is depleted by: (a) death or injury of personnel, (b) their temporary absence because of the need to attend to personal issues relating to the disaster and/or (c) their re-deployment for addressing humanitarian issues;

3. Inability to enforce legislation: Disasters often cause economic hardship to individuals and nations. Therefore, in post-disaster settings, there is often pressure on the environmental ministries (and other enforcement agencies) not to enforce even the existing environmental provisions so that people can recover their life faster.

EFFECTS ON RISKS AND VULNERABILITIES

Disasters do not just damage the environment. Environmental degradation aggravates the effects of natural hazards. It is important to identify these environmental drivers of disaster risks. Table 1 provides some of the environmental drivers of disaster risk.

Table 1. Environmental Drivers of Disasters

Environmental Driver	Type of Disaster Caused or Exacerbated
Deforestation	Landslides, flash floods, droughts through desertification
Coral reef damage	Storm surge
Conversion of wetlands	Floods
Monoculture forestry	Forest fires
Mangrove damage	Floods, storm surges, coastal erosion
Damage to sea grass	Beach erosion

In addition to the conventional environmental drivers, climate change is expected to increase the frequency and severity of weather-related hazards such as hurricanes, floods and drought. Disasters and associated environmental damages can increase future risks. Forest fires may increase the risks of landslides; sandstorms may enhance the risk of damages associated with droughts; damages to mangroves due to coastal events may exacerbate the risks of coastal erosion.

CLASSIFYING THE DISASTER EFFECTS ON THE ENVIRONMENT

The quality, intensity and extent of the effects of a natural phenomenon on the environment varies according to the force released, the sensitivity and quality of the medium receiving it, the medium's capacity for recovery, the time it takes to recover and the partial or total loss of environmental assets or services. The environmental impact can be classified into zero impact, minimal or significant impact.

These assessments are based on observations, professional judgment, or by hypothetical or actual experiments. One classification system for negative effect following ECLAC (2003) is given below:

(a) Zero effect. Insignificant or very slight, with swift environmental recovery or with minimal or very low prevention or recovery costs.

(b) Insignificant or minimal effect. An outcome that does not affect the system's stability; recovery in the short or medium term; problems, alterations, changes and damage are insignificant when the benefits derived from the situation are taken into account.

(c) Moderate effect. Change is marked, but restricted to a relatively limited area; slight regional effect; short-term recovery; moderate or acceptable problems; simple and cheap mitigation.

(d) Severe effect. Very marked regional or very extensive change; recovery in the short or medium term if appropriate mitigation measures are implemented; a high level of discomfort and inconvenience, and mitigation is costly.

(e) Very severe effect. Very extensive, heavy and harmful consequences in the region; possibility of partial or slight recovery at a very high cost in the medium and long terms; fewer options for using resources in the future; in the context of development, it signifies a permanent threat to resources, health or life.

QUANTITATIVE ESTIMATE

Once the environmental effects have been identified and classified into significant, severe, and so on, the next step is to quantify and assess them. This is the most difficult stage of the assessment task, mainly because of time constraints, and difficulty in getting quality information.

The quantification process establishes the magnitude of the identified areas that have borne the brunt of the disaster: the area of burnt forest or of eroded soil, the length of beach damaged, the reduction in the volume of fishery catches, the reduced flow of water, the presence of pollutants in the water, the number of individual members of a species killed, and so on.

Geospatial inputs, especially satellite imageries before and after the disaster, may be of great help at this stage. Reconnaissance surveys and field work after the disaster and comparison of the pictures that emerge from such surveys with the baseline information collected through the desk study can also be useful. Consultations with local government officials or the rescue team members may also provide useful information on the extent of damage.

In many cases, quantification cannot be carried out. There may not be sufficient time available for disaster assessments to obtain quantitative information about the effect on specific species. It will only be possible to describe these effects qualitatively, even if they can be identified and sustained. For example, in the case of fauna, it is hardly ever possible to ascertain the number of affected individuals. In such a case it would only be possible to identify the environmental effect.

As mentioned above, while undertaking PDNAs it is important to keep in mind that some of the consequences of the disaster may not be manifested immediately. For example, due to disruption of primary livelihoods after a disaster, rapid depletion of forest resources may occur as communities seek alternative coping livelihoods and energy sources.

ESTIMATING THE VALUE OF THE EFFECTS OF THE DISASTER

This section gives guidance on how to estimate the value of damage and changes in economic flows, extracting from the section on effects those elements that have financial implications, either in damage of assets, as well as loss due to changes in financial flows as linked to service/production, governance and risks.

ECONOMIC VALUATION

Environmental goods are typically hard to establish economic values for. However, since all sectors involved in PDNA are expected to come up with monetary estimates, the environmental sector also has to undertake economic valuation of damages and changes in flows. Valuation of environmental damage and loss of environmental services is a complex process and there are different valuation techniques. A broad outline is provided in Table 2.

Table 2. Valuation Approaches of Typical Environmental/Ecosystem Services.

Environmental/Ecosystem Services	Valuation Approach				
	Market Price	**Effect on Productivity**	**Travel Cost**	**Hedonic Pricing**	**Contingent Valuation**
Provisioning	X	X			
Regulating		X		X	
Supporting		X			
Cultural			X	X	X

It is important to mention here that when disasters affect ecosystems, not only are their provisioning services disrupted, but other ecosystem services are affected too. Economic valuation of ecosystem services is a growing area of research activity. It is not the objective of this document to present in detail the methodology for quantification of each of the ecosystem values as outlined in earlier sections. However, a range of methodologies available for quantification is presented here.

In most situations, given the level of data available in a post-disaster setting, and the time and resources available to collect new data, it is not always easy to quantify the economic value of such disruption. In some situations it may be possible to use costing data that has been produced for a similar environmental/economic context. However, in order for the recovery recommendations to factor in the significance of non-quantified ecosystem services, it is important to articulate those services in the report.

ASSESSMENT OF DISASTER IMPACT

Issues of environmental conservation (or destruction) are closely linked to economic and human development. The lower levels of economic development in poorer or developing countries may have led to under-investments in protecting environment and natural resources before the disaster. These may have contributed to the severity of disaster impacts as a consequence of natural hazards. However, the disaster could drastically reduce the level of human development, and this may lead to a further decline in the willingness to protect the environment after the disaster. The environment could become a low-priority item, even if the deterioration of natural resources could negatively affect the rebuilding of livelihoods of people after the disaster. Hence the restoration of human development and normalisation of economic development after the disaster, mainly through the (Build Back Better) recovery strategies envisaged in other sector PDNAs, could be a prerequisite for the recovery of the environment and natural resources.

The impact analysis of the environmental issues should result in a clear presentation of the short , medium and/or long-term consequences of the event. The best and worst-case outcomes as a consequence of the disaster on the environment should also be considered. Such scenarios should be based on the context analysis or the pre-disaster situation, the effects of the event on the environment and the socio-economic costs to society .

CROSS-SECTOR LINKAGES INCLUDING CROSS-CUTTING ISSUES

Due to the interweaving nature of the environmental sector, it is important that the ENA Team is fully engaged with other sectors during all stages of the PDNA process. A number of environmental issues may already be factored in by other sectors, so it is important that there is no duplication of data gathering efforts or costing of damages. In an ideal case, the role of the environmental experts in the PDNA team is to verify from other sectors if the relevant environmental issue has been factored in and prompt and support them to do so if they have not. However, it is more common that other sectors are too busy concentrating on their "core" issues and environment and other cross-cutting themes are not given any attention. So environmental experts should be prepared to undertake assessment of these issues themselves and provide damage, loss and recovery figures to other sectors. Such an approach, in practice, gives a better chance for environmental issues to be factored into the final report.

Table 3 is an indicative list of issues most likely to be dealt with by other sectors.

Table 3. Sectoral Integration of Environmental Issues

Sl #	Environmental Issue	Sectoral Overlaps
1	Surface/groundwater pollution	Water supply, sanitation and hygiene (WASH)
2	Disaster waste management	Infrastructure/Early Recovery/Employment
3	Healthcare waste management	Health
4	Damage to mangroves/wetlands	Agriculture
5	Damage to forests, soils	Agriculture and forestry
6	Waste management centers	Waste management systems Infrastructure
7	Sewage systems and sewage treatment plants	Wastewater management Infrastructure
8	Solid and liquid wastes from camps	WASH/ camp coordination
9	Damaged facilities of environmental sector	Infrastructure
10	Environmental pollution from damaged industrial facilities	Labour/Infrastructure
11	World Heritage sites and national parks	Culture

Yet another cross-cutting issue is the environmental footprint of relief operations. There are a number of humanitarian and relief-related activities that are commonly undertaken during the early recovery phase which may, in turn, have an impact on the state of the environment. Setting up of camps for survivors produces significant sanitation issues and support for housing may increase the extraction of timber from forests in the locality. Specific attention needs to be given to these impacts. Some other relief-related environmental impacts to consider during the assessment are listed below:

a. Over-extraction of ground water aquifers as a coping strategy;

b. Unsustainable supply of shelter materials like burnt bricks (with firewood extracted from forests) or excessive or ill-managed quarrying;

c. Unsustainable use of timber for construction and fuel wood;

d. Land degradation and soil erosion, due to a distress-driven cultivation strategy;

e. Selection of inappropriate sites for temporary shelter, which may increase the likely of landslides, water stagnation, etc.;

f. Solid waste disposal from the camps without proper treatment;

g. Selection of inappropriate or energy-intensive systems such as a large number of small-scale diesel generators for electricity; and

h. Impacts associated with reconstruction and repair to damaged infrastructure (e.g. deforestation, quarrying, waste pollution) without due environmental controls applicable in normal times.

THE SECTOR RECOVERY STRATEGY

SECTOR RECOVERY VISION (RATIONALE FOR THE SECTOR)

'Build back greener' should be the main thrust of the vision of PDNA-Environment. Stakeholder consultations have to be an important part of this envisioning exercise. This is discussed in the following section.

STAKEHOLDERS' CONSULTATION

Engaging with a broad range of people—from decision-makers in line ministries to affected people who have a direct dependency on certain natural resources—is a fundamental part of the ENA process. Some consultation will naturally occur during the site assessment work, but given the importance of making sure that peoples' own voices and experiences are recorded, and their immediate and specific needs identified, special attention is given to this phase of work. Consultations are also an essential opportunity to ensure that all members of the affected society have an opportunity to contribute to the early recovery process, while at the same time ensuring that cross-cutting issues such as gender are properly addressed.

The core team should hold initial consultations with leaders from the affected communities and the officials of local authorities to explain the purpose of the ENA, to record their views and opinions on the issues being discussed, and to seek their approval and advice on how to proceed. Special attention should be given to ensure that women's leaders/groups are also contacted at this stage.

Additional meetings should be arranged with a broad representation of local stakeholders from within communities, NGOs active in the region, and others, at times and venues suitable to them. For this, the core team is likely to be split into smaller groups in order to be more time-efficient. Further meetings will also need to be arranged with local authorities and line ministries, as necessary and appropriate. The latter, for example, will be necessary in relation to considerations regarding future needs and options for early recovery, as it might relate to the environment and ecosystem services. It is possible that there are other assessments ongoing in the field concurrently with the PDNA and engagement of such assessment teams is also important.

Women, men, boys and girls are differently affected by disasters. They may face different disasters risks and have different capacities and resources on which to draw to respond and cope. In general, women and girls are more vulnerable to disasters due to low education, limited access to resources and economic options, differences in mobility, and entrenched discrimination, among other factors. Compounding these factors is the dependence of many women on natural resources for their livelihoods. Women tend to do most of the agricultural work and provide energy (e.g. fuel wood) and water for their families. Disaster impact on natural resources such as agricultural land and clean water can create an extra burden on women and girls and generate secondary threats where women and girls may need to walk longer distances to access clean water or fetch fuel wood.

Therefore disasters impacting directly on local livelihoods, and natural resources upon which women depend, can have a disastrous effect on women. It is imperative that while assessing factors such as the access to goods and services, the need for rebuilding livelihood systems, reducing the impact of future risks, and for restoring institutions that manage environment/natural resources, care should be taken explicitly consider the gender issues. Gender differences are also evident in the local use and management of natural resources and livelihood strategies. Often elderly women have critical local knowledge on managing community natural

resources and after disasters. Capturing women's voices during environmental PDNA may also reveal hidden livelihoods that are dependent and yet not directly linked to natural resources. These include fish processing and small cottage industries.

In addition to gender-sensitive consultations, efforts should also be made to address the specific vulnerable and socially marginalised sub-groups of the population living in or around natural resources where applicable. These sub-groups include people with disabilities, religious minorities, class/caste/ethnic minorities, indigenous people etc. Due to discrimination, vulnerable sub-groups also face inequitable access, use and management of resources.

Going along the lines of building back better, sustainable management of natural resources and resilience to disasters can only be achieved if all members of society are included and participate in the management of resources before and after disasters. In addition, addressing these social issues may also create opportunities and lay the foundation for the affected country or community to address gender and social inequalities in the access, use and management of natural resources.

RECONSTRUCTION AND RECOVERY NEEDS, INCLUDING BUILD BACK BETTER

Post-disaster geographical and political settings offer opportunities to build back greener. There are multiple opportunities to be kept in mind:

a. Utilisation of greener building materials and energy sources for reconstruction;

b. Changing to cleaner production technologies in damaged industries;

c. Establishing better urban services, such as landfills and sewage collection and treatment systems; and

d. Promoting ecosystem-based approaches to disaster risk reduction.

Sustainable natural resource management can be promoted as a disaster risk reduction strategy. Healthy and diverse ecosystems are more resilient to hazards. For example, reforestation: forests provide shelterbelts and windbreaks, and protect against landslides, floods, and trees stabilise riverbanks and mitigate soil erosion. Wetlands serve to store water, provide storm protection, flood mitigation, and erosion control, etc. Proactively using ecosystems as a disaster reduction measure through improved land use planning should also be considered.

While post-disaster environmental settings will always have resource scarcity and competing priorities, it is also the time when government, donor and NGO attention are focused on the location. This should be leveraged to ensure a build back greener strategy. The PDNA process should facilitate this by highlighting the opportunities and costing them in at an early stage.

Reconstruction needs in environment may be categorised as follows:

REBUILDING OF NATURAL ASSETS

Forests or coral reefs or mangroves damaged as part of the disaster may have to rebuilt, or atmospheric pollution brought down. The pre-disaster levels on each of these items should be known from the baseline data, and bringing back to that level could be the first objective. However, as noted, there could be many opportunities to build back greener and these should be explored.

RESTORING THE ACCESS TO ENVIRONMENTAL GOODS AND SERVICES

As noted earlier, environmental damages associated with disaster could lead to the disruption of access to environmental goods and services, and the recovery strategy should include measures to restore the access. Some examples of such goods/services are listed in Table 4. The fieldwork and consultations carried out as part of PDNA should see whether the disaster has affected the access to such goods and services. If so, there is a need for two responses: (a) costing (and provisioning) of the substitutes to the affected population until the recovery of the natural resource/environment; and (b) planning (and working towards) the recovery of natural resources/environment, keeping in mind the rebuilding of the access of women and men to such environmental goods and services.

Table 4. Restoring Access to Environmental/Natural Goods and Services

Type of Disaster	Restoring Access to Environmental Goods	Restoring Access to Environmental Service
Hurricane/Cyclone/Typhoon	• Access to fishing grounds/loss of fish stocks • Access to fresh water	• Access to eco/natural tourism sites including beaches
Tsunami	• Access to fresh water • Access to fishing grounds	• Access to beaches
Earthquake	• Access to common property resources	• Access to natural systems that provide environmental services • Access to man-made systems that help controlling environmental damage/pollution
Flood	• Access to fresh water	• Access to natural and man-made barriers that offer protection from soil and water erosion
Volcanic eruption	• Access to forests and common property resources	• Access to man-made system that regulates environmental damage
Landslide	• Access to forests and common property resources	
Drought	• Access to common property	
Forest fires	• Access to forest and wildlife habitat	
Sandstorms	• Access to common property	
Forest fires	• Loss of forests and common property resources (CPR)	• Regeneration of forests
Sandstorms	• Loss of CPR	• Regeneration of CPR

RESTORATION OF ENVIRONMENTAL RESOURCES THAT SUPPORT LIVELIHOOD SYSTEMS

The damage to the environment/natural resources due to a disaster could have destroyed certain livelihood systems, and their restoration cannot be done without rebuilding the concerned/environment base. For example, common properties or rural forests could be providing some inputs (like non-timber forest products) to sustain the livelihood of the people living nearby. If the farming depended on the natural manure collected from the common property resources (CPR), the restoration of farming needs to take into account the loss in this regard. There could be two issues here: restoration of farming as part of post-disaster rebuilding should take into account the non-availability of enough vegetative matter (as manure) in nearby areas for the time being. Secondly, a complete/sustainable restoration of farming is possible only after rebuilding the lost CPR. This may require

some more investments and time beyond which farming can be restored with provision or arrangements for man-made inputs (say in place of vegetative matter). Or the provision of arrangement for man-made inputs should be continued until the restoration of the CPR. A similar situation may arise with regard to many other livelihood systems. The loss of, or disturbance to, fishing grounds due to coastal disasters such as typhoons or tsunamis are other examples. Some of these livelihood issues and restoration needs are mentioned in Table 5.

Linkages with other PDNA teams become critical during the analysis of the environmental goods and services disrupted by the disaster and the recovery-planning phase. For instance, the impact on the fish processing livelihoods of poor women (who may not necessarily need to access fishing grounds) and the link to the environmental resources may be missed because the impact only becomes evident during a value chain analysis.

Table 5. Restoration of the Environment/Natural Resources to Address Livelihoods

Type of Disaster	Impact on Livelihoods	Restoration Need
Hurricane/Cyclone/Typhoon	Impact on fishing Impact on tourism	• Understanding the changes in fishing grounds • Allowing natural rebuilding • Artificial rebuilding without creating further environmental damage
Tsunami	Impact on recreation	
Earthquake	Impact on all livelihoods that use CPR including forests Secondary damage of resources, e.g. disposal of disaster debris in river	• Understand the contribution of CPR to livelihoods • Alternative arrangement until CPR is regenerated • Strategies to regenerate CPR
Flood	Breaking of natural erosion barriers affecting farming/fishing operations	• Creation of man-made barriers • Possible regeneration of natural barriers
Volcanic eruption	Impact on all livelihoods that use common property resources including forests	• Understand the contribution of CPR to livelihoods • Alternative arrangement until CPR is regenerated • Strategies to regenerate CPR
Landslide	Impact on agricultural livelihoods, loss of natural resources	
Drought	Overuse of CPR leading to its destruction Loss of species/crops suitable for a specific environment	Rebuilding CPR using its original diversity
Forest fires	Loss of forests and CPR	Regeneration of forests
Sandstorms	Loss of CPR	Regeneration of CPR

RESTORING GOVERNANCE MECHANISMS

The relevant strategies in this regard may include:

a. Restoring physical resources including infrastructure, vehicles, equipment, data gathering systems, data records of the institutions, such as Ministry of Environment, National Parks Authority and Waste Management Department and other government institutions dealing with environment;

b. Rebuilding staff capacity at the institutions of environmental governance; and

c. Rebuilding capability to enforce legislation.

REDUCING ENVIRONMENTAL RISKS AND VULNERABILITIES

As mentioned, disasters and associated environmental damages can increase future risks. These increased risks arising out of disasters have to be considered part of recovery planning. In certain cases, even if these risks cannot be averted, the potential damages associated with them can be reduced. If the destruction of mangroves has increased the risks of coastal erosion, regulations could be introduced or existing ones reinforced on the use of coastal areas for habitation, which may reduce the number of people likely to be affected in the event of any future disasters.

On the other hand, one could use healthy ecosystems as defence against natural hazards. This can be done by enhancing an existing ecosystem, restoring a damaged one, or building in an ecosystem as part of the land use planning to defend against disaster risks. Investing in enhancing ecosystems for disaster risk reduction is a no-regret strategy while building a new ecosystem defence would need significant research into its suitability and alternatives. A few such cases are listed in Table 6.

Table 6. Increased Risks Associated with Disasters and Strategies to be Considered in Recovery

Type of Disaster	Impact on Livelihoods	Possible Strategies to Reduce Impact
Hurricane/Cyclone/Typhoon	• Coastal erosion	Coastal zone regulations
Tsunami		
Earthquake	• Landslide	Settlement and building regulations
Flood	• Epidemic, erosion	Water/Drainage management planning
Volcanic eruption	• Forest fire; drought	Settlement regulation; early warning systems
Landslide	• Soil erosion	Erosion control practices; settlement regulation
Drought	• Forest fire; sandstorms	Protection of forests and natural barriers
Epidemic	• Water pollution	Effective enforcement of pollution control
Forest fires	• Landslides	Reforestation

THE SECTOR RECOVERY PLAN

PRIORITISING AND SEQUENCING RECOVERY NEEDS

The recovery program should consist of measures that help to restore people's abilities to reach their full potential to lead productive, creative lives in accordance with their needs and interests. This assessment should then lead to the following prioritisation of the needs for environmental rebuilding based on the impacts and extent of losses:

- Plan for environmental rebuilding, including the estimation of the costs and details of implementation and monitoring of the planned projects;
- A forward looking plan that aims to "Build Back Better," by integrating sustainable environmental practices and natural resource management within recovery programming and across the relevant relief and recovery clusters. A strategic baseline data that could eventually feed into a monitoring and evaluation system to track implementation of environmental recovery interventions;

- Finding opportunities to re-orient livelihoods along sustainable pathways using environmentally sound construction practices and/or alternative energy options, by identifying ecosystem restoration requirements and by mainstreaming disaster risk reduction;
- Providing an understanding of the specific vulnerabilities that women and other sub-groups in the communities face, and identifying their capacities and needs to engage in the environmental recovery process.

The results of the effects and impact of the events and needs arising from this assessment may be presented the stakeholders, and, through this process, a recovery strategy may be developed within a consultative process. Key stakeholders in the national and regional governments, the international community and local areas affected by the disaster should be consulted. Active support and participation from these stakeholders is critical for successful implementation of the recovery plan as national and local groups will be the ones implementing the recovery plan. These stakeholders can be consulted via individual interviews, small group discussions, joint seminars with civil society representatives (communities, women's associations, private sector organisations, etc.), or national workshops.

The recovery strategy for the environmental sector should strive to 'build back greener' together with enhancing the resilience of the natural/environmental systems. This implies not only the reconstruction of physical assets, but also restoration of systems, processes and functions.

The recovery strategy for the environment sector follows the guiding principles, objectives and consultative process of the overall PDNA as outlined in Volume A. As such the sector recovery strategy will include the following core components:

a. Outline of recovery needs, based on results of the assessment;
b. The agreed vision and guiding principles for the overall recovery process of the sector;
c. Outline of results-based recovery plan for the environment; and
d. Outline of implementation arrangements.

COSTING

New projects or new programs have to be planned to minimise the actual or potential environmental threats. Cleaning up of polluted water bodies or additional measures that are taken to reduce further soil erosion, etc., come under this category. There may be certain cases where the mitigating environmental impact can be much costlier than the benefits of such action. In such cases, there can be alternative arrangements to mitigate those losses. For example, if some agricultural land is already contaminated with some pollutants, and if decontamination procedure to make it fully re-cultivable is costlier than the benefits of future cultivation, then the cultivators may be supported for alternative livelihood options.

The economic assessment of damage and changes in flows may provide some insights into the needs for recovery and reconstruction and their costs. For each of the environmental effects identified, the need for remedial action has to be specified and the costs of these remedial actions have to be estimated. In estimating costs, duplication has to be avoided. Though there are multiple environmental effects of each event, such as soil erosion or loss of wildlife habitat due to deforestation, the remedial action of 'afforestation' can address a number of such effects, albeit partially.

The costing should also take into account the rebuilding of environment/natural resources so that people's access to environmental goods and services and their livelihoods that have depended on these natural/environmental systems can be restored. This is to be carried out in cases where such restoration is cost-effective and also where such rebuilding of environment is required for ecological needs. The cost of rebuilding institutions for the sustainable management of the resources/environment, and the strategies and programs needed to reduce future risks also have to be estimated.

All the net costs (listed in the last column of Table 7) can be added after considering the possibilities of duplication. For example, the project to control coastal erosion could be beneficial for the restoration of coral reefs too, and in that case it should not be counted for the second time. A typical costing example for recovery after a hurricane is presented in Table 7.

Table 7. Final Tabulation of Cost of Recovery

Effect	Value of Change in Economic Flows	Restoration Cost (B)	Net Costs
Destruction of vegetation cover	Value of short-term revenue lost (until restoration) A1	Restoration costs (B1)	A1+B1 or A1+A2, whichever is less
Mudslides	Value of long-term revenue lost (in the event of no restoration) A2	Restoration costs (B2)	A3+B2
Saltwater intrusion to freshwater reservoirs	Value of short-term losses (until restoration) A3	Restoration costs (B3)	A4+ B3 or A4+A5, whichever is less
Damage to offshore coral reefs and natural coastal defence mechanisms	Value of short-term revenue losses + higher operational costs (until restoration) A4	Restoration costs (B4)	B4
Waste (some of which may be hazardous) and debris accumulation	Value of long-term loss of revenue (in the event no restoration) A5	Removal cost (B5)	B5
Impact on wildlife habitat	Value of short-term loss of income (until long-term control) A6	Cost for allowing the habitat to regenerate (B6)	B6
Increased soil erosion	Value of short-term loss of income (until restoration) A7	Implementation of erosion control mechanisms (B7)	A6+B7
Soil contamination from saline water	Value of long-term costs associated with relocation(in the event no restoration) A8	Restoration costs (B8)	A7+B8 or A7+A8, whichever is less
Secondary impacts by temporarily displaced people	Additional costs to see that environmental impact of temporarily displaced people is minimal (A9)		A9
Access to fishing grounds/loss of fish stocks	Cost of providing access (A10) or value of lost revenue to unavailability of access/stock until it is rebuilt naturally (A11)		A10 or A11, whichever is less
Access to freshwater	Cost of providing access (A12) or Cost of provision of freshwater until access is rebuilt naturally (A13)		A12 or A13, whichever is less

Effect	Value of Change in Economic Flows	Restoration Cost (B)	Net Costs
Rebuilding institutions Norms/rules regulating access to fishing grounds Norms regulating access to other CPR Reduction in future risks Coastal zone regulations		Costs of (re)building the institution and its renewed enforcement (B9) Costs of (re)building the institution and its renewed enforcement (B10) Cost of making and enforcing coastal zone regulations (including the capacity building) (B11)	B9 B10 B11

IMPLEMENTATION ARRANGEMENTS

IMPLEMENTATION RESPONSIBILITIES

The recommendations of the environmental recovery need to be implemented by two sets of actors. Primarily, the recovery actions will happen in the main productive and social sectors, such as Forestry, Agriculture, Housing etc. There will also be some action, such as cleanup of contamination hotspots and restoration of environmental infrastructure, which will need to be undertaken by the environmental actors themselves. Both government and non-government actors will be involved.

MONITORING OF RECOVERY

Monitoring of the recovery of the environmental issues should be mainstreamed into the productive and social sectors. Depending on the nature of impact, direct measurements, in the field, as well as remotely, could be done to monitor environmental recovery.

COORDINATION

Regardless of which actor, government or private, national or local, is implementing recovery, it is important that the activities are coordinated. Once again there is no one-size-fits-all model for this. While the traditional approach is to leave this responsibility to the established national institutions, since the Indonesian tsunami the model of having a dedicated institution established to coordinate recovery has received increased appreciation.

FINANCING RECOVERY

Post-disaster situations open up a range of national and international funding options for recovery. Funding could be available both as loans or grants and also often as technical assistance. Private sector investments are yet another source of funding in post-crisis situations.

KEY CHALLENGES

While there is increased appreciation of the environmental impacts of disasters and the environmental imperative of recovery, the reality is that no recovery is fully funded. In such a sub-optimal situation, non-urgent items get pushed back. For example, when there is not adequate funding for health sector recovery, a hospital rebuilding will get priority over refurbishing the incinerator. In the long run, of course under-investment in the environmental sector will lead to accumulation of disaster risk. The key challenge of the environmental sector is to advocate to the stakeholders the importance of longer-term perspectives while dealing with the desire for immediate recovery.

This is also played out in the overriding of environmental controls during rapid phases of recovery and reconstruction. Conventional controls such as environmental impact assessments, and due processes associated with it, will be seen as a nuisance, hindrances to recovery and time-consuming. Often, such processes are overruled in favor of achieving rapid and visible recovery. Such short-term vision endangers the recovery itself.

REFERENCES

United Nations Environment Programme (UNEP) and Cluster Working Group for Early recovery, Environmental Needs Assessments in Post-Disaster Settings, March 2008, UNEP.

European Commission on Latin American and the Caribbean (ECLAC), Handbook for estimating the Socioeconomic and Environmental Effects of Disasters, ECLAC and Inter-American Development Bank, 2003, Washington.

ANNEX 1. SCOPING CHECKLIST

Sl #	Country	
1	**Nature of Disaster**	
2	**Name and Intensity if Known**	
3	**Disaster Date/Period**	
4	**Key Disaster Statistics**	
	Number of people killed, by sex and age	
	Number of people injured, by sex and age	
	Number of people displaced, by sex and age	
5	**Area Impacted**	
	Major Cities	
	Provinces/States/Prefectures	
	Offshore locations	
	Offsite locations impacted	
	Neighboring countries impacted	
6	**Key Environmental Issues**	
6a	**Emergency Issues**	
	Reports of oil/chemical spills/fires	
	Impact on industrial facilities	
	Impact on chemical stores/ food warehouses/fuel depots	
6b	**Impact on Natural Environment**	
	Impact on forests, if yes, location(s)	
	Impact on rivers, if yes, location(s)	
	Impact on lakes, if yes, locations	
	Impact on coastlines, if yes, location(s)	
	Impact on mangroves/wetlands	
	Impact on mountains/hills, if yes, location(s)	
	Impact on national parks	
6c	**Impact on Man-made Environment-Related Infrastructure**	
	Power stations	
	Sewage treatment plants	
	Waste management centers	
	Urban water supply systems	

Sl #	Country	
7	**Institutional Systems**	
	Ministry in charge of environmental governance	
	Other ministries involved in Environmental Sector	
	Focal agency for emergency response	
	Focal agency for environmental emergency response	
	Major national NGOs in the environmental area	
	Major international NGOs in environmental area	
8	**UN/WB Involvement**	
	Was there an UNDAC mission deployed?	
	Was a cluster system rolled out?	
	Previous PDNA experience in country	
9	**PDNA Related Information**	
	Counterpart ministry of PDNA	
	Leading agency for PDNA	
	Duration of PDNA	
	Funding for PDNA	

ANNEX 2. FIELD CHECKLIST

COVER SHEET

Date of visit (dd/mm/yy) |__|__|__|__|__|__|__|__|

Team members _____

LOCATION (to be completed with interviewer's observation)

City _____ State _____ Area/Village _____

Significance _____

GPS Coordinates _____

Access Constraints (if any) _____

Reference of Photographs Taken _____

PERSONS CONTACTED

Name _____

Sex: Age

Affiliation _____

Address _____

Mobile Phone Number _____

DATA RECEIVED

Reports _____

Maps _____

Photographs _____

Satellite Images _____

DATA PROMISED

Type of Data Promised _____

Name of Person _____

Affiliation _____

Mobile Phone Number _____

When is the data supposed to be received _____

Remarks _____

SAMPLE TECHNICAL CHECKLIST (TO BE DEVELOPED BASED ON THE SPECIFIC CONTEXT)

ISSUE	REMARKS
Industrial hotspots	e.g. Environmental pollution from a factory due to chemical spills during flooding
Type of chemical released	
Quantity if known	
Death	
Injuries	
Surface area impacted	
Is the groundwater impacted	
Has the chemical leaked to neighbouring water bodies?	
Have neighbouring farms been impacted?	
Preventive measures taken	
Restoration plans ready?	
Estimated economic loss of materials (if known)	
Estimate production loss (if known)	
Clean-up costs (if known)	

ISSUE	REMARKS
Natural resources	e.g. Forest fires along hill-side
Surface area impacted	
Death (sex and age)	
Injuries (sex and age)	
Extend of damage (in %)	
Have neighbouring farms been impacted?	
Major functions of the forest prior to the incident	
Logging/tourism/ Non -timber products	
Did the community have access to the site?	
Is the access of community now restricted?	
Were there forestry/tourism-associated buildings/infrastructure?	
Preventive measures taken	
Restoration plans ready?	
Estimated loss of timber	
Estimated loss of infrastructure	
Annual income from productive services from the forest	
Annual income from recreational services from the forest	
Estimated cost of restoration (if known)	

ISSUE	REMARKS
Man-made environmental infrastructure	Visit to the municipal waste management facility
Degree of impact (zero to severe)	
Death of staff (at site/off site) + sex and age	
Injuries (at site or off site) + sex and age	
Capacity of the facility (tons per day)	
Loss to infrastructure at site or off site (list)	
Is the facility operational?	
Is the facility working at full capacity, less or more? (Provide % figures)	
Has there been modification of operating procedures? (If yes, list)	
Is there an increase in cost of services passed on to the customer? (If yes, give % figures)	
Are there restrictions placed on the types of wastes/quantities that could be disposed of? (If yes, list)	
Estimated loss of infrastructure	
Loss/increase of revenue since disaster	
Key requirements for restoration/ increasing capacity	

ISSUE	REMARKS
Institutions for environmental governance	Visit to the Ministry of Environment
Number of offices (total)	
Number of offices in the impacted area	
Total number of staff (total)	
Number of staff (in impacted area)	
Death of staff, if any (at site/off site)	
Injuries, if any (at site or off site)	
Infrastructure damage	
Buildings (# and %)	
Monitoring networks (# and %)	
Labouratories (# and %)	
Changes in environmental controls requested since the disaster	
Disruption to normal operation due to disaster	
Is there an environmental emergency department?	
Is the ministry involved in post-disaster response and recovery?	
If yes, number of staff deployed	
Emergency budget released	
Post-disaster needs of the ministry	
Infrastructure	
Building ((details, estimated cost)	
Labouratory (details, estimated cost)	
Monitoring network (details, estimated cost)	
Databases (details, estimated cost)	
Equipment	
For emergency response	
For supporting additional workload	
Human resources	
Staff redeployment (#s, cost)	
Temporary recruitment (#, cost)	
Overtime (#, cost)	
Additional training (details, cost)	

ANNEX 3. COMMON AND RECURRENT NATURAL DISASTERS AND SOME ENVIRONMENT-RELATED CONSEQUENCES

TYPE OF DISASTER	PRIMARY ENVIRONMENTAL IMPACT	SECONDARY IMPACT
Hurricane/ Cyclone/ Typhoon	• Loss of vegetation cover and damage to natural landscapes • Short-term heavy rains and flooding of inland • Mudslides • Saltwater intrusion to underground fresh water reservoirs • Damage to offshore coral reefs and natural coastal defence mechanisms • Waste (some of which may be hazardous) and debris accumulation • Loss of productive systems, e.g. agriculture	• Impact on wildlife habitat • Increased soil erosion • Soil contamination from saline water • Changed marine environment and its impact on coral reefs • Secondary impacts by temporarily displaced people
Tsunami	• Water pollution through sewage overflow • Saline incursion • Loss of coastal forest/plantations • Destruction of coral reefs • Marine pollution from backflow of wave surge • Soil contamination • Waste accumulation–additional waste disposal sites required	• Contamination of groundwater reservoirs • Coastal erosion and/or beneficial deposition of sediment on beaches/small islands • Secondary impacts by temporarily displaced people • Damaged infrastructure as a possible secondary environmental threat. e.g. tailing dams
Earthquake	• Damage to natural landscapes and vegetation • Possible mass flooding if dam infrastructure is weakened or destroyed • Waste accumulation – additional waste disposal sites required	• Secondary impacts by temporarily displaced people • Damaged infrastructure as a possible secondary environmental threat, e.g. leakage from fuel storage facilities • Damage to industrial facilities resulting in a toxic release
Flood	• Water pollution through sewage overflow • River bank damage from erosion • Chemical releases from factories	• Secondary impacts by temporarily displaced people • Excessive siltation affecting marine biodiversity • Contamination of ground water
Volcanic Eruption	• Loss of wildlife following gas release • Toxic chemicals from eruption • Lahars • Toxic ash	• Forest fires as a result of molten lava • Secondary impacts by temporarily displaced people • Secondary flooding should rivers or valleys be blocked by lava flow • Damaged infrastructure as a possible secondary environmental threat, e.g. leakage from fuel storage facilities
Landslide	• Damaged infrastructure as a possible secondary environmental threat, e.g. leakage from fuel storage facilities • Secondary impacts by temporarily displaced people	• Impacts associated with reconstruction and repair to damaged infrastructure (e.g. deforestation, quarrying, waste pollution)
Drought	• Loss of surface vegetation • Loss of species	• Increased migration • Loss of biodiversity
Epidemic	• Loss of species • Forced human displacement • Introduction of new species	• Loss of biodiversity
Forest Fires	• Loss of forest and wildlife habitat • Loss of biodiversity • Air pollution from smoke and haze	• Loss of ecosystem services • Soil erosion • Secondary encroachment for settlement or agriculture
Sand Storms	• Soil erosion	• Desertification