# Integrating environmental safeguards into Disaster Management: a field manual

## Volume 2: The Disaster Management Cycle

Sriyanie Miththapala

Ecosystems and Livelihoods Group, Asia, IUCN

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IUCN
4/1, Adams Avenue
Colombo 4
Sri Lanka
Phone: +(9411) 255 9634-5
Fax: +(9411) 255 9637
email: coastalinfo@iucnsl.org
website: http://data.iucn.org/places/asia/coastalinfo/

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# Executive summary

This volume presents the Disaster Management Cycle and its phases: Prevention, Mitigation, Preparedness, Response, Recovery and Rebuilding. It uses one of the main lessons learned after the Indian ocean tsunami of December 2004 - the lack of coordination among agencies - to recommend an integrated approach that uses assessments (including biodiversity, ecosystem, livelihood and economic valuation) to ensure that a holistic picture is obtained during the disaster management cycle. It emphasises that it is only when a holistic approach is used that reducing all types of vulnerability (physical, environmental, social and attitudinal vulnerability) becomes possible. Therefore, in the long term, it is only through integrated assessments that risk can be minimised. A holistic approach also allows for identification of gaps throughout the disaster management cycle. In addition, an integrated approach in disaster management demands involvement and collaboration not among local sectors but also at national and regional levels.

Models of both non-integrated and integrated assessments are described briefly. The process for integrated assessments (how it should be done), sourced directly from Springate-Baginski, et al. (in press), is also presented in the form of a framework and steps to be followed.

Using the framework of the Millennium Ecosystem Assessment, which links clearly ecosystem well-being and human well-being, and the main drivers of the loss of ecosystem services (over-exploitation, invasive alien species, habitat degradation, pollution and climate change), this volume presents steps that must be followed during each phase of the disaster management cycle. It emphasises that policy decisions and actions taken during prevention and mitigation have enormous and far reaching impacts on all stages of post disaster management. All decisions and actions taken  after a disaster will be justified based on information gathered and actions taken during the pre-disaster phases of prevention and mitigation. Therefore, the success of post disaster management depends entirely on pre-disaster management.

This volume stresses how critically important it is, therefore, to plan and implement actions to reduce the impacts of natural disasters during pre-disaster phases to minimise impacts after a disaster. The end result should be that environmental safeguards are incorporated into every stage of the disaster management cycle, as well as into general development.

The second volume of this manual deals with each of the components of the disaster management cycle, lists steps and raises questions that must be asked at each step in order to integrate environmental concerns into disaster management. The steps and questions are designed round the framework of the Millennium Ecosystem Assessment and its identified threats.

## The Disaster Management Cycle (the DRM cycle)

The Indian Ocean tsunami of December 26, 2004 was one of the most horrific tragedies of recent human history. The details of the tsunami's immediate impacts in coastal countries of Asia and Africa were shocking: 186,983,000 people died and 42,883 were reported missing. There was a massive displacement of populations, as well as extensive damage to infrastructure and coastal natural resources. In India, 235,377 homes were reported to have been damaged or destroyed; in Indonesia, 141,000; in Sri Lanka 103,836; in the Maldives, 8,074; in Thailand, 4,806; in the Seychelles, 500 and in Somalia 1,400; and. In the province of Aceh, Indonesia alone, 600,000 people lost their livelihoods (http://www.un.org/News/Press/docs/2005/hab196.doc.htm; http://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake).

In addition to this enormous toll on human lives and livelihoods, the tsunami also damaged ecosystems that provided vital protection to coastal communities. Terrestrial coastal ecosystems and wetlands, as well as key marine ecosystems - such as coral reefs and sea-grass beds - suffered seriously from the tsunami. The loss of these ecosystems resulted in the loss of ecosystem services and thereby reduced the options of people to rebuild their livelihoods.

'Four provinces of Andaman Sea coast of Thailand impacted by the tsunami - namely Trang, Krabi, Phang Nga and Ranong - were selected and a rapid assessment was carried out to review indicative costs associated with the loss of ecosystem services including environmental goods, reef-based fisheries (a joint value of mangroves, reefs and sea grasses) as well as the costs of physical rehabilitation of damaged ecosystems.

The results of the study showed that there were significant economic costs related to damages to coastal ecosystems. In particular, Phang Nga, which suffered the highest damages to its coastal ecosystems, also suffered the highest economic costs ranging from 10.47-11.15 million USD. Damages to non-timber forest products from mangroves were 607,010 USD; damages to reef fisheries 262,060-942,650 USD; the loss of coastal protection by damage to coral reefs was 9,213,000 USD and to mangroves, 286,470 USD. It was estimated that the economic costs of damages to mangroves in Phang Nga to almost 6.1 million USD, in Net Present Value.[1]'

This study showed empirically that ecosystem services are not only of direct value to people, but also offer tremendous indirect benefits in terms of supporting and regulating services (IUCN/UNEP, 2006).

The devastation caused by the tsunami has served to highlight the dangers of other, recurrent natural hazards - such as intense rainstorms, cyclones, floods, fires, and worsened droughts - which are predicted to increase in the future. (Refer to section on Climate change in Volume 1.) Because natural hazards cannot be stopped, learning to reduce vulnerability to these hazards and reducing/eradicating natural disasters that stem from these recurrent natural hazards becomes important. Learning to manage these disasters – disaster management – therefore, becomes critically important.

The goals of disaster management are to

1. 'Reduce, or avoid, the potential losses from hazards
2. Assure prompt and appropriate assistance to victims of disaster and
3. Achieve rapid and effective recovery' (GDRC, 2008).

[1] Net Present Value is the sum of discounted net benefits - i.e. benefits minus costs - which shows whether a project generates more benefits than it incurs costs.

In order to achieve the first goal, it is necessary to prevent, prepare for, mitigate and minimise effects of a natural disaster. Therefore, before a natural disaster, the phases of Prevention, Mitigation, and Preparedness are essential.

*Before a natural disaster:*

### Prevention

Prevention includes the safeguards that you establish to stop the effects of a disaster. These include policies and legislation that affect urban planning and are not damaging to human and ecosystem well-being.

It is usually difficult to prevent entirely a natural disaster and therefore, the next two steps become important.

### Mitigation

Mitigation reduces risk from natural disasters. Zoning and proper land use management – for example, building with a set-back on a coastline or leaving intact stands of mangroves and public education – are examples of mitigation.

### Preparedness

Preparedness aims to reduce to the minimum level possible, the loss of human lives and damage to built and natural infrastructure through the prompt and efficient actions to response and rehabilitation. Effective preparedness allows communities and institutions to provide a quick, organised response to disasters and include early warning systems, planned evacuation routes and sites etc.

*After a natural disaster:*

Achieving the second and third goals occurs after a natural disaster. Response (Relief), Recovery, and Rebuilding then become essential.

### Response (Relief)

Response (Relief) is the collective actions carried out immediately after a disaster with the objective of saving lives, alleviating suffering and reducing economic losses. For example, relief includes getting people to safe locations, provision of food and clothing etc.

### Recovery

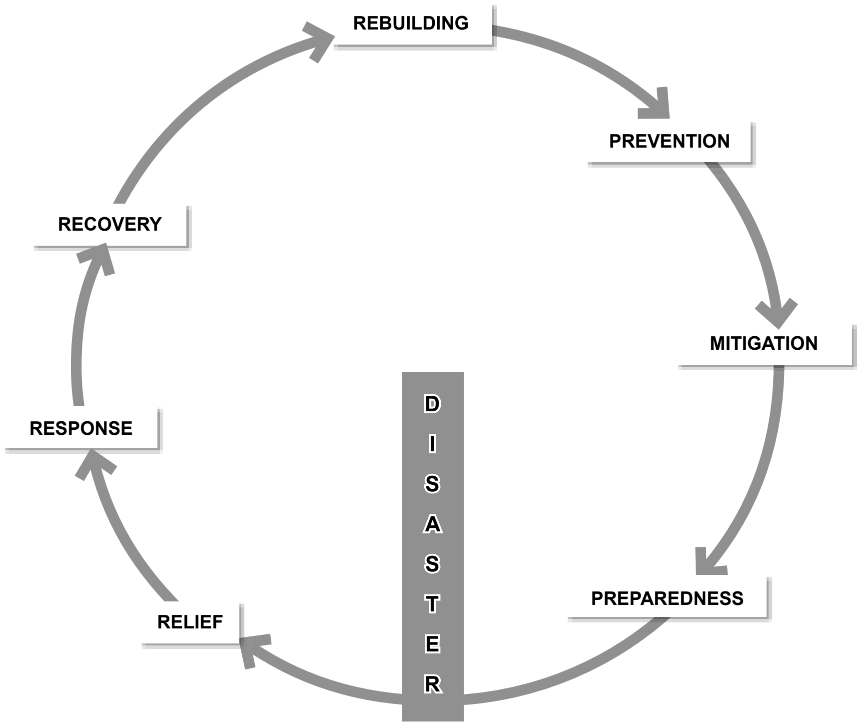
Recovery is the activity that returns humans and built infrastructures to minimum living/operating standards and guides long-term efforts designed to return life to normal levels after a disaster. This includes building temporary housing and provision of basic household amenities.

### Rebuilding

Rebuilding is the long term response to a disaster. In this phase, permanent infrastructures are rebuilt, ecosystems are restored and livelihoods are rehabilitated (GDRC, 2008).

All these disaster management phases are inter-linked and are cyclic – i.e., one phase cannot be effective in isolation of the others. In other words, the phases before an event – prevention, preparedness and mitigation – are as important as response, recovery and rebuilding.

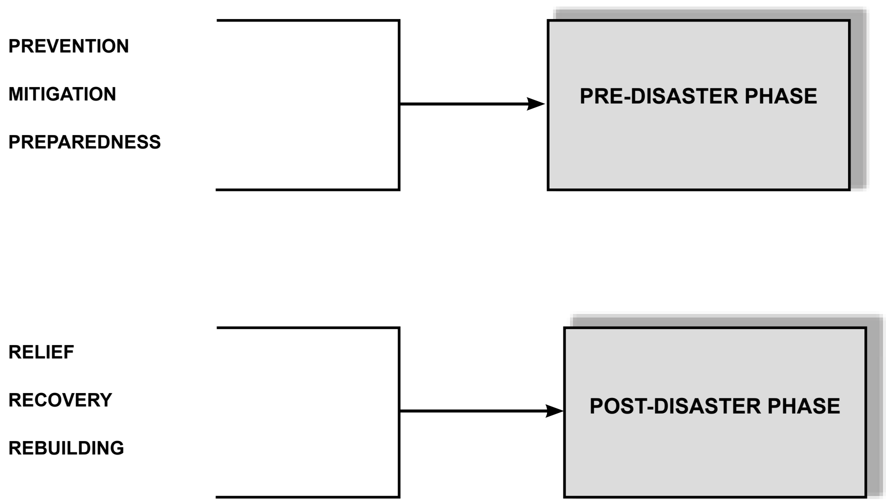
Figure 1: The Disaster Management Cycle (Source: GDRC, 2008)




Because of the cyclic nature of DRM, a lot of steps that need to be taken in one phase are repeated in another. For emphasis, this repetition is preserved in this volume.

Each step can be grouped into two phases as follows:

Figure 2: Phases in the Disaster Management Cycle

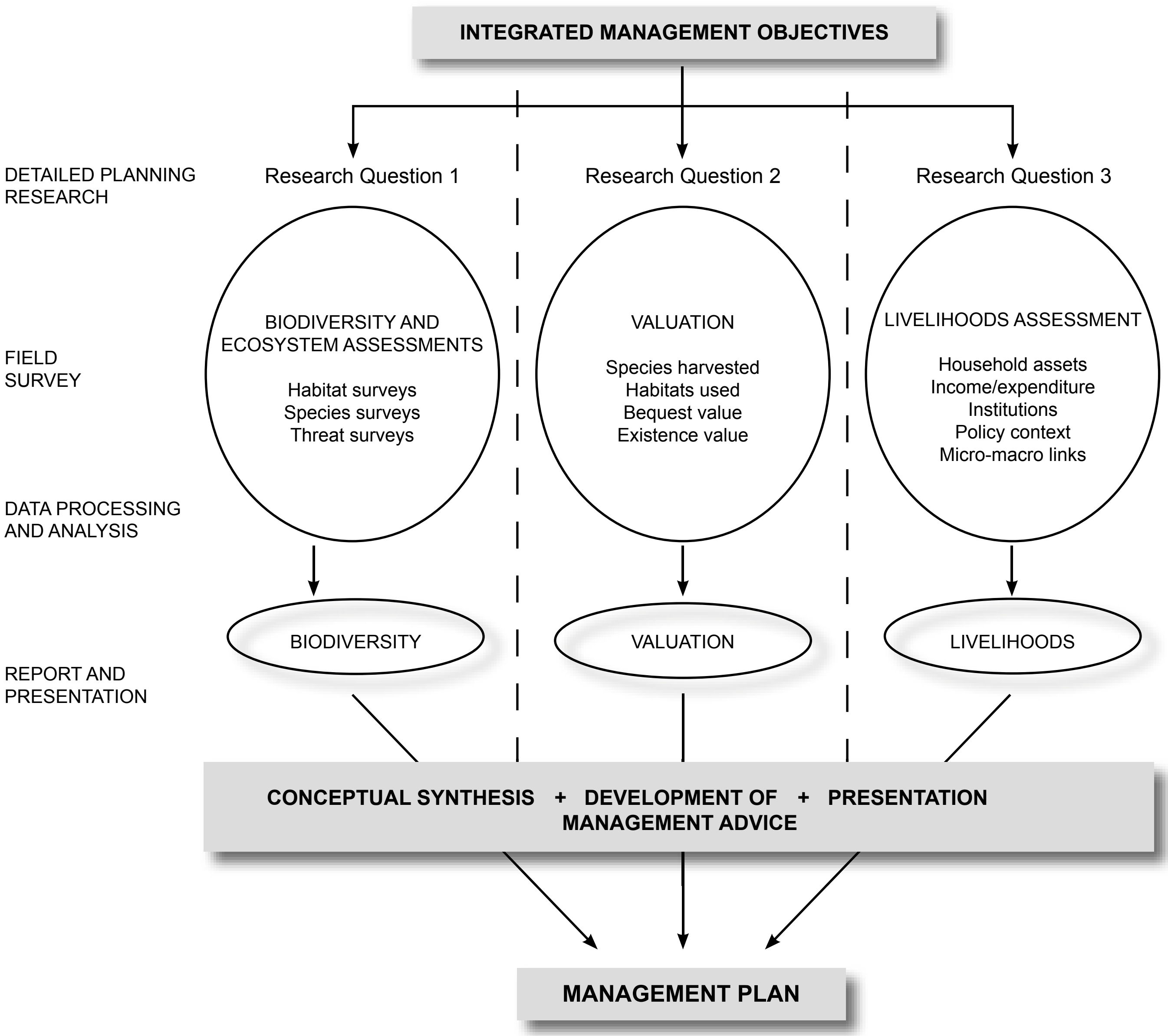


## The importance of integrated assessments in DRM (Why?)

In the rush to provide relief and aid in the aftermath of the Indian Ocean tsunami of December 2004, not only were environmental concerns ignored but it was also apparent that many institutions worked in isolation, leading to omissions, duplications in research and implementation, piecemeal results and a lack of accountability. An integrated approach that includes biodiversity, ecosystem, livelihood and economic valuation is recommended to ensure that a holistic picture is obtained during the disaster management cycle.

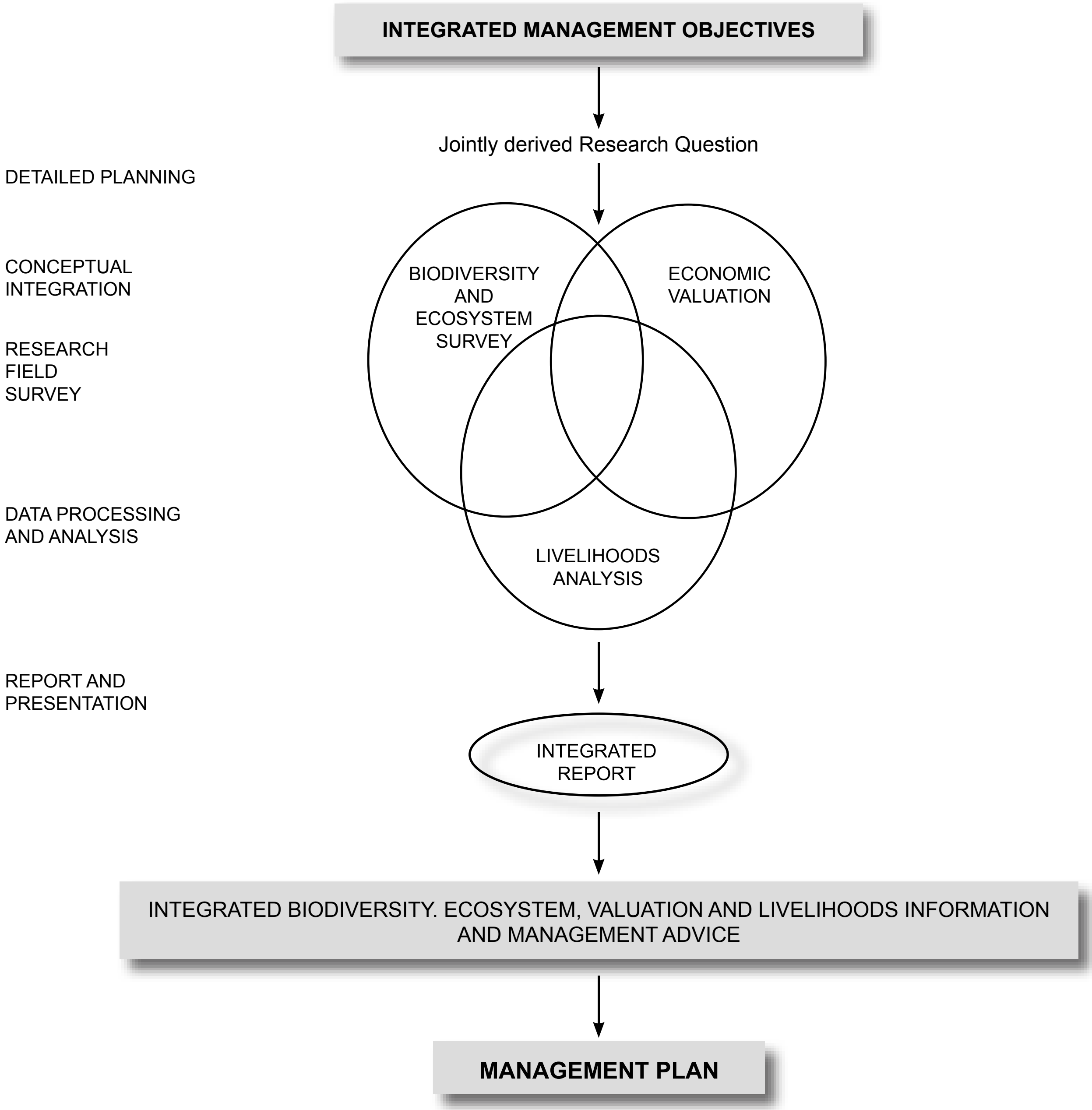
Figure 3 below shows a non-integrated assessment model while Figure 4 shows an integrated assessment module.

Figure 3: Schematic diagram of a non-integrated assessment model
(Sourced directly from Springate-Baginski, et al., in press)



‘The fully integrated assessment model (Figure 4) presented below has the advantage that exchange of ideas takes place at all stages from defining objectives, through carrying out fieldwork, to data analysis and presentation. Its disadvantages may include the time and difficulty it takes to plan and conceptualise and the intellectual and professional demands it places on participants. This model helps environmental conservation and development stakeholders to move away from a situation where they are making decisions on the basis of a series of biodiversity assessments, economic valuations and social development reports that have been carried out by different groups of people, who were commissioned separately by programme or project planners, did not consult one another, worked in different places and at different times to each other, using different methods, analytical tools and scales of working, and were each able to provide only a part of the information required and who left gaps which had to be filled by information derived from guesswork, inapplicable generalisations or vested interests’ (Sourced directly from Springate-Baginski,et al., in press).

Figure 4: Schematic diagram of an integrated assessment model
(Sourced directly from Springate-Baginski, et al., in press)




It is only when a holistic approach is used that reducing all types of vulnerability (physical, environmental, social and attitudinal vulnerability) becomes possible. It is only through integrated assessments that risk can be minimised in the long term. A holistic approach also allows for identification of gaps throughout the disaster management cycle. In addition, an integrated approach in disaster management demands involvement and collaboration not among local sectors but also at national and regional levels.

The process for integrated assessments (How?) (Quoted directly from Springate-Baginski, et al., in press)

A framework for integrated assessments and steps to be followed in such an assessment are given below.

| | | |
|---|---|---|
| A. Preparation | 1 | Identifying the management context and questions to be addressed. |
| | 2 | Forming a multi-disciplinary team. |
| | 3 | Identifying the information required. |
| | 4 | Framing the study and take sampling decisions. |
| | 5 | Planning within the constraints. |
| | 6 | Collation of secondary data and pre-existing literature. |
| B. Field assessment | 7 | Conducting the fieldwork. |
| C. Analysis, Write-up and Presentation | 8 | Integrated data management and storage. |
| | 9 | Integrated data analysis. |
| | 10 | Integrated presentation of results. |

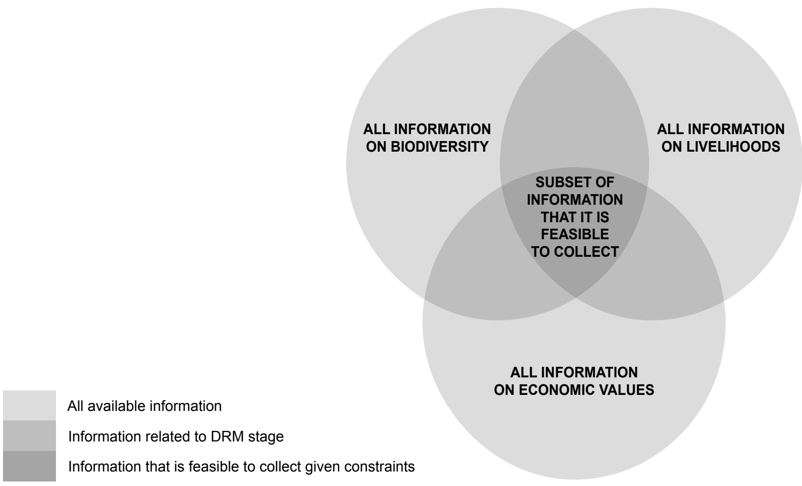
*A. Preparation involves:*

1. Identifying the management context and questions to be addressed.
   - This focuses the assessment and
   - involves multiple stakeholders.
   - The management issue should encompass both environmental and social issues.
   - From this general issue, specific questions should be developed.

2. Forming a multi-disciplinary team:
   - This team should involve both specialists and generalists. Ideally, the team leader is in the latter category
   - Together they should bring the following expertise:
     - i. biodiversity and ecosystem surveying,
     - ii. economic valuation,
     - iii. livelihoods surveying and participatory research methods,
     - iv. possibly ethnobiological methods and
     - v. geo-referencing and spatial mapping.
     - vi. All should recognise the value-addition of the integrated approach and be willing to stretch themselves in order to achieve it.

3. Identifying the information required:
   - The information should provide adequate data to answer questions identified.
   - The information should be the subset of all information which forms the intersection of biodiversity/livelihood /economic values relevant to the overall management issue.
   - The information should be feasible to collect.

Figure 5: Identifying the information required
(Sourced directly from Springate-Baginski, et al., in press)



4. Framing the study and taking sampling decisions:
   Framing is
   - Defining the assessment boundaries (defining the methodology);
   - Defining the geographic boundary (defining space); and
   - Defining a temporal boundary (defining time).

   Sampling is
   - Selecting species groups to survey;
   - Defining the socio-economic boundaries; and
   - Identifying which ecosystem values to quantify.

5. Planning within the constraints:
   There are many constraints within which integrated assessments have to be carried out.
   - Time constraints (deadlines, other obligations);
   - Funding constraints (budget);
   - Expertise constraints (skills and experience of team);
   - Political constraints (permits, permissions, access, conflicts);
   - Institutional constraints (networks etc.);
   - Social, cultural constraints (festivals, languages, customs); and
   - Natural constraints (seasonal factors and risks).

6. Collating secondary data and existing literature:
   It is important during a survey to gather existing information.
   a. Gathering Information:
   - Types of information:
     – Species information should aim to include information on taxonomy, geographic range, population size and trends;
     – Trade and value of species or species products: CITES, livelihoods reports;
     – Resource use: livelihoods reports, FAO;
     – Wealth/poverty status: census data, livelihoods reports, government/district data, health statistics (from health organisations) or studies from NGOs/medical centres in the area;
     – Livelihoods information: World Health Organisation, government agencies;
     – Maps: government mapping agency, aerial photography companies, NGOs that have produced maps as part of their reports.
   - Sources: reports and 'grey literature' of government and other agencies, government data and maps, online databases ('red list', books and miscellaneous materials).
   - Follow an integrated search - materials may be relevant to one or more disciplines.
   - Refer to key informants/experts for help.

   b. Reviewing Information:
   Clarify current state of knowledge and information gaps.

*B. Field assessment:*

7. Conducting the fieldwork:
   - Develop an integrated fieldwork plan;
   - Develop and adapt integrated field tools;
   - Train the fieldwork team and pilot the plan and tools;
   - Do the fieldwork;
   - Maintain rapport with respondents based on mutual respect. Observe research ethics;
   - Maintain field team networking and communication.

*C. Analysis, Write-up and Presentation:*

8. Integrated data management and storage protocols:
    - Data should be carefully and systematically compiled into a user-friendly archive, inter-referenced and backed up.
    - Data loss is a surprisingly common problem. In an age of effortless back-up it is hardly professional. It is easy to avoid by establishing a regular back-up system.
    - The 'clean' dataset should be kept separate from sets used for analysis.

9. Integrated data analysis:
    - Each aspect of the assessment should be analysed
    - Then the analysis should be integrated through team discussions.

10. Integrated presentation of results. This should include:
    - Recommendations from analysis of results;
    - Internal feedback;
    - Local feedback;
    - National feedback.

## The importance of integrated assessments in disaster management

An integrated approach that includes biodiversity, ecosystem, livelihood and economic valuation is essential to ensure that a holistic picture is obtained during the entire disaster management cycle.

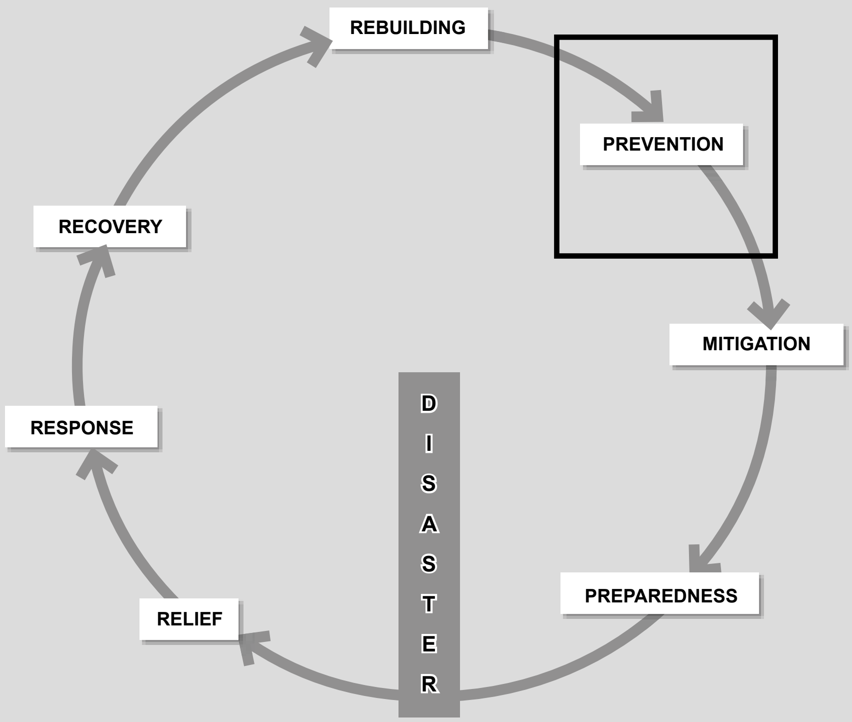
It is only when a holistic approach is used that reducing all types of vulnerability (physical, environmental, social and attitudinal vulnerability (see Volume 1) - becomes possible. It is only through integrated assessments that risk can be minimised in the long term. A holistic approach also allows for identification of gaps throughout the disaster management cycle. In addition, an integrated approach in disaster management demands involvement and collaboration not among local sectors but also at national and regional levels, leading to development that is geared at a landscape level, yielding the 'big picture.' This ultimately, is the most effective approach.

'After the Indian ocean tsunami of 2004, a serious problem that emerged was a lack of coordination among agencies: between government and non-government agencies, among donors and between national and local governments.

This lack of coordination extended to various sectors as well. For example, the fisheries sector had little influence on national governments regarding the issue of boats (see page 33, this volume). Meanwhile, environmental organisations tried to convert the converted by reaching out only to the environmental community, developing guidelines and checklists which few outside their sector, value or even read. They found it difficult to accept the unfortunate fact that the very word 'environment' is viewed by the mainstream development sector as an ill-afforded luxury. Architects designed houses that did not reflect cultural needs or were environmentally friendly; builders paid scant respect to existing laws and environmental standards.'

The end result was, largely, confusion, duplications and omissions, that retarded recovery and hindered restoration (IUCN, 2006).

## Pre-disaster management: Prevention




Prevention includes the safeguards that you establish to stop the effects of a disaster. These include assessments, policies and legislation that affect urban planning and are not damaging to human and ecosystem well-being.

*Policy decisions and actions taken during prevention and mitigation have enormous and far reaching impacts on all stages of post disaster management. All decisions and actions taken will be justified based on information gathered and actions taken during prevention and mitigation. The success of post disaster management depends entirely on pre-disaster management. It is critically important, therefore, that great attention is paid during these pre-disaster phases to minimise impacts after a disaster.*

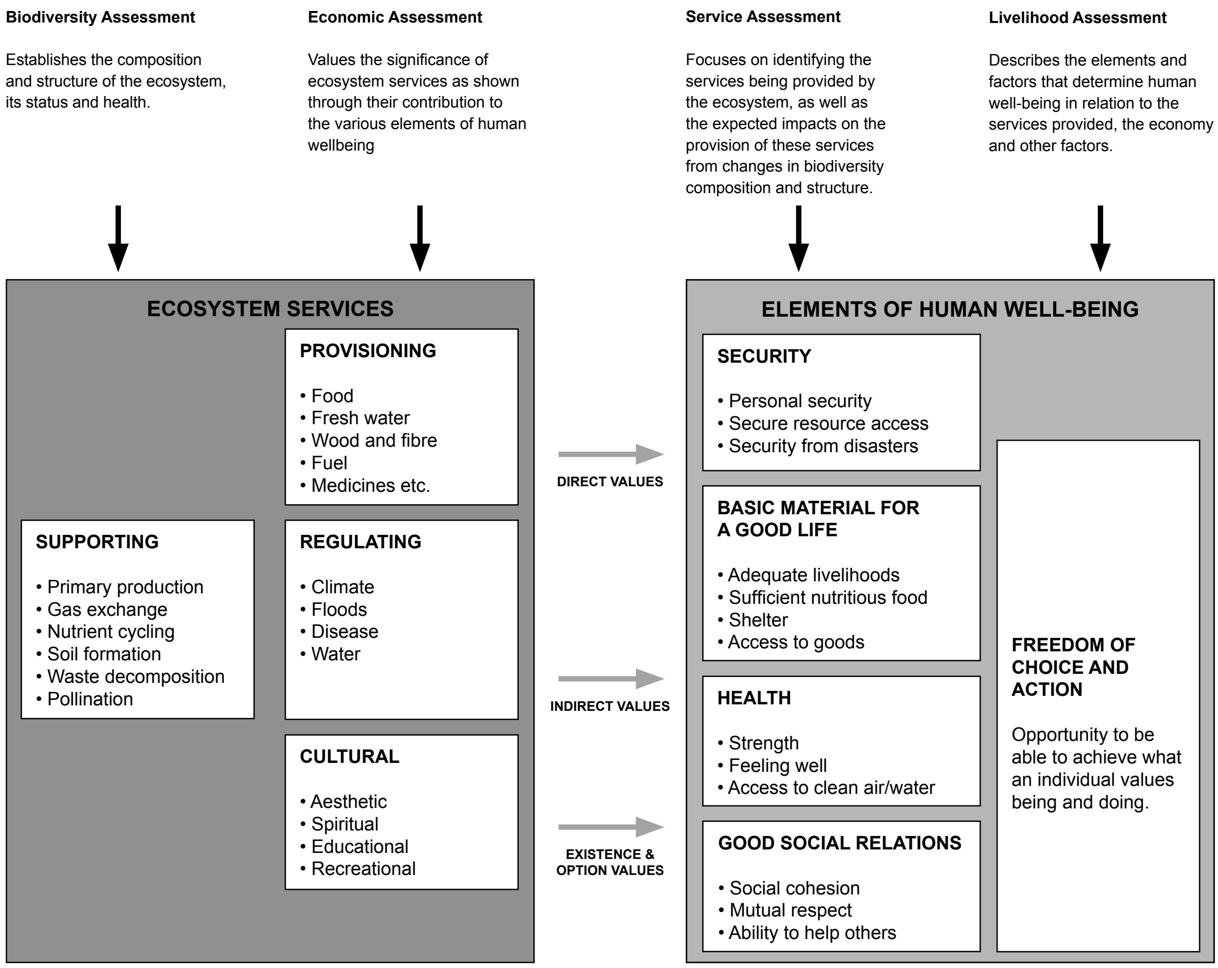
In the pre-disaster phase, it is essential to map all natural and socio-economic resources. In this way, a community's dependence on a resource and its use of the ecosystem services provided can be assessed. The mapping should be carried early enough so that it can serve practically as an important contribution to the decision-making process and will not be used to justify a decision already made.

It is also important to carry out this mapping in such a way that allows for comparisons across time and space so that changes can be monitored. This means that we must be able to measure our knowledge (assess) and also be able to describe (map) it. With reference to natural disasters, we need to collect and integrate baseline information so that comprehensive comparisons can be made after a disaster.

A framework has been proposed that includes four sub-assessments: on biodiversity; ecosystem services; economic values; and on livelihoods and human well-being (Kallesøe et al, 2008). (See Figure 1 page 2 of Volume 1.)

'The Biodiversity Assessment establishes the composition and structure of the ecosystem, its status and health. The Ecosystem Service Assessment focuses on identifying the services being provided by the ecosystem, as well as the expected impacts on the provision of these services from changes in biodiversity composition and structure. The Livelihood Assessment describes the elements and factors that determine human well-being in relation to the services provided, the economy and other factors. Finally, the Economic Assessment values the significance of ecosystem services as shown through their contribution to the various elements of human well-being' (Kallesøe et al, 2008).

Figure 6: Framework for an integrated assessment
(Source: Kallesøe et al, 2008)



A combined integrated assessment of all four components allows managers to establish a baseline on the status of ecosystem well-being and human well-being in order that informed and planned decisions are made in relation to management interventions.

A working checklist for an integrated assessment is presented in Annex 1, but the steps listed below should be followed in the process of collecting information:

a) Biodiversity Assessment: (see Volume 3 for detailed techniques)

*Step 1: Identify the extent and type of natural habitats*.
- What is the type of ecosystem: lowland rain forest, coral reef, sand dune, mangrove?
- What is the distribution and extent of habitats within these ecosystems?

*Step 2: Identify species diversity (species richness[2] and abundance[3]) of plants and animals.*
- How many different species of animals?
- How many different species of plants?
- How many individuals per species of animal?
- How many individuals per species of plant?

b) Ecosystem Services Assessment:

*Step 3: Identify ecosystem services provided: for example,*
- What are the provisioning services: i.e., what are the goods provided by the ecosystem – food, timber, fuelwood, medicines, other non timber forest products (NTFPs), water etc. What is the number of households/individuals that use/depend on the above services?
- What are the supporting services: i.e., how much primary production is there? In addition, the yield (amount of fish catch, fruit yield) also indicates the how good the supporting service is.
- What are the regulating services: i.e., is the ecosystem providing protection from natural hazards, such as prevention of floods and sequestering carbon?
- What are the cultural services provided by the ecosystem? Is it used for recreation/tourism/education?

*Step 4: Use indicators to assess the above. For example,*
- The quality and quantity of fish, vegetables and fruits, for example, indicate the extent of the ecosystem's provisioning services.
- Species diversity and quality of vegetation indicate the extent of the ecosystem's supporting services.
- The extent of tree cover (i.e. number of trees per $km^2$, height and the width of the trunk etc.), vegetation stands, protection by vegetation of built infrastructure etc. indicates the extent of the ecosystem's regulating services.
- Assess the demand for recreation and education: i.e., the number of tourist-related built infrastructure and educational facilities such as outreach stations indicate the extent of the ecosystem's cultural services. In addition, the extent of traditional knowledge practiced also indicates the extent of the ecosystem's cultural services.

*Step 5: Assess direct drivers of ecosystem loss. For example,*
- Is there over-exploitation? Are there harmful fishing practices (dynamiting, small net fishing), illegal felling of trees, coral mining, overuse of a single resource? (This can be assessed if a reduction of numbers is noted in Step 4.)
- Is there habitat destruction? Is there clear-felling, filling of wetlands, land reclamation, road and infrastructure building or any other alternative use?
- Are invasive alien species spreading?
- Is there pollution? Has solid waste accumulated? Is there water pollution: foul smell, foaming, eutrophication?

[2] Species richness is the number of different species in a habitat.
[3] Species abundance is the number of individuals of each species.

c) Socio-economic Assessment (Livelihoods and Economics):

*Step 7: Assess household benefits from ecosystem services.*

- Does the household benefit from any provisioning services? If so, which and for what purposes?
- Does the household benefit from any supporting services? If so, which?
- Does the household benefit from any regulating services? If so, which?
- Does the household benefit from any cultural services? If so, which?

*Step 8: Identify livelihood dependence on provisioning services.*

- For provisioning services, list how much of the household cash and non-cash income is obtained from natural resources as part of their whole income.
- From where do households get the cash and non-cash income that is not obtained from the provisioning services of ecosystems (what are the other livelihoods)?
- What is the proportion of cash and non-cash income from provisioning services to cash and non-cash income from livelihoods not related to natural resources?
- For provisioning services, list how much (what percentage) of natural resources are used by the household and how much (what percentage) is proportion is sold/traded.
- Is there seasonal variation in provisioning services during the year? If so, when?

*Step 9: Assess the impacts from ecosystem loss on human well-being.*

- What are the impacts of ecosystem losses on the livelihood of dependent households/individuals/communities?
- Would the safety (food security, adequate and safe water supply, protection from extreme weather events etc) of households/individuals be affected by ecosystem loss?
- Would the health of their households be affected negatively by ecosystem loss (through loss of provisioning/supporting/regulating services)?
- Would the social relations of their households suffer with ecosystem loss? (i.e., reduce time allocated for community common work, initiate/increase conflict with each other for resource extraction etc)?
- Would their freedom of choice and action be reduced with ecosystem loss?
- Would their household lose basic materials for good life with ecosystem loss?
- Will government expenditure on social welfare and security increase due to loss of environmental services?

*Step 10: Ensure that gender sensitivity is mainstreamed into the above steps, as relevant.*

- For example, traditionally, it is women who collect fuelwood and women who collect water. Therefore, they are likely to know best about use, quantities and quality.

Once integrated assessments have been carried out, mapped assets have to be ranked. Ranking, however, is country-specific exercise, although three general criteria may be used a) uses and economic value, b) uniqueness, and c) pre-existing threats.

The following questions may be asked based on the above criteria:

1. Which species/ecosystem has the most number of uses?
2. Which species/ecosystem is the most economically valuable?
3. Which species/ecosystem is the most over-exploited?
4. Which is the greatest threat to ecosystem services?
5. Which is the ecosystem service that impacts the most number of people?
6. Which sector of the community is most affected by the above?

- Assets which serve a greater number of uses and produce economic value may be assigned a higher importance rank than those which serve less uses and produce less economic value.
- Unique assets are more important than those which are more common (and hence easier to replace). the post-disaster scenario than those which were not under threat.
- After this, policy and legislation protecting ecosystems and services become important. Both local legislation and international treaties have impacts on the conservation of the natural environment.

The next phase in prevention is risk analysis and hazard mapping.

## Hazard Mapping Assessment

Hazard maps show where a natural hazard is likely to occur. They also map the intensity of occurrence.

Most often hazard mapping is defined as 'the process of establishing geographically where and to what extent particular phenomena are likely to pose a threat to people, property, infrastructure, and economic activities' (Coburn et al., 1994). However, this omits the integral need to assess threats to ecosystems as well.

Therefore, with the integration of environmental issues into disaster management, this definition should read to mean that hazard mapping is the process that establishes where and to what extent a natural hazard is likely to pose a threat to humans, biodiversity, property and infrastructure (both natural - ecosystems and man-made), to livelihoods and economic activities.

The following questions need to be asked

- What: what kind of hazard occurs? For example, a heavy rain causes a flood, a landslide or a debris flow.
- Where: where does the hazard occur? For example, tidal surges affect coastal areas; landslides are more common on hill slopes. Which ecosystems are affected?
- How large is the scale of the hazard?
- How intense is it? For example, there is a heavy rain of 500mm in one day, or lava flow of 300,000$m^3$.
- How does the phenomenon develop or spread? Is it rapid, slow onset or cyclic?
- When does it occur or when is it likely to occur?
- What is the frequency or probability of occurrence? For example, there is a heavy rain that occurs once for 30 years, or a great volcanic eruption that occurs once for 200 years.
- Who suffers from a disaster?
- How high is the grade of disaster?
- How many deaths, building damage or collapse?
- How much is the total loss?

Using spatial information to plan for disaster management:

Disasters have a spatial nature and hence, the use of geographical data at various points in the disaster management cycle can serve as a powerful tool for more effective and efficient planning and response at various points in the disaster management cycle.

Management of spatial information used in disaster management is carried out through a Geo-Spatial Information System (GIS), which is a collection of computer hardware, software, and geographic data for capturing, managing, analysing, and displaying all forms of geographically referenced information. There are various kinds of spatial data used to increase disaster risk understanding including various types of multilayered geographically referenced information such as aerial photographs, satellite imagery and digital maps (R. Roberts, personal communication).

Spatial data can be used in a GIS to produce visual displays of hazard risk and vulnerability to facilitate planning to reduce the impacts of disasters on humans and infrastructure. Hazard maps can also show where major public works, roads, hospitals, schools and other major infrastructure are situated to reduce the degree of risk. In newly developing areas, hazard maps can be crucial in ensuring that key infrastructure, human settlements and tourism facilities are located out of high risk zones. In already developed areas, while complete avoidance of hazardous areas may not be possible, hazard maps can be very useful in planning for evacuation and for employing different or additional design standards for structures to ensure that they can withstand shocks or to ensure that only non-critical components are lost to such hazards. GIS can be used also to identify ecologically sensitive areas.

Hazard maps can be also very important in identifying the sources and causes of hazards at a location that increase the degree of potential damage from various types of disasters. For instance, using a simple GIS model, land cover maps, overlaid with risk and topography maps can be used to identify and further test linkages between vegetation cover and flood or storm surge risk in disaster prone areas. More complex GIS applications can provide an important analysis for instance, of the increased landslide or flood threat as a result of the construction of a highway into a fragile hilly environment.

Models can be used to evaluate future aspects of disaster risk, for example for a set of land-use planning scenarios towards developing a prior understanding of the potential risks and for arriving at the best possible alternatives, within the given constraints. These can be prepared based on the historic data of any past similar events and modeling for the dispersion of disaster impacts. Such an analysis can be coupled with information on the changes in demographics and socio-economic profiles of a region - such as population concentration, degree of poverty, land-use, wild-life attributes - to identify clearly and demonstrate the linkages between ecological damage and worsening of the impacts of natural disasters.

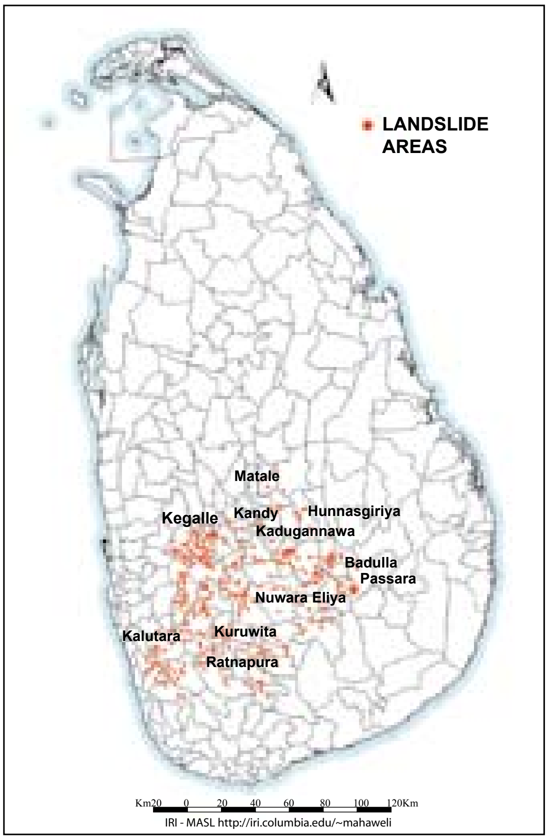
In the aftermath of a disaster, spatial information is very useful in damage assessment to provide information for rehabilitation and construction. Economic evaluation can be carried out to assess the percentage damage or cleaning/reconstruction cost; pollution/contamination concentration ranges, especially in the case of damaged sewage works or industrial complexes. Following a disaster, the results of such models could also provide information towards the analysis of long-term impacts of disasters, such as impacts on wildlife or fish stocks that would, in turn, impact the tourism and fisheries sectors, and thereby, the capacity and amount of time required by local communities to recover from a disaster (R. Roberts, personal communication).

Evacuation analysis

During the disaster phase, GIS can be used to support emergency response in the provision of timely and appropriate humanitarian assistance to save lives and protect livelihoods of the poor and vulnerable households against shocks and food emergencies. For instance, a catastrophic spatial model can be used for a region to: identify a) the exact geographical location; b) which population groups are affected and how many people may be in the area; c) the duration of the intervention; d) store emergency management-related departments' locations; e) provide online systems for tracking and communication of the hazard and damage spread; f) identify natural resources and critical infrastructure at risk; and g) mobilise available resources for response (R. Roberts, personal communication).

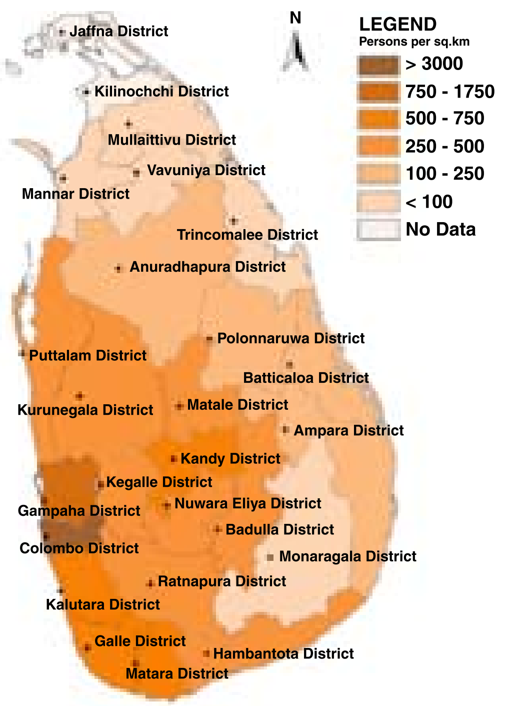
Using the above data, it is possible to generate a hazard map using basic GIS technology as shown below. The data used were landslide incidence in Sri Lanka (Figure 7a).

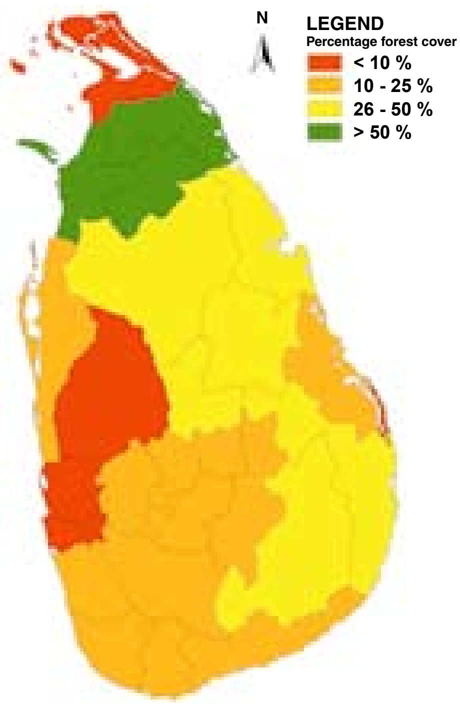
Figure 7: a) Landslide incidence in Sri Lanka (Source: Zubair & Ralapanawe 2008)




Next, a vulnerability map is needed. Population density, industrial regions, concentration of economic activities, livelihoods, infrastructure (ecosystems and man-made), income levels etc. all indicate vulnerability. Presented below are maps of human population density and the forest cover of Sri Lanka - the latter, important natural infrastructure.

Figure 7: b) Population density in Sri Lanka (Source: Zubair & Ralapanawe 2008), c) Forest cover in Sri Lanka (Source: Data sourced from IUCN and MENR, 2007, map compiled by Eric Wikramanayake, 2008)



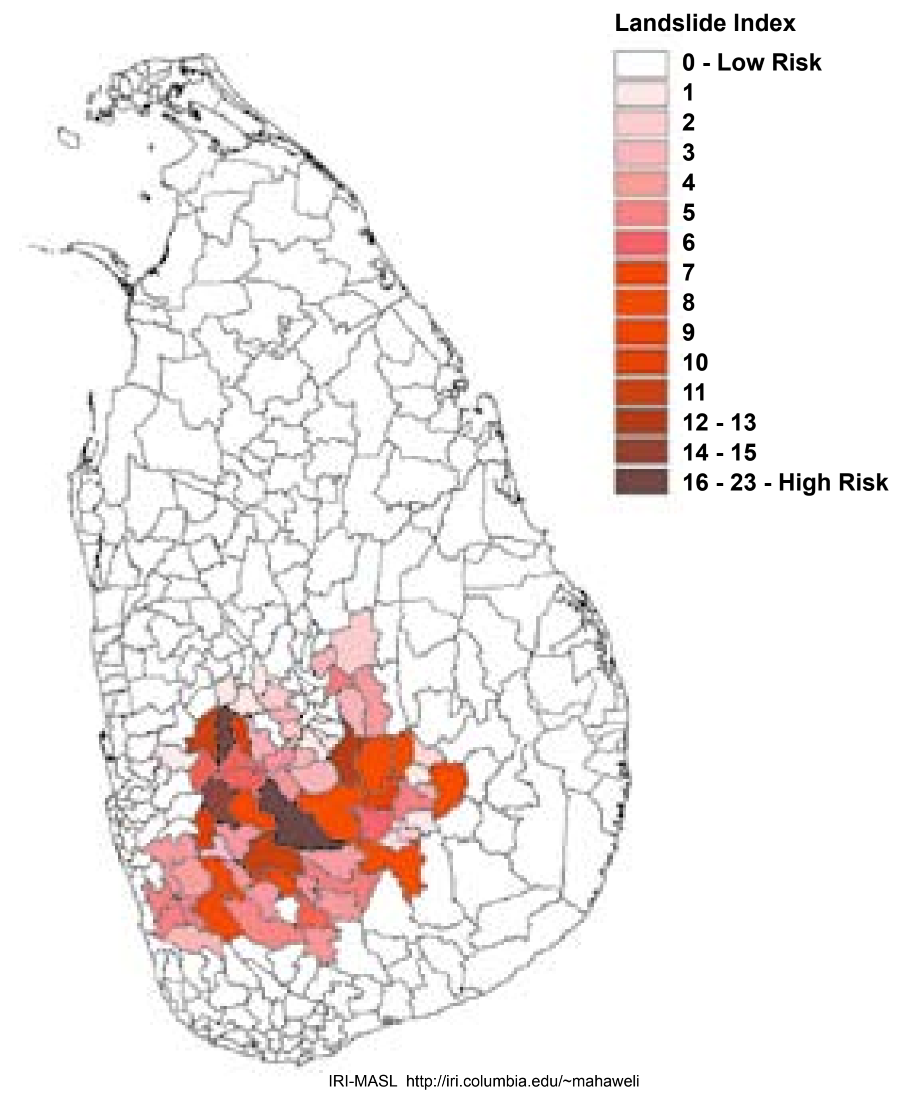
Risk analysis

Risk analysis is 'the systematic use of available information to determine how often specified events may occur and the magnitude of their consequences' (www.riskmanagement.qld.gov.au/info/guide/gls.htm). Again, this is a huge topic which is used for a range of topics, from assessing risk for car and other insurance to analysing risk in business ventures and disaster risk management.

Simply stated, risk analysis estimates the likelihood of a hazard occurring.

The simplest way of analysing risk using GIS technology would be to overlay the hazard map over the vulnerability map to generate a risk map. An overlay of Figure 7a and b will generate a map similar to the one presented below, which shows landslide risk in Sri Lanka.

Figure 8: Landslide risk map of Sri Lanka (Source: Zubair & Ralapanawe 2008)

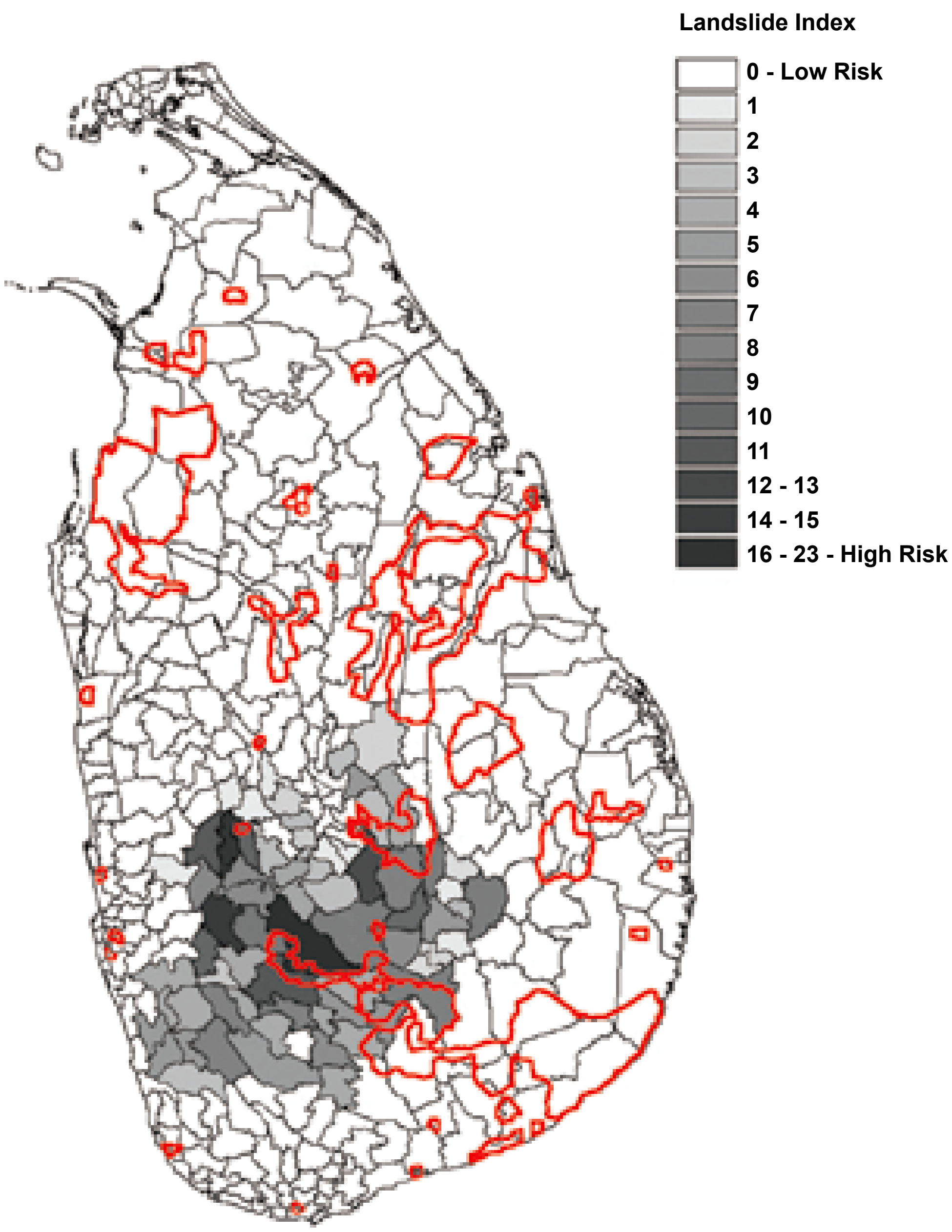



The International Research Institute for Climate and Society (IRI) is engaged currently in identifying global natural disaster risk hotspots in Sri Lanka. It is examining water resource management, climate predictions, flood, drought and landslide to map and identify high risk areas. Through extensive literature surveys and research, high resolution hazard maps, vulnerability maps (based also on previously published work), and risk maps are being generated with the intention of sharing these data with relevant disaster management agencies in Sri Lanka (http://iri.columbia.edu/~mahaweli/disaster/concept.html).

IUCN defines a protected area an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.( http://www.unep-wcmc.org/protected_areas/ categories/ index.html). Protected areas are extremely important in mitigating the effects of disasters.

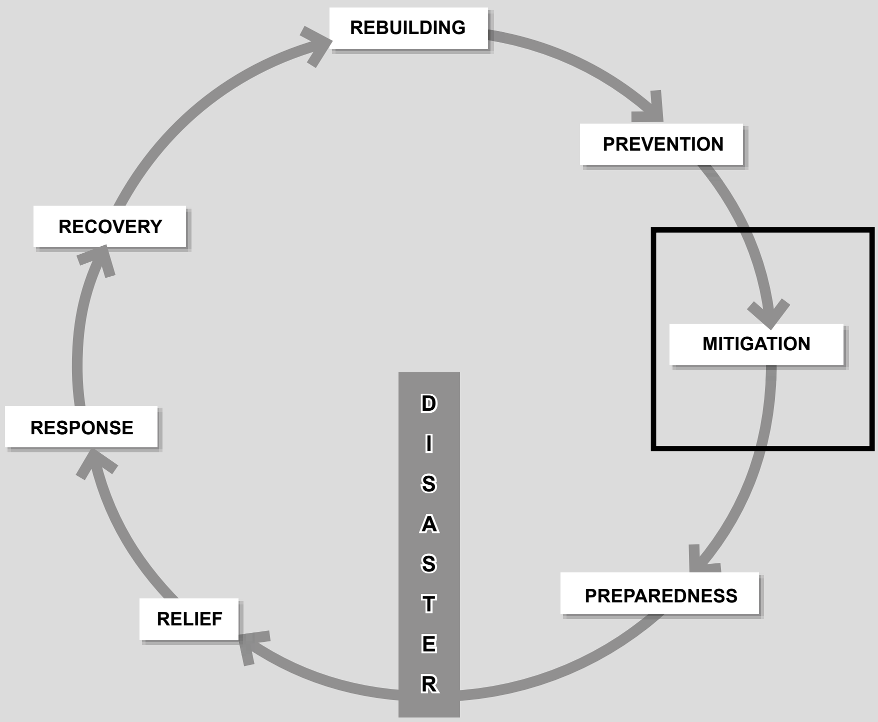
Overlaying protected areas over risk maps clearly reveal their importance.

The map below shows a landslide risk map of Sri Lanka (the darkest shades are the high risk areas) overlaid with the larger protected areas under the jurisdiction of the Department of Wildlife Conservation. This map shows how critical protected areas are in areas of high landslide risk, because of their services of flood attenuation.




Source of base map: Zubair & Ralapanawe 2008.
Source of protected areas: Department of Wildlife Conservation, Sri Lanka)

## Pre-disaster management: Mitigation




Mitigation reduces risk from natural disasters. Zoning and proper land use management – for example, building with a set-back on a coastline or leaving intact stands of mangroves and public education are examples of mitigation.

Prevention - although the ideal for management - can be achieved rarely in a real-life situation. Mitigation strives to reduce risk from natural disasters. The mitigation phase, like rebuilding, is different from other phases because it focuses on long-term measures for reducing risk.

Much of the measures that are taken during mitigation are also the same measures that are taken during rebuilding and therefore, there is overlap in the steps to be followed.

Mitigation can be categorised into structural and non structural actions.

Structural mitigation:

Building infrastructure that has design standards to withstand earthquakes in earthquake prone areas, floods in flood prone areas, tropical cyclones in cyclone prone areas and so on are examples of structural mitigation.

In all these actions, it is necessary to assess continually the impacts on species and ecosystem services, in order to minimise impacts on human well-being.

In the process of structural building to mitigate the effects of hazards these steps should be followed. All these steps prevent or reduce damage to natural ecosystems and therefore, their different ecosystem services. These services, in turn, all affect human well-being.

*Step 1: Ensure that there is no over-exploitation of species.*

- For example, is timber use sustainable? Or is it being obtained from unmanaged forests/protected areas?

*Step 2: Minimise habitat change.*

- Check whether sensitive areas (identified in the previous chapter) are being cleared for buildings.
- Check whether coastal/river morphology is being changed by built infrastructure.

*Step 3: Minimise pollution.*

- Check whether the area is being polluted by the process.
- Check whether there is collection of non-biodegradable solid waste.
- Check how solid waste is being collected and disposed.
- Check whether an effort is being made to reduce, reuse and recycle waste.
- Check whether the air is being polluted by the process.
- Check whether air pollution control measures are in place.
- Check whether the water around is being polluted by the process.

*Step 4: Prevent the spread of invasive alien species.*

- Ensure that the spread of invasive alien species is not increased. (Building equipment is known to be a mechanism through which IAS spread.)

*Step 5: Ensure that measures are taken to mitigate the impacts of and adapt to climate change.*

- Ensure that energy conservation measures are being adopted. For example, is there through-flow ventilation in hot climates? Are energy saving bulbs and alternate energy sources - such as solar power - being used where ever possible?
- Ensure that water conservation measures are being adopted.
- Ensure that waste water is managed hygienically. Are toilets being built at safe distances from drinking water sources?
- Ensure that environmentally-friendly materials are used as much as possible.
- Ensure that efforts are made to replant and landscape during structural changes.

## Non Structural mitigation:

Non structural mitigation includes policy, legislation, insurance and awareness.

Policies that integrate environmental concerns into development and include building and zoning codes are essential.

In some countries, new legislation may need to be enacted, but in others, it is important that existing environmental legislation is followed.

It is important to know the following

- Know *what* you may build.
- Know *where* you may build.
- Know which activities *are prohibited* where you propose to build.
- Know which activities *require a permit* and from which government department.
- Know which activities may be conducted *without a permit.*

The box on the opposite page show laws related to coastal reconstruction in Sri Lanka. The large number of the relevant laws exemplifies why disaster management is so complex, and reinforces the need for a holistic approach and integrated assessments.

## Laws relevant to reconstruction in Sri Lanka

- Agrarian Development Act No. 46 of 2000 Section 32 of this Act prohibits the conversion of paddy land for a purpose other than agricultural cultivation without the written permission of the Commissioner General shall be a punishable offence under this Act.
- Antiquities Ordinance No. 9 of 1940 as amended provides for the Director General of Archaeology to declare certain areas as Archaeological Reserves. Encroachment of any kind, for whatever purpose is deemed an offence under Section 34 of the Ordinance.
- Antiquities (Amendment) Act No. 24 of 1998 Section 40 (g) empowers the Director General of Archaeology to conduct an Archaeological Impact Assessment of areas that may be affected by development, industrial or other projects proposed by the Government or any person and implement any mitigatory measures that may be required. Sections 43 (A) and 43 (B) govern the Impact Assessment Procedure to be complied with in the event the Director General deems it necessary.
- Coast Conservation Act No. 57 of 1981 (CCA) as amended (Section 42 of the CCA) defines the coastal zone.
- Coast Conservation Act No. 57 of 1981 (CCA) as amended (Section 14 of the CCA) lists activities that are prescribed within the coastal zone.
- Coast Conservation Regulation No. 1 of 1982 as set out in Gazette Notification No. 260/ 22 – 1983 sets out in details the regulations pertaining to development activities that are permitted and prohibited.
- Common Law of Sri Lanka.
- Customary Laws of Sri Lanka.
- Criminal Procedure Code No 15 of 1979 Section 98 in concurrence with Section 261 of the Penal Code further elaborates on Public Nuisance.
- Fauna & Flora Protection Ordinance No. 2 of 1937 as amended, (FFPO) specifies the areas under the jurisdiction of the Department of Wildlife Conservation in which no construction or developmental activities can occur.
- Fauna & Flora Protection Ordinance No. 2 of 1937 as amended, (FFPO) specifies the areas under the jurisdiction of the Department of Wildlife Conservation in which a permit is required from the Director of Wildlife Conservation for construction or developmental activities can occur.
- Fauna & Flora Protection Ordinance No. 2 of 1937 as amended, (FFPO) specifies activities which are prohibited within national, reserves, sanctuaries and buffer zones as well as fauna and flora that are protected nationally.
- Forests Ordinance No. 16 of 1907 as amended specifies the areas and activities prohibited in designated forest areas. The felling of tress, cultivation and the construction of buildings and roads are prohibited activities together with poaching, cattle grazing etc.
- Fisheries and Aquatic Resources Act No. 2 of 1996 Section 36 specifies areas that are demarcated and protected as Fishery Reserves. Any development activity in a fishery reserve requires the permission and approval of the Director of Fisheries and Aquatic Resources.
- Land Acquisition Act No. 9 of 1950 as amended should be complied with when considering land use and allocation.
- Land Development Ordinance No. 19 of 1935 as amended should be complied with when considering land use and allocation.
- Land Grants (Special Provisions) Act No. 43 of 1979 as amended should be complied with when considering land use and allocation.
- Land Settlement Ordinance No. 20 of 1931 as amended should be complied with when considering land use and allocation.
- Marine Pollution Prevention Act No. 59 of 1981 authorises the Marine Pollution Prevention Authority (MPPA) to implement and take necessary steps to prevent Marine Pollution.
- Municipal Councils Ordinance No. 29 of 1947 should be complied with when considering land use and allocation.
- National Environmental Act No. 47 of 1980 as amended, Gazette No. 772/ 22 – 1993 sets out in detail the projects and undertakings for which approval is required and Environmental Impact Assessments necessary, whether they be wholly or partly outside the Coastal Zone as defined by the CCA.
- National Environmental Act No. 47 of 1980 as amended. Section 33 defines pollution and waste.
- National Heritage Wilderness Act, No 3 of 1988 defines areas of exceptional ecological value that need protection.
- National Housing Development Authority Act No. 17 of 1979 as amended empowers the National Housing Development Authority it in terms of Section 4 of the Act to engage in all housing and construction issues at a National level and its powers and functions are more specifically set out in Section 5 of the Act.
- Nuisance Ordinance enacted in 1862 with provisions to protect pollution and public nuisance.
- Penal Code enacted in 1880 Section 261 provides for environmental protection where any person/ s is prohibited from causing public nuisance such as noise, odour, and other irritant that causes harassment to society.
- Pradeshiya Sabha Act No. 15 of 1987 should be complied with when considering land use and allocation.
- Acquisition of Land Act No. 33 of 1950 as amended should be complied with when considering land use and allocation.
- State Lands Ordinance No. 8 of 1947 as amended should be complied with when considering land use and allocation.
- State Lands (Recovery and Possession) Act No. 7 of 1979 as amended should be complied with when considering land use and allocation.
- Urban Development Authority Law No 41 of 1978 as amended. The area lying within the limits of one kilometre (1 km) landwards of the Mean High Water line of the sea is suitable for development and by order of the Government of Sri Lanka declared to be an Urban Development Area.
- Urban Development Authority Law No 41 of 1978 as amended promotes integrated planning and implementation of economic, social and physical development in areas declared as urban development areas, all development activity within the said areas as set out in Section 8 of the UDA Law shall fall within the purview of the UDA.
- Urban Councils Ordinance No. 61 of 1939 as amended should be complied with when considering land use and allocation.
- Urban Development Authority Planning and Building Regulations 1986 as set out in Gazette No. 392/ 9 sets out the regulations covering any development activity, including reconstruction and rebuilding within the area demarcated as falling within One kilometre landwards from the Mean High Water line as set out in Gazette No. 223/ 16 – 1982 as mentioned more specifically above.

*(Source: EFL 2005, in IUCN 2005)*

It is also important to know which international treaties have been ratified by a respective country and to follow these.

For non-structural mitigation, the following steps need to be followed.

*Step 1: Enforce strictly design standards and building codes.*

*Step 2: Enforce strictly zoning legislation.*

- Is zoning legislation that steers development away from ecologically sensitive areas being adopted?
- Is zoning legislation that steers development away from hazard prone areas obtained from hazard mapping or areas subject to flooding, storm surge or coastal erosion being adopted?
- Have set backs that have been legislated been maintained? This is particularly relevant for coastal areas.

*Step 3: Enforce strictly existing laws and policies related to environmental management.*

- Are existing laws and policies that relate to environmental management and protection being followed?
- Is clearance of natural habitats such as mangroves, scrubland and forests being avoided?
- Is building on/filling lowland wetlands and watershed areas being avoided?
- Is destruction by clearing only for the essential, minimal area per building?
- Is it being ensured that natural water courses, watershed areas, flood plains etc. are not blocked by construction?

*Step 4: Actively restore and conserve ecosystems.*

- Are efforts being made to restore and conserve ecosystems as part of the reconstruction process?
- Are Environmental Impact Assessments required?
- Have native species been chosen actively in place of exotics?
- Are IAS being eradicated actively and prevented from spreading?
- Are multi-use, locally beneficial species being introduced?
- Are mono-cultures being avoided?

### Mitigation related to Climate Change

The term mitigation in relation to climate change has a different, distinct meaning. *Mitigation in climate change relates specifically to reduction in carbon emissions.* Stringent energy saving measures, improving energy supplies, optimising equipment to work at 100% efficiency - all reduce the quantity of $CO_2$ emitted. Hydropower, wind and solar power emit no $CO_2$ and are, therefore, *carbon clean*.

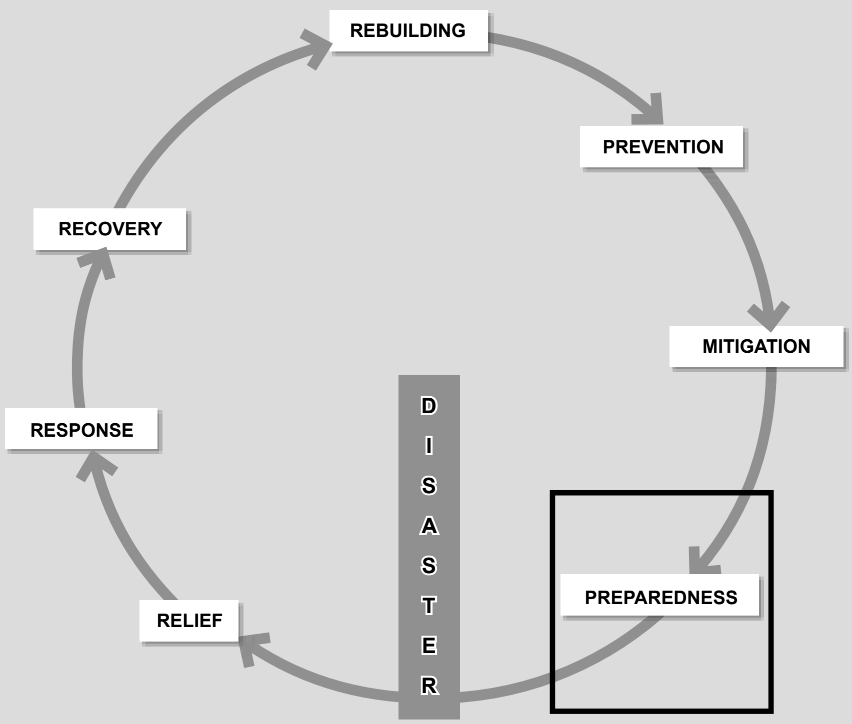
Another option is to use *carbon neutral* energy such as dendro power (energy generated by burning plants grown for the purpose) and bio-fuels (fuels obtained from plants, animals and their by-products: manure, garden waste and crop residues). In carbon neutral energy processes, plants absorb the same amount of $CO_2$ that is emitted into the air on burning. However, the increase in the use of carbon neutral energy has given rise to considerable debate and conflict. Deforestation to grow monocultures of energy generating crops and competition for land use between agricultural and energy crops negates the advantages of growing crops to generate bio-fuels.

It is also important to ensure that there is reduction of carbon emissions when mitigation is practised in disaster management.

- Are energy conservation measures in place?
- Is carbon clean energy (hydropower, wind and solar power) being used as possible options for energy?
- Is carbon neutral energy (dendro power) being used judiciously as possible options for energy?
- Are carbon offsets being established - i.e. is there a definite effort to replant and reforest particularly if trees have been cut down?

The number of vehicles in Asia doubles every five to seven years, increasing by three times by 2030 the energy consumption in the transport sector. Alternate fuel and higher efficiencies that generate simultaneously local and global benefits (i.e., reducing congestion as well as air pollution) are essential in the region. The Asian Development Bank is working in 11 Asian cities (including Changzhou and Harbin in China; Colombo, Sri Lanka; Dhaka, Bangladesh; and Kathmandu, Nepal) on pilot urban transport projects to address this (ADB, 2007).

## Pre-disaster management: Preparedness




Preparedness aims to reduce - to the minimum level possible - the loss of human lives, damage to built and natural infrastructure, through the prompt and efficient actions to response and rehabilitation. Effective preparedness allows communities and institutions to provide a quick, organised response to disasters and include early warning systems, planned evacuation routes and sites etc.

Preparing for a disaster involves a long process of planning what the response should be to a natural disaster. Understanding what hazards are, what the risks are, setting up early warning systems – i.e., becoming informed - is the first step. Information and decisions made under the Prevention and Mitigation phases will form the basis on which the Preparation phase is planned.

Planning for an emergency – how you would respond (i.e., what are the early warning systems), when and with whom, preparing emergency checklists, assembling emergency kits are the next steps in preparedness. Knowing where to evacuate to is the final stage in preparedness. It is not within the purview of this manual to detail these areas and there are many other manuals that describe them (http://secap480.un.org/search?q=early+warning+systems&Submit=Search&ie=utf8&site=un_org&output=xml_no_dtd&client=UN_Website_English&num=10&proxystylesheet=UN_Website_English&oe=utf8; http://www.redcross.org/).

In all these steps, again, it is vital that environmental concerns are incorporated; otherwise, much damage can be inflicted in the next, Response phase.

There is overlap in the steps that are taken at this stage and at the prevention phase, but specifically, the following steps should be followed.

*Step 1: Identify clearly where temporary shelters will be put up in the event of a natural disaster.*

- Ensure that environmentally sensitive areas are not cleared in the event of a disaster.
- Ensure that protected areas are not encroached up in the event of a disaster.
- Ensure that coastal morphology is not changed when temporary shelters are set up in the event of a disaster.

*Step 2: Identify the sources from which natural resources such as timber and fuelwood will be obtained in the event of a disaster.*

- Ensure that timber is not sourced illegally but instead, obtained from sustainably managed forests.
- Ensure that fuelwood will not be obtained illegally from protected areas.

*Step 3: Identify locations at which sanitation facilities will be built/put up in the event of a disaster.*

- Will toilets be built at safe distances from drinking water sources?
- Will toilets be built without contaminating ground water or water sources such as streams and rivers?
- How will waste water be managed in the event of a disaster?

*Step 4: Identify locations at which solid waste will be disposed of in the event of a disaster – both from post disaster debris and from shelters.*

- Ensure that locations are identified for use in the event of a disaster for the safe dumping of solid waste.
- Know where hazardous materials can be disposed of in the event of a disaster.

*Step 5: Ensure that emergency kits minimise disposable waste.*

*Step 6: Ensure that gender sensitivity is incorporated into all the above steps.*

## Climate Change

As detailed in Volume 1, climate change is increasing the frequency and intensity of natural disasters. Dealing with climate change, therefore, becomes an integral part of disaster management. Dealing with climate change involves two approaches: the first is climate change *mitigation* - the reduction of carbon emissions - dealt with under the previous phase.

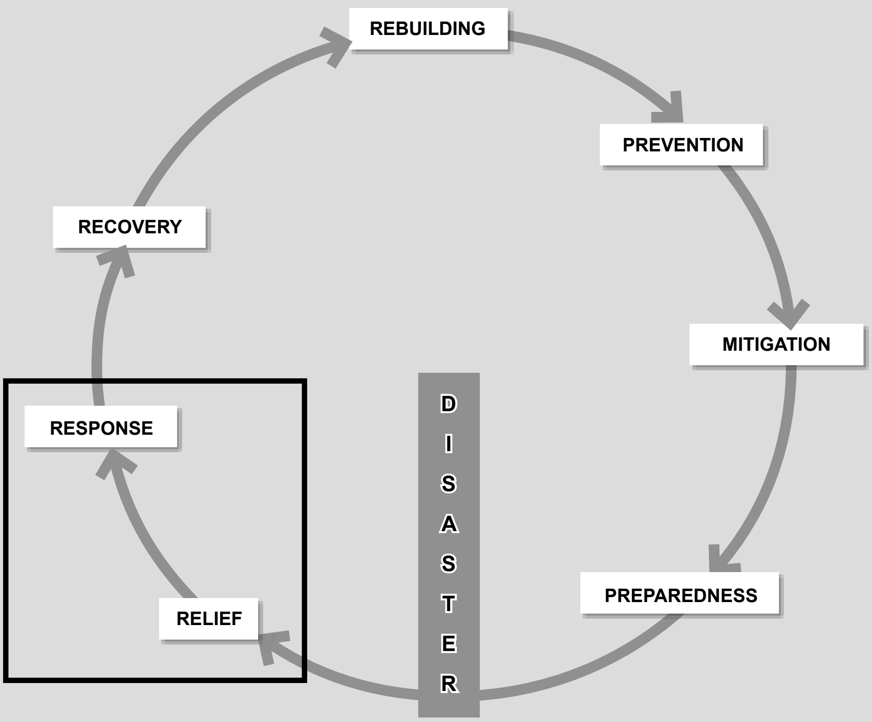
However, climate change mitigation alone will not be enough. Even if green house gas emissions are reduced drastically, the current effects of climate change will be felt for several decades more. It will also take 20-30 years for carbon offsets to become effective, as trees have to grow and mature. Therefore, a second strategy for dealing with climate change – *adaptation* – also becomes essential. Simply stated, adaptation is accepting that climate change - and natural disasters - will occur, and preparing for them. At a local level, the single most important response to climate change is adaptation.

Anticipating climate change, planning in advance to minimise damage from an extreme weather event and responding to it in a pre-planned manner that minimises risk is critical. Adaptation also entails using innovative agricultural methods – such as selecting different crops that absorb more carbon. Collecting rain water in a drought-prone area is another adaptation to climate change; installing proper insulation in buildings, designing/constructing building infrastructure that is disaster resistant are others methods of adaptation.

It is, therefore, essential to ensure that measures are taken to integrate adaptation measures in disaster management.

- Are water conservation measures in place? For example, are rainwater collection tanks built in dry areas?
- Are innovative agricultural methods being used? For example, in Bangladesh, farmers have learned to make floating beds out of an invasive alien plant and they grow vegetable and herb crops on these floating beds during the monsoons, when regular plating areas become flooded.
- Are traditional methods of agriculture - crop rotation, leaving land to fallow - being practised?
- Are building designs suited to local climates: i.e., in hot climates, is there proper ventilation and through-flow?
- Are buildings constructed with appropriate climate-proofing in mind? For example, in flood prone areas, are houses built on raised platforms and in earthquake areas, are they built with reinforcements to withstand minor earthquakes?
- When houses are painted, are appropriate colours - such as light colours to reflect the heat in hot climates - used?
- Is landscaping used as a means to provide natural shade and cooling in hot climates?

## Post-disaster management: Relief and Response




**Relief and Response** are the collective actions carried out immediately after a disaster with the objective to save lives, alleviate suffering and reduce economic losses. For example, relief includes getting people to safe locations, provision of food and clothing etc.

The Relief/Response phase is the period during which saving human lives, alleviating suffering and reducing economic loss take priority. During this phase, emergency needs, water supplies and sanitation, food aid, setting up shelters, health needs must be supplied in the shortest possible time.

Environmental issues are never considered during this phase. Barring rapid environmental assessments that are carried out in the aftermath of a disaster, at best, the role of biologists is minimal; at worst, non-existent during this period. At this stage, environmental concerns are seen as an unwanted luxury. This view is held even by many biologists concerned with environmental issues.

However, it can not be over-emphasised that during this phase, much environmental damage can be caused, endangering the sustainability of recovery and, in turn, rebuilding. During this phase, there can be a great deal of over-exploitation (for example, of timber) and much habitat destruction (for example, clear-felling forests to make temporary shelters) because the immediate goal is to get roofs over people's heads, at whatever cost. Also during this phase, the rush to get food and other emergency supplies also results in much environmental damage. Often, these supplies have to be packed in non-degradable packing such as plastic. Irresponsible disposal of large quantities of such waste can create enormous ecological and health problems. Debris created by the hazard is often cleared into ecologically sensitive habitats - such as lagoons and wetlands - that sustain livelihoods, or protected areas - that provide other ecosystem services - causing further damage.

Again, the cyclic nature of disaster management is exemplified clearly in actions that are carried out under this phase. If pre-disaster management has been effective in incorporating environmental safeguards, then damage during this phase will be minimised. If pre-disaster management has included integrated assessments and integrated planning, then biologists will be included to assist in this phase.

As mentioned before, it is during this phase that the cyclic nature of disaster management becomes very clear. Without Prevention (i.e., without mapping and valuing assets, without identifying resource use, dependency and livelihoods) it is not possible for Mitigation and Preparedness to be effective. Without Mitigation and Preparedness (i.e., without clear, empirically and analytically derived policies) the Relief/Response phase can cause great environmental damage, leading to settlements that are unsustainable in the long term and cause great damage in the short term.

For example, if environmentally sensitive areas have been identified in the Prevention stage and zoned for no building in the Mitigation phase, then during the Preparedness phase, alternative areas will be identified for putting up shelters in the Relief/Response phase.

The following steps should be followed in the Response phase.

*Step 1: Avoid over-exploitation of natural products.*

- Ensure that fuelwood and timber are obtained according to plans set during the Preparedness phase.
- Ensure that natural resource extraction for shelter and food is carried out according to existing legislation.

*Step 2: Avoid unplanned habitat change.*

- Put up shelters only in areas that have been identified for the purpose.
- Avoid clearing natural habitats if they have not been identified for clearance in the Prevention phase.

*Step 3: Minimise solid waste pollution.*

- Dispose of solid waste at locations identified in the previous phase.
- Start a process of separating degradable from non-degradable waste and recyclable and reusable waste.
- Ensure that incineration is not used as a method of waste disposal, as this contributes to global warming and air pollution.
- Actively train persons at shelters to dispose of waste responsibly.

*Step 4: Minimise water pollution.*

- Build toilets only in locations identified in the Preparedness phase.
- Manage waste water only in the manner identified in the previous phase.

In the Asian region, debris management and waste disposal after natural disasters has been a significant weakness during the Relief/Response phase.

After the tsunami of December 2004:

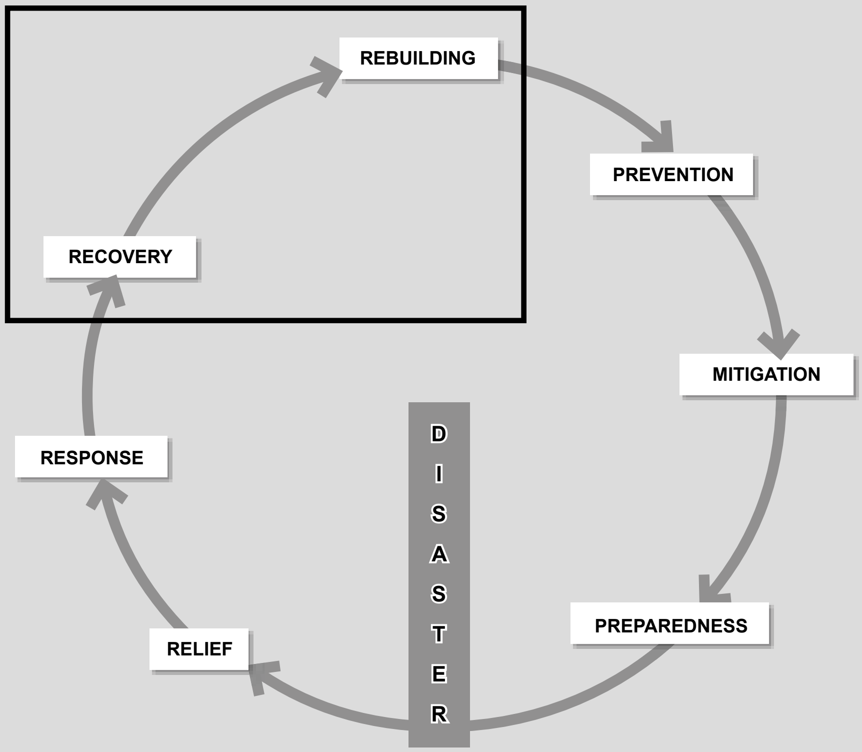
- ‘In the city of Banda Aceh alone, it was estimated that 7-10$m^3$ of waste was generated. When the tsunami hit, the domestic waste was first carried inland, some was then washed back, while some was mixed with debris. Routine collection of municipal solid waste was hampered after the tsunami by the loss of landfill sites, equipment and staff. In any case, landfill sites were not run according to internationally accepted standards before the disaster.

- The extent of debris created in Sri Lanka as a result of the tsunami was enormous – estimated at some 500+ million kilograms of rubble. The disposal of this waste proved to be a huge problem in terms of volume and costs. Emergency efforts resulted in haphazard disposal of debris along roads, playgrounds and sensitive ecosystems. Previously identified landfills were not available in each district at the time of the disaster. Irresponsible waste disposal from resettlements after the Indian Ocean tsunami in southern Sri Lanka has led to the formation of large garbage dumps. Dumps in some settlements sited in migratory pathways of elephants attract wildlife – even elephants. The non-degradable waste such as plastic can pose a threat to such animals.

- In the Maldives, it is estimated that the tsunami created approximately 290,000$m^3$ of debris, which contaminated groundwater supplies and the coastal environment. Efforts to clean up the debris after the tsunami did not improve conditions, and in some cases, worsened them.

- In Somalia, the debris contained a mix of hazardous materials and non-toxic waste. Rapid clean-up efforts resulted in inappropriate disposal, such as open dumping of asbestos, open-air burning. It is reported that Somalia’s coastline has long been used as a dumping ground for other countries’ nuclear and hazardous wastes. The impact of the tsunami stirred up this hazardous waste, causing health and environmental problems to the surrounding local fishing communities. Many people in Somalia’s tsunami affected areas complained about unexpected health problems such as acute respiratory infections, mouth bleeds and skin conditions’ (UNEP, 2005).

## Post-disaster management: Recovery and Rebuilding




Recovery is the activity that returns humans and built infrastructure to minimum living/operating standards and guides long-term efforts designed to return life to normal levels after a disaster. This includes building temporary housing and provision of basic household amenities.

Rebuilding is the long term response to a disaster. In this phase, permanent infrastructure is rebuilt, ecosystems are restored and livelihoods are rehabilitated.

Recovery deals with short term responses and Rebuilding, with long term responses. In the short term, temporary housing sites, temporary housing material, arranging for safe removal of debris, decontamination of water etc. are needed.

In the long term, permanent solutions for housing and sanitation, as well as the basic amenities of life are needed.

In both these phases, it is essential to keep in mind the five major drivers of ecosystem loss: over-exploitation, invasive alien species, habitat degradation, pollution and climate change. Every effort must be made to reduce impacts from these threats.

## The Indian Ocean tsunami of 2004: a missed opportunity

The Indian Ocean tsunami of 2004 was a disaster of unprecedented proportions and sparked off a massive process of reconstruction, which aimed to meet the urgent need to rebuild shattered settlements and infrastructure. In many cases, these efforts were carried out with little regard for the environment and with little coordination amongst agencies. Yet post-tsunami reconstruction did not create these environmental problems – it merely brought a series of long-term issues sharply into focus. The rapid pace of post-tsunami reconstruction has meant that since January 2004, many of the environmental impacts of haphazard coastal zone development have been illustrated graphically over a short period of time. Although the tsunami provided an opportunity to demonstrate a truly environmentally sustainable approach to coastal zone development, and to apply the many lessons and best practices that have been learned over recent decades, in reality, these critically-needed inputs were most often lacking. This is despite the fact that many people had recognised publicly the need to incorporate environmental concerns into the reconstruction process, and a massive rise in public awareness about ecosystem values (IUCN, 2006).

Numerous guidelines and recommendations were provided to coastal developers, and despite the fact that some tsunami-affected countries have a comprehensive set of laws and regulations governing development in the coastal zone, these do not for the most part seem to have been followed in the post-tsunami reconstruction process.

Indiscriminate dumping of tsunami debris in wetlands has decreased fish catch; decreased water depth and diminished water storage during the drought period. A sudden increase in the extraction of timber and land requirements for housing units has resulted in deforestation. This, in turn, has resulted, in some areas, in habitat loss for species such as elephants, thereby increasing human-elephant conflict, and not only depleting livelihoods (damaging crops) but also causing deaths of both humans and elephants. Increased sand mining for building is another issue that has the potential to severely affect coastal morphology. The over-supply of boats and fine-meshed nets, and consequential over-fishing has the potential to wreak havoc on the fisheries sector. Improper management of solid waste at the shelter sites is a serious and ever-increasing health hazard. These environmental concerns were overridden either to achieve rapid results on the ground or by some cosmetic work to satisfy internal environmental standards, if any. That sound environmental conditions are essential to the sustainable revival of communities and to long term livelihoods and economic security has been ignored largely. Frequently, the environment is seen as a stumbling block to rehabilitating efficiently disaster victims. In addition, governmental environment agencies have little influence in decision-making processes (IUCN, 2006).

Although post tsunami reconstruction has wound down, as described in Volume, 1 natural disasters will recur. It is essential that we learn from the missed opportunity of post-tsunami reconstruction and ensure that present and future disaster management incorporate environmental safeguards as integral components of their work plans and strategies (IUCN, 2006).

The following steps should be followed in the processes of both recovery and rebuilding (short-term and long-term responses).

*Step 1: Ensure that you carry out a post-disaster integrated assessment in order to obtain a complete picture of the state of the ecosystem well-being and human well-being after the disaster.*

- Comparison of these data with the baseline data obtained in the Prevention stage will allow for clear analysis and informed decision-making. Refer to Volume 3 for a worksheet that can be adjusted to suit this stage. The economic valuation and livelihoods data from pre and post disaster assessment will feed into the ecosystem and biodiversity assessment data.

*Step 2: Ensure that there is no over-exploitation of species.*

- For example, is timber and sand extraction sustainable and legal?

> In Aceh, the 800,000ha Gunung Leuser National Park - part of a World Heritage Site - is a biodiversity hotspot, with some 700 different animal species and about 4,500 plant species. It is home to some 4% percent of all known bird species. The ecosystem is also rich in tropical hardwood trees, which fetch a high price on international markets.
>
> After the 2004 tsunami, workers were illegally logging timber for temporary shelters. All Indonesian forests are over-logged by a factor of three, mostly through illegal logging. Eight million cubic metres of timber was needed for rebuilding (equal to four times the size of Singapore) WWF, Conservation International and others started a 'Timber Aid' programme. British Red Cross, Oxfam, and Premiere Urgence imported sustainably-logged timber from Australia and New Zealand, instead of using timber from unmanaged forests (WWF, 2005).

*Step 3: Ensure that existing legislation is followed.*

- Sometimes there are only a few laws related to building and protected areas; in contrast, sometimes there are a plethora of relevant laws as shown in the box under the Mitigation section. (See page 23.)

> The Indian ocean tsunami of December 2004 served to highlight the lack of proper regulatory policies and laws in affected Asian countries. 'Only India and Sri Lanka have laws or regulations in force specifically governing the coastal zone. India's Coastal Regulation Zone Notification totally prohibits development in mangrove ecosystems, but for various reasons the Notification is not enforced consistently. In Sri Lanka, the Coast Conservation Act governs the coastal zone, but mangroves are governed by the Forest Act, which opens the door to conflicts of jurisdiction under the two laws and inadequate enforcement of both. In July 2006, Thailand finalised a draft ICM law, which may be considered for adoption in 2007. Indonesia is in the process of preparing an ICM law. The Maldives does not currently have a regulatory regime for ICM or for mangroves' (IUCN, 2006).

*Step 4: Ensure that proper design standards are followed.*

- Avoid using designs that are not appropriate and lack use of environmentally-friendly materials and climate-proofing.
- Avoid forcing culturally unsuitable designs onto communities. i.e., designs should be drawn up with community input.
- Ensure that gender concerns are integrated into designs, while making them environmentally-friendly and climate-proof.

> In 2001, an earthquake hit Bhuj city in Gujarat, in India. Good seismic codes of practice exist in India, but they were not enforced nor was building construction inspected properly, leading to heavy damage of 179 high-rise buildings in Ahmedabad, 230km from the epicentre.
>
> In contrast, in 1977, a group of volunteers from AWARE built 1,500 houses in Andra Pradesh, India, following a cyclone that damaged coastal areas. These houses used government cyclone-proof designs, and of these, 98% withstood a stronger cyclone that hit the region in 1990 (http://www.proventionconsortium.org/themes/default/pdfs/tools_for_mainstreaming_GN12.pdf).

A major challenge after the Indian ocean tsunami of 2004 was an increase in fishing capacity and an ensuing state of over-fishing in a region already over-exploited for fisheries resources. Throughout the region, more small fishing boats were replaced than were lost, expanding fishing fleets to a size greater than they were before the disaster.

It is estimated that 19,000 boats were destroyed in Sri Lanka by the tsunami of 2004. Two and a half years later, some fishermen had not yet fully restored their livelihoods despite assurances from the Reconstruction and Development Agency (RADA) that 90% of the boats have been replaced and that catch levels were then 70% of what they were before the tsunami.

Only 30% of large weight boats had been replaced at that time – although these big boats accounted for a third of the overall catch in Sri Lanka before the tsunami. In contrast, there was an excess of small boats that were distributed *ad hoc* by well-wishers, small NGOs and other small donors. It is estimated that over 3,000 small boats were donated, causing over-exploitation of coastal fish. In southern Sri Lanka, some fishermen now complain that they do not catch any fish at all on certain days. In addition, the ready availability of small boats has resulted in new people turning to fisheries as a livelihood in an already overcrowded coastal fishing industry.

An FAO survey carried out one-year after the tsunami, revealed that on 28% of the required nets were donated to fishermen in need, 63% of the boats replaced had no fishing gear, and 19% had inadequate gear; less 50% who received boats were not fishermen (http://www.irinnews.org/report.aspx?ReportId=72857).

*Step 5: Minimise habitat change.*

- Ensure that sensitive areas/ecologically and economically valuable areas (identified in the Prevention stage) are not cleared for buildings or resettlements.
- Ensure that coastal/mountain morphology is not changed by built infrastructure.

> Some post tsunami permanent settlements in Southern Sri Lanka have been sited in areas known to be used as migratory pathways by elephants. This has likely worsened the human-elephant conflict: deaths, damage to crops and houses (IUCN, 2006).

*Step 6: Minimise pollution.*

- Check whether the area is being polluted by the process.
- Check whether there is collection of non-biodegradable solid waste.
- Check how solid waste is being collected and disposed.
- Check whether an effort is being made to reduce, reuse and recycle waste.
- Check whether the air is being polluted by the process.
- Check whether air pollution control measures are in place.

*Step 7: Be careful about disposal of debris.*

- Before disposing debris, contact the relevant authorities for identification of recommended disposal sites.
- Prevent irresponsible dumping of waste.
- Provide safety training and involve communities in sorting waste.

*Step 8: Create awareness among communities about responsible disposal of waste.*

- This is very important for long term mitigation.

> Tsunami debris in Koh Phra Thong, Thailand generated large quantities of solid and liquid waste, from damaged sewage tanks, cesspits and overflowing mains, together with waste material blocking water drainage systems and sewers, increasing the threat of water borne diseases.
>
> 'Deeply concerned about the waste disposal mechanism and its cascading effect, the International Union for the Conservation of Nature (IUCN) took up the challenge of creating awareness about solid waste disposal among community members. IUCN has, to date, trained over eighty people in waste management practices in the island of Phra Thong, to say "no'" to plastic bags, to separate waste into recyclable, non-recyclable and reusable waste, to sell waste for income generation and to use fruit scraps and other organic garbage to make detergents' (IUCN, 2006).

*Step 9: Prevent the spread of invasive alien species.*

- Check whether IAS are spreading. Building equipment is known to a mechanism through which IAS spread.

> In southern Sri Lanka, Prickly Pear (*Opuntia dillenii*) has spread in sand dunes and beaches after the tsunami, preventing the regeneration of natural beach vegetation such as *Spinifex*. *Salvinia* and Water hyacinth (*Eichhornia crassipes*) have spread in lagoons and estuaries (Bambaradeniya et al., 2006).

*Step 10: Ensure that water is not polluted.*

- Are resources protected from further contamination, such as faecal waste?
- Are organic and inorganic debris disposed of in a proper manner so that water bodies are not polluted?
- Do housing and new construction ensure good sanitation facilities and sewage systems?
- Do construction designs ensure good drainage systems in place as approved by relevant local authorities?

> Various development and humanitarian agencies were responsible for setting up new settlements after the tsunami. Although each organisation adhered to standards that required sewage collection tanks to be sited a certain distance from buildings, because of a lack of coordination, the distance between the tanks built by one organisation and the houses built by another did not meet the minimum required standard. This was observed in northern Sri Lanka (Ali Raza Rizvi, personal communication).

*Step 11: Ensure that measures are taken to mitigate the impacts of and to adapt to climate change.*

- Are communities that are most vulnerable to natural disasters identified? (See Hazard and Risk mapping, this volume.)
- Have women been identified as an important group for climate change mitigation and adaptation?
- Are energy conservation measures being adopted? For example, is there through-flow ventilation in hot climates? Are energy-saving bulbs and alternate energy sources-such as solar power-being used where ever possible?
- Are water conservation measures are being adopted? For example, in drought prone areas, is there provision for rain water harvesting?
- Is waste water managed hygienically? Are toilets being built at safe distances from drinking water sources?
- Are environmentally-friendly materials used as much as possible?

> In Rajastan, India, village communities are trained to build rainwater cisterns. During the monsoons, rainwater is collected by channels which run into the cisterns. Each cistern can store 40,000 litres and is shared by three families. When full, the cistern can provide drinking water for these families all year round. It can also be used to store water brought in by tankers in times of drought (Reid & Simms, 2007).

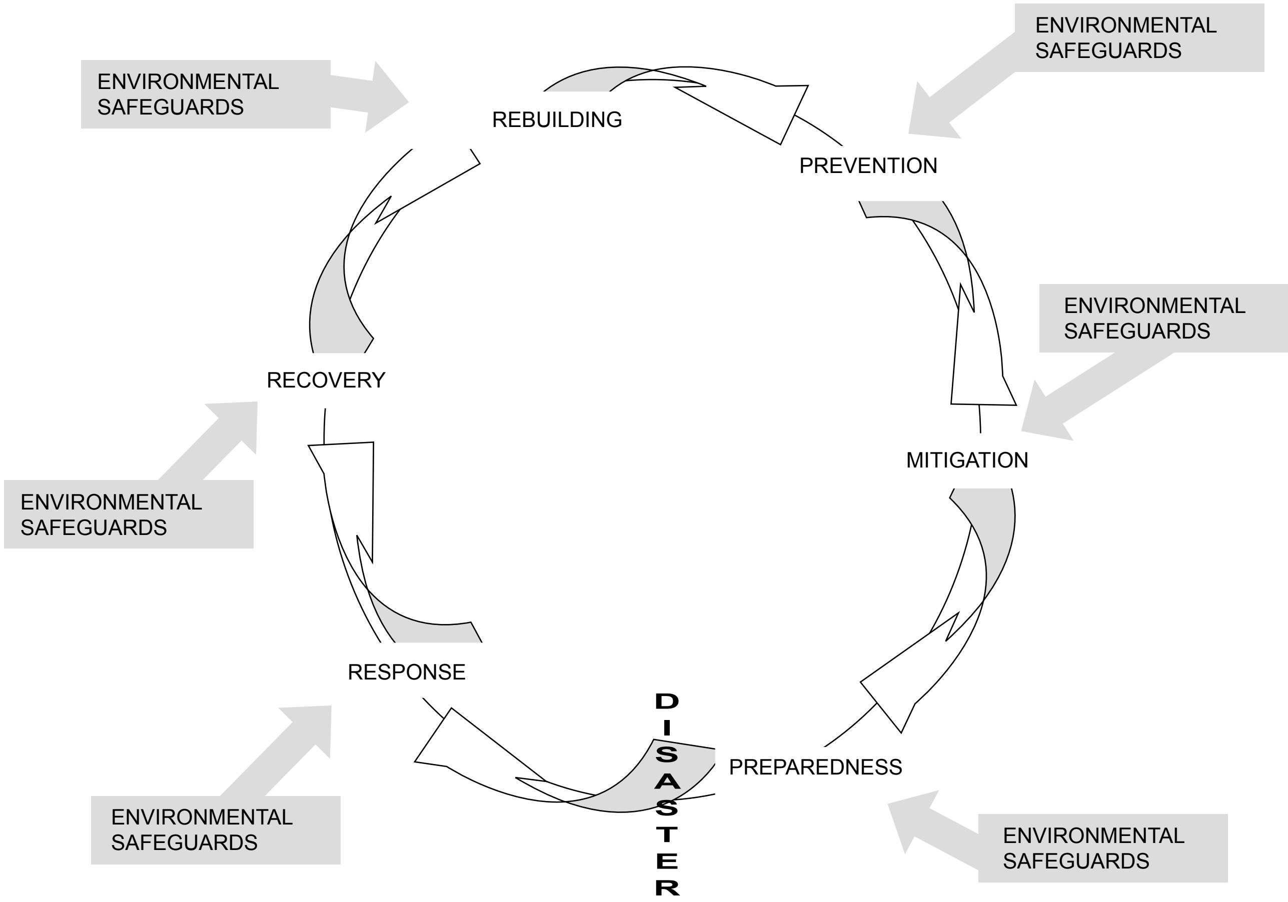
*Step 12: Ensure that ecosystems and natural habitats are conserved, restored and created.*

- Are efforts being made to replant and landscape during structural changes?
- Is ecosystem restoration being carried out with reference to existing national laws and with reference to existing resource maps?
- Is ecosystem restoration being carried out by matching local needs and priorities the services that ecosystems provide, rather than implementing land use patterns in a top-down manner?
- Are native, multiple-use and locally beneficial species being used while carrying out restoration?
- Are efforts being made to ensure that replanting is carried out only in suitable areas? For example, mangrove replanting in many areas in Asia was carried out in areas where there previously had been no mangroves or where sand dunes - essential for the prevention of coastal erosion - were flattened for this purpose.
- Are efforts being made to ensure that only indigenous species - native to the specific area - being used? For example, using plant species found in the wet zone of Sri Lanka to replant areas of the dry zone will be doomed to fail, as these plants will lack xeromorphic[4] adaptations necessary for the dry zone.
- Are efforts in place to ensure that identified IAS are never used?
- Are all relevant government departments - such as the Forest Department, the Coast Conservation Department, Environmental Authority, Urban Authority and the Department of Wildlife Conservation - consulted from the beginning and do they play a central role in restoration together with the local communities?
- Is a landscape approach to restoration adopted? Ecosystems do not function as closed units but as open systems that are affected by ecological process that occur on a larger scale. Because of this, it is necessary to look at the broader picture, not just the specific restoration site alone.

[4] Xeromorphic adaptations allow plants to conserve water.

The end result of incorporating environmental safeguards is presented below in Figure 9.

Figure 9: The end result of incorporating environmental safeguards




There should be a checklist of environmental safeguards for every step of disaster management. These checklists can be for a given location or a given hazard, but should use the steps provided in this manual as a guideline.

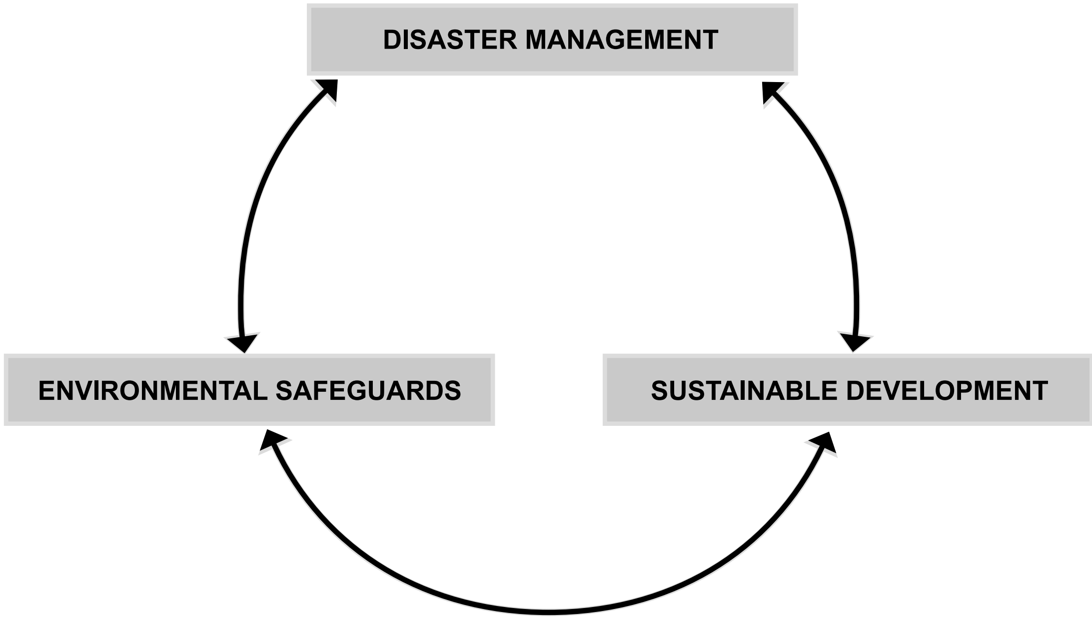
The ultimate goal is to incorporate environmental safeguards into both disaster management and sustainable development.

The entire global community or civil society - which includes, *inter alia,* donors, policy makers, governments, communities, development agencies, humanitarian agencies, the private sector, media and academics - must be sensitised to this need. In order to do this, advocacy, awareness and science-based knowledge generation - that result in changes in governance - are essential. Empowerment through capacity building, institutional strengthening and training makes this possible.

A knowledgeable and empowered civil society will know how

- to sustain healthy ecosystems that facilitate the reduction of natural disasters;
- to facilitate sound practices of land use planning;
- to reduce social, physical, attitudinal and environmental vulnerability to natural disasters;
- to safeguard livelihoods;
- to ensure human well-being;
- to empower highly vulnerable groups;
- to enhance overall resilience; and
- to have access to the right to information and services.

The end result should be that environmental safeguards are integrated not only into disaster risk management but also into every facet of development.

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IUCN's seven regional thematic programmes, known collectively as the Ecosystems and Livelihoods Group (ELG), are based in two clusters: one in Colombo, Sri Lanka (environmental economics, marine and coastal, species conservation), and one in Bangkok, Thailand (environmental law, forests, protected areas, wetlands and water resources).

**Ecosystems and Livelihoods Group Asia**

IUCN
4/1 Adams Avenue
Colombo 4
Sri Lanka
Phone: + 94 11 2559634
Fax: +94 11- 2559637
E-mail: coastalinfo@iucnsl.org
**http://data.iucn.org/places/asia/coastalinfo/**