Tsunami Damage to Terrestrial Coastal Ecosystems[1]

Common Guidelines and Methodology for Rapid Field Assessment

IUCN – The World Conservation Union

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1.0 Introduction

Following the recent Indian Ocean tsunami a number of governments and organizations, including IUCN, have been undertaking Rapid Environmental Assessments across the impacted region to assess the damage caused by the tsunami to natural ecosystems – mangroves, coral reefs, wetlands, other coastal vegetation, marine and terrestrial protected areas, etc.

While a working draft of the *ICRI/ISRS Guidelines for Rapid Assessment and Monitoring of the Tsunami Damage to Coral Reefs* has been co-developed by IUCN, CORDIO and other partners, this document offers similar guidelines for rapidly assessing the damage caused by the tsunami to terrestrial coastal ecosystems at the site- and landscape-level. The document draws and builds on several rapid assessment guidelines prepared by various other organizations such as OECS, ECLAC, Wetlands International, etc. (full list given in Reference section) and is also consistent with the Coral Reef assessment guidelines referred to above.

The specific aim of this document is to ensure that all the rapid terrestrial assessments that take place at various sites (and landscapes), and by different partners or field teams, follow a common methodological framework to the largest extent possible or practical. If the assessment data is collected and recorded using the same methodology everywhere and in a consistent manner, this will help to ensure comparability of the impacts from one region to the other. It will also allow the rapid assessment data to be fed into other more comprehensive assessments, enable the setting of initial baselines for future monitoring, and help in identifying and deciding the restoration priorities and actions that are needed both immediately and in the medium-longer terms.

The objective of the rapid field assessment of terrestrial coastal ecosystems is to get a quick but reliable overview from a wide range of impacted regions on the following issues:

1) What has been the damage to terrestrial coastal ecosystems?
2) What have been the livelihoods, environmental security and biodiversity impacts of the damage caused to terrestrial coastal ecosystems?
3) Where are the potential sites where ecosystem restoration and rehabilitation is now a priority?
4) What role, if any, did terrestrial coastal ecosystems, such as sand dunes, mangroves, lagoons, estuaries and other coastal forests/ plantations etc. play in reducing or mitigating the impact of the tsunami, and under what circumstances and to what extent did this occur?

[1] Terrestrial coastal ecosystems in this document covers beach, sand dune, scrub, sea-shore vegetation, plantations, mangrove, lagoons, estuaries, salt marshes, maritime grasslands, agricultural lands, home gardens etc.

Objectives 1 and 2 are of higher priority than Objectives 3 and 4. The latter two objectives will to a large extent depend on the findings of the former two.

Such an assessment will increase the likelihood that funds and other resources are properly prioritized and targeted and also help to provide policy makers with guidance as they plan and implement the future reconstruction. While these rapid assessments may not lead to statistically robust analyses, nonetheless the data and other information collected though this process should be able to feed into the more comprehensive field assessments that follow subsequently. It should be noted that the guidelines provided in this document are intended only for rapid **field** assessments, and do not elaborate on the more rapid or macro-scale assessments that may be possible using satellite imagery and/or aerial photography. However, such macro-level satellite imagery/aerial photography-based assessments will also be needed in parallel in order to assist the field-level assessments that are covered by these guidelines, and also to provide the sub-national, national or regional-level assessments of damage to decision makers. This will need to be done in collaboration with partners and agencies such as NASA, GLCF, NUS, IRSA, etc. The field-based assessments (both rapid and comprehensive) can then act as ground-truthing points for these larger satellite-based assessments. However, the absence of appropriate satellite imagery or aerial photographs should not prevent the field level assessments from being undertaken.

While this document intends to provide common guidance to all field teams involved in doing the terrestrial rapid assessments, it also recognizes the need to be adaptable in the field to respond to, and take into account, any additional site-specific field observations that are required to be recorded. Provisions for these have therefore been made in the Rapid Assessment Form (see Annex 1).

2.0 General Principles for Rapid Assessment

1. Rapid assessment to be a participatory and consultative process, wherever possible: Local communities and relevant stakeholders, including village leaders, fishermen, local farmers/fisheries associations, forest department staff, etc., who have a long-term knowledge of the site and have the greatest stake in it, and who may have observed the effects of the tsunami on terrestrial ecosystems first-hand will be the most valuable sources of information available, and should be consulted by the field teams during the assessment process. While a proper full-scale PRA involving the entire or all sections of the community will not be practical, short focused discussions with key groups/ individuals will be more realistic. In either case, sensitivity must be maintained while consulting local stakeholders taking into account the serious losses that many of them may have suffered.

2. In-situ, not remote, assessments: As mentioned in the introduction, these rapid assessments are all field-based (on-the-ground) assessments focusing only at the site- and landscape-levels. Assessment of the damage caused by the tsunami will be made both with reference to the particular terrestrial coastal ecosystem type located immediately adjacent to the sea (for example sand dunes and mangrove forests) and to the ecosystem zones that lie further inland such as agricultural land (see also section on Vertical Transects below). Doing so will help provide a landscape view of the damage caused. The condition of the coastline itself will also be recorded. For example, how have sections of the coast that had been converted to other land uses/ deforested/ degraded (for example by conversion to shrimp farms, agricultural land, tourism infrastructure etc.) prior to the tsunami been affected by it and if some of these areas are a priority for restoration now.

3. Focus on 'what' not 'why': The basic objective of a rapid assessment is to quickly and accurately collect and record relevant data and observations, both qualitative and

quantitative, on 'what happened' in a particular site, and to then move on and repeat the same process in the next site. Collection and recording of all the data in a consistent manner, using the same methodology, is a key basic requirement. The objective is not to get diverted into drawing inferences from these observations or in making any detailed on-site analysis. That will follow later on in the more comprehensive assessments.

4. Timing requirements: The time required for doing the assessments will vary from site to site, depending on the accessibility of the site and the size and experience of the assessment team. The general guidance is not to spend more than 1 day per site. This however does not take into account travelling time. This means being suitably judicious in the number of variables that the survey team assesses. Each additional piece of information involves an additional marginal increase in survey time per site and could be of diminishing marginal return in terms of provision of basic information, after a point. The basic aim is to be able to collect important perishable data that may not be possible to collect later on.

3.0 Doing the Rapid Assessment in the Field

Background Preparation and Site Selection:

- The proposed rapid assessment methodology can be applied at either of the following two levels:
  - To cover the entire coastline that has been directly affected by the Tsunami
  - To cover a particular stretch of coast **(location)** that has been pre-identified as severely affected, and may consist within it several **sites** that represent different coastal features (natural habitats, human modifications)

- Ideally, GIS-interpreted 'before-after' tsunami maps (for example, a vegetation map of scale 1:10,000 or 1:25,000) derived from satellite images or aerial photographs should be used to identify and mark the various coastal locations and sites to be assessed. However, in the absence of such images the locations and sites to be assessed will have to be selected to cover broad representative stretches of the affected coastline depending on early reports of damage that emerge, on rough estimations made from examining contour maps (as these will give an indication of the low-lying coastal areas that may have been the most affected).

- The basic equipment needed for the rapid field assessments will include necessary topographic/ vegetation maps, GPS, binoculars, measuring tape, ropes, camera, etc.

- Once a particular stretch or location has been selected, and the team reaches this location, a rapid reconnaissance of the area should be done to draw up a rough schedule of the field assessment i.e. how many and which sites will be covered at the end of each day, how long the field assessment will last (one week, 10 days, etc.), and how many sites will be covered in all by the end of that assessment.

- As wide a range of sites as practical/possible within the selected location should be selected based on:
  - Representative samples of different coastline features that visually show differential degrees of damage. Do not bias the assessment by selecting only those sites that can be most easily reached or those which have been most severely affected. It is also important to assess a couple of sites within a selected location that were not impacted at all, as these can then act as 'control sites'. Sequence the assessment so that only when the key representative sites along a particular location have been covered, are additional assessments undertaken.

- Typically, the different coastline features that would need to be assessed would include:
  - mangroves (intact/degraded/deforested)
  - coastal scrub/sea shore vegetation
  - plantations (casuarinas, palm)
  - sand dunes / beaches
  - lagoons, estuaries, salt marshes
  - maritime grasslands
  - human modifications (beach revetments, artificial canals, other physical constructions)
  - areas (including the above coastline features) that are classified as protected areas of national/regional/global importance, Ramsar sites, etc.

- Additional criteria for selecting locations/sites, which would facilitate the field assessments would include:
  - Past knowledge/experience of the sites and availability of good data before the tsunami
  - Availability of local contacts. It will be extremely useful to have a local person who is familiar with the location that is being assessed on the field assessment team.

- Inform the key local contacts of the field visit in advance – so that they in turn can plan ahead.

- It is important to be aware of other assessments that may have taken place at the selected sites/location while being in the field to avoid duplication and also to feed/link the teams' own findings into those other assessments. Try to link early on with relevant agencies to feed back the field assessments to higher-level (province, state, etc) assessments/ collation of data (for example into the UNEP/government-led country REA reports). Also consult the broader scale assessments (generally by remote sensing/ aerial photography) that may have been done for that particular location/ region.

- While collecting background information on the location/site to be assessed (population, main sources of livelihoods, topographic/land use/forest maps, etc) may not be feasible, such information may be collated, if possible during the field visit or soon after it, for cross-referencing and later analysis.

Assessing the damage caused to terrestrial ecosystems:

- If the intent of the field assessment is to cover the entire affected coastline, it is recommended that sampling be done at sites located at intervals of every one kilometre (1000m), starting from any physically identifiable and accessible geographical feature/ site on the coastline. The assessment itself needs to be conducted along the coastline in order to capture the variability of different coastal features that may exist therein. However, the distance of the sampling interval may be adapted to suit on the ground conditions related to variability (i.e., the more variable the coastline features are, the shorter the sampling interval required). That said, additional samples within the pre-determined sampling interval could also be taken if a different or unique manifestation of damage is observed, or if it is felt that a particular site needs to be assessed. This will also help the team to get a 'coastline-wide' sense of how an entire stretch has been affected and also to ensure an unbiased sample. The GPS coordinates of the starting site and of the subsequent sampling points should be recorded.

- If the intent of the rapid field assessment is to cover a particular stretch of coast (location) that has been pre-identified (either through satellite images or early reports) as severely affected, then the sampling should be carried out in representative sites, that cover the full range of coastal features – including those altered by human modifications – that are present within this location. Move to a different location of the country's coast only once one particular location has been covered and the team is confident that their site assessments include a range of different scenarios that occurred in that location and provide a realistic unbiased picture of the tsunami's impact therein. Most sites will have a local name, though it is possible that in some cases, such names may not exist. However, in all cases, it will be necessary to record the GPS coordinates of these sites, and mark them on a topographic map and as a sketch drawing in the space provided in section A of Annex 1 for future reference.

- In both cases, it is recommended that a Vertical Transect Assessment i.e. systematically covering the various habitats/vegetation types from the seaward side back to the inland areas up to the point where the tsunami reached (point of incursion) be conducted. This will give a good estimation of the impact the tsunami had on terrestrial areas immediately adjoining the sea, for example, beaches, sand dunes, the various zones (sub-tidal, inter-tidal, high-tide) of mangrove forests (as mangroves sometimes occur in clear-cut zones depending on the salt-tolerance of individual species and tidal flow regimes), scrub and sea-shore vegetation, lagoons, estuaries as well as casuarinas plantations, other forests and vegetation, home gardens, palm trees, agricultural fields, etc., which are located further inland. Particular attention should be paid to record the damage caused to threatened species/biodiversity, either from direct mortality or loss of habitats. In wetland systems attention should also be paid to record observations that indicate salinity impacts such as dieback/discoloration of vegetation and mortality of fish and other freshwater fauna[2]. GPS coordinates should be recorded at the start and end of each habitat/vegetation type along the Vertical Transect. A profile diagram of the transect will also need to be drawn in the space provided in the datasheet (Annex 1- Section A)

- The Vertical Transects typically need to be carried out as by following a Vertical Line Transect from the High Water Line (HWL) up to the point of incursion covering the various habitats/vegetation types that the tsunami waves have affected. Observations will be recorded based on what one sees on a roughly 20m wide strip of land i.e. 10m on either side of the transect line while walking perpendicular inland from the coastline to the point of incursion (see Figure 1 below). The area of each habitat/vegetation type being assessed will be visually determined. In areas where funnelling of sea water has occurred (i.e., tidal inlets, river-mouth/estuary, artificial canals), the vertical transects should be done within 100m from the edge of these inland aquatic systems on either side or, where feasible, around the boundaries of that aquatic system (see Figure 1).

- Even in cases where no apparent zonation is observed, following a vertical (sea → land) transect will give a good idea of the damage caused to terrestrial ecosystems. In most areas following an exact vertical transect will not be practically feasible. However this is not a problem as the key aim is to get a picture of what the variance of damage to the terrestrial ecosystem has been as one moves inland from the coast. In some areas, the best way of conducting these vertical transect assessments may be only through a combination of navigating a boat/dugout canoe though the system of creeks and channels that normally typify a mangrove forest or coastal wetland ecosystem, and/or on foot (for the more inland areas).

[2] Ideally there should be a soil/water expert in the rapid assessment team and equipment such as refractrometers, etc. for salinity measurements but this may not always be possible.

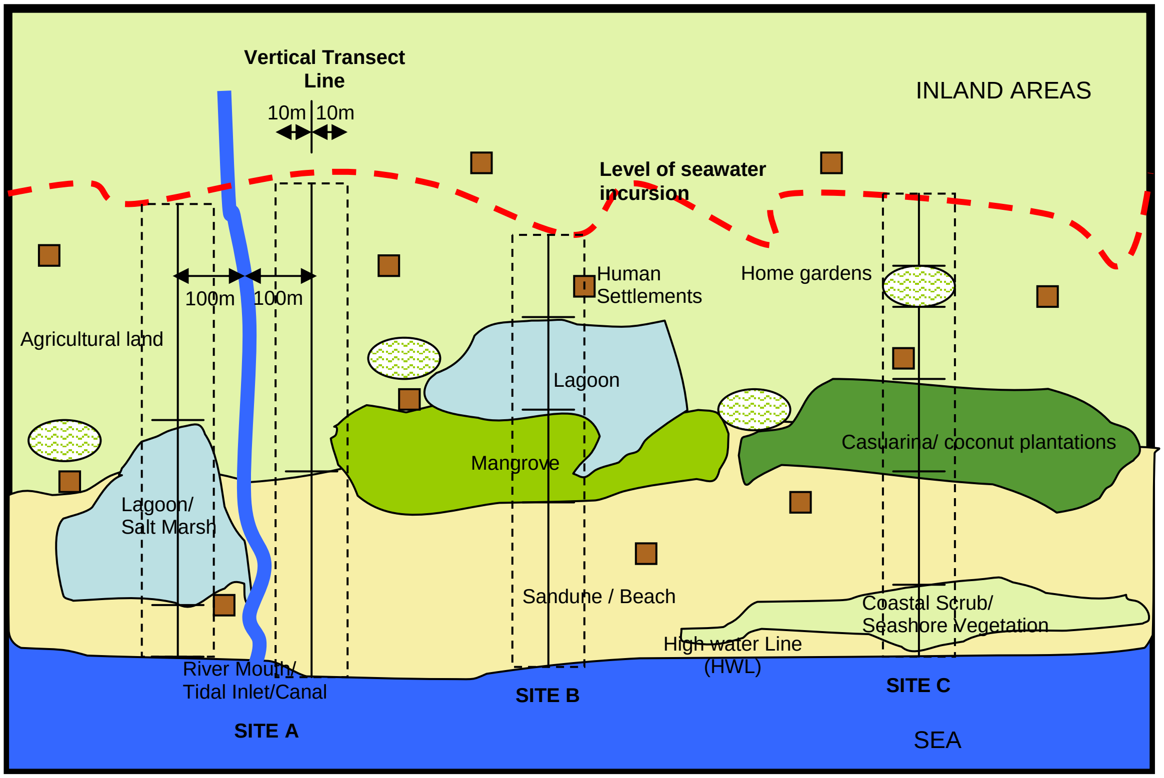


Figure 1: Diagram illustrating Vertical Transects at various sites in a given location

- Effort must also be made, to the extent feasible, to assess the damage caused from different points within the same site, particularly if it is felt that a single vertical transect does not reliably represent the damage caused in other parts within that site. The types of damage that need to be recorded for each terrestrial ecosystem type are shown in the Rapid Assessment Form in Annex 1 (section B). However, these damage types are only indicative and may be modified depending on field requirements.

- As is recommended in the ICRI/ISRS Coral Reef Rapid Assessment Guidelines, photographic (preferably digital) /video evidence should be taken of the visual damages observed during the rapid assessments, and also of the general landscape. This will provide a permanent record and also allow more detailed data collection from the images at a later date, as well as for fact-checking and to show the impacts of the tsunami to the public. It is important to put proper identification tags/obtain GPS readings to link the photos/videos to the sites and locations in which they were taken to prevent any possible future confusion.

How to Record and Rate the damage

- For assessing the specific types of damage caused to each terrestrial ecosystem type, we use a rapid assessment methodology and rating parameters similar and consistent to that recommended by OECS (2003). As per these, 'Overall Damage' ratings are assigned based on two parameters:
  (i) Intensity of the Damage, and
  (ii) Spatial Extent of the Damage.

- *Intensity of damage:* The 'Intensity of damage' describes the degree to which the environmental asset has been affected by the adverse event, and this requires comparison with the pre-disaster condition. For example, if mangrove forests in a particular area were already be threatened, for example, by conversion to aquaculture/salt production, then the assessment must record only the *additional* damage that has been caused by the tsunami (i.e. net of the pre-existing damage).

In this method, intensity is classified as 'Minor', 'Medium' or 'Major' according to the damage caused to the functioning of the asset and/or the number of individuals affected [see Table 1 below].

Table 1: Rating Incremental Damage Intensity

Intensity of Damage	**Definition**		
	Physical Impact on Asset	***Functioning of Asset***	***Recovery of Asset***
Minor	Few individual trees/ stands affected; minor breakage and leaning; no significant debris/ sediment load/salination, discoloration observed	No or very little impact expected	Largely natural over a relatively short period of time (6months-1 year)
			May require some basic interventions, like clearing of debris, unblocking water channels, etc.
Medium	Some leaning, breakage and uprooting of trees/stands; sedimentation/debris, siltation, discolouration, change in tidal flows observed	Possibly limited impact at landscape scale, but negative impact at the site/stand level.	Natural over a medium time period (2-3 years)
			Requires site specific protection/ restoration measures
Major	Severe breakage and complete uprooting; almost complete loss of seed trees, high level of debris/ sedimentation, discolouration, complete blockage or change in tidal flows observed	Major impact at both site and landscape levels	Will recover naturally only if left undisturbed over a very long time frame (over 3 years)
			Requires major restoration/ protection work either through plantation activity or Assisted Natural Regeneration (ANR)

(Adapted from Table 5-2 of OECS, 2003)

- *Extent of damage:* The 'Extent of damage' is defined in terms of the spatial area of the asset affected, and is classified as follows (adapted from OECS, 2003)[3]:
    - No damage (0 % of the asset affected)
    - 1-10% of the asset affected
    - 11-25% of the asset affected
    - 26-50% of the asset affected
    - 51-75% of the asset affected
    - More than 75% of the asset affected

The spatial area of the affected habitat/vegetation type being assessed will be based on the visual estimation of the approximately 20m wide belt (10m on each side of the vertical

[3] Where this is different from the OECS guidance is that a zero value has been added to distinguish 'no damage' from other categories; additionally a 51-75% range has also been added.

transect line) and the estimated length of that habitat (i.e. the distance that it extends from the seaward to the landward side).

Attention should also be paid to record the differential damage that may have occurred in the proximal and distal parts of each habitat/ vegetation type being assessed in relation to the direction of the tsunami incursion.

- *Overall Damage Assessment:* Based on the dual criteria 'Extent' and 'Intensity' the overall damage caused to an particular type of ecosystem is assessed as 'No damage', 'Low', 'Moderate', 'High' or 'Extreme', as shown in Table 2 below.

Table 2: Overall Ecosystem Damage Assessment

Intensity of Damage	Area Damaged					
	0%	*1-10%*	*11-25%*	*26-50%*	*51-75%*	*>75%*
Minor	**No damage**	**Low**	**Low**	**Moderate**	**High**	**High**
Medium	**No damage**	**Low**	**Moderate**	**High**	**High**	**Extreme**
Major	**No damage**	**Moderate**	**Moderate**	**High**	**Extreme**	**Extreme**

(Adapted from Table 5-3 of OECS, 2003)

However, it is possible that even the areas that have be placed in the 'No Damage' category may face increased pressures in the post-tsunami phase, and the risks of this should be indicated in section C of the Rapid Assessment Form (No. 3). In some sites post-tsunami damage related to reconstruction or relocation activities may be apparent already and these should be recorded as well in as much detail as possible.

Additional Assessment Information

In addition to the above it is recommended that information be also collected on the following parameters:

- **Salvage Potential from Damaged Areas:** In some cases, while the mangrove, coastal plantations, other tree-dominated ecosystems etc. may have suffered major damage, it is possible that some of the damaged parts can still be used for meeting some of the immediate timber, fuelwood and other livelihood needs of the local population, but in a way that supports, or at least does not hamper, longer-term rehabilitation and restoration. A visual assessment of the salvage potential from damaged ecosystems from a particular area following a general categorisation (*None/Low/Moderate/Good)* would be useful for local planners as they go about the reconstruction process. This would also help reduce the pressure on other unaffected forest areas to that extent. Concrete figures should be recorded in your notes wherever possible (for example at least 50 building pole quality timber from fallen casuarinas that will remain viable over next 6 months, etc.). In all such instances, the source of the information should preferably be noted. It should also be noted how close or accessible such potential salvage material is to the people in need.

- **Natural Regeneration Potential of damaged area:** A visual assessment of the natural regeneration potential of the affected sites (*None/Low/Moderate/High)* should also be recorded, based on survival of seed trees, availability of different age classes, conditions for rhizomal coppicing / propagule dispersion, status of tidal flows, silt/debris levels, visible changes in edaphic conditions, etc. This will in most cases be a best guess based on expert observations and will need to be reconfirmed in more detailed assessments subsequently. In the case of mangroves, it may also be possible that the particular species composition/dominance may change after the tsunami, depending on the post-tsunami conditions, so it would be useful to note the original/current mangrove composition mix in the affected site.

- **Livelihood Impact of Damage:** The assessment team should also indicate the level of livelihood impacts that will be caused by the damage to different types of terrestrial ecosystems (*None/Low/Moderate/High/Extreme).* This will be done primarily by interviewing key stakeholders/members of the local community, or a relevant local level organisation or institutions such as the agriculture/fisheries officers, farmers/lagoon fisheries associations, etc to gauge their dependence on the natural ecosystems affected. The assessment team should be sensitive to the recent losses that the local communities may have suffered while asking questions. The assessment team should try to record, wherever possible, specific information on the livelihood impacts of damage, for example 'x' ha of area of agricultural land affected by siltation/ water logging, 'y' number of fishing ponds/lagoons silted in, loss of 'z' ha of timber/fuelwood sources, etc., and also some of the indirect economic/livelihood impacts caused by loss of tourism income or fishing-related income due to lack of local demand, reconstruction and relocation efforts, etc. It should also separately record (see section C of Annex 1), how much wood may be needed for immediate reconstruction purposes and where this may potentially come from, best as possible, as this can cause further damage to the local ecosystem. It will also be useful to collect land-tenure information in the affected areas i.e. who owns or has access/use rights to different parts of the terrestrial coastal ecosystem – beaches, mangroves, lagoons, etc., and if (and how) the tsunami or actions taken after may affect the current tenure structure in those areas.

- Environmental Security Impact of Damage: The assessment team should also try and assess as *None/Low/Moderate/High/Extreme*, based on observations and information from local communities, the extent to which ecosystem damage caused by the tsunami has left the local inhabitants/coastline more exposed and vulnerable to high winds, tidal surges, cyclonic activity, etc. For example, certain natural water flows may have changed as a result of breaching of sand bars across river outlets or by the blocking of canals (natural or manmade), or damage may have been caused to beach revetments, which may place local communities at greater risk from flooding, extreme weather events, etc. and for which some restoration action needs to be taken up on a priority basis.

- **Restoration requirements and priority in damaged area:** The areas requiring restoration action will need to be prioritised based on two key parameters:

    (i) The cumulative of (a) the overall damage caused to the particular site/ecosystem type (b) the livelihood impacts of that damage and (c) the potential environmental security impacts of that damage. This cumulative can be classified as None/*Low/Moderate/High/Extreme*. If there are differential combinations, for e.g. Low-Moderate-Extreme for Overall Damage, Livelihood Impact and Environmental Security Impact respectively, then the highest level of classification i.e. Extreme should be used for classifying the cumulative.

    (ii) The level of effort required for restoration. This will be based on the team's assessment of the natural restoration potential of that site and the level of local support that exists for it. This will be determined from field observations and by interviewing key members of the local community). The level of effort required could thus be 'Low'(where high potential for NR exists, only basic clearance of debris, blockages & salvageable material is required, and high local support for restoration exists), 'Moderate' (significant clean up, channelling and/or protection of habitat/vegetation type required and moderate local support exists) or 'High' (where medium to intensive large-scale planting and intensive clearance of debris is required and low local support exists).

Restoration Priorities will be ranked I-IV following the guidance provided in Table 3 below:

Table 3: Restoration Priority Ranking Matrix

Restoration Effort Required	**Cumulative Ecosystem Damage – Livelihood – Environmental Security Impact**			
	Extreme	*High*	*Moderate*	*Low*
High	II	II	III	IV
Moderate	**I**	II	II	III
Low	**I**	**I**	II	III

Areas that had no/degraded tree and vegetative cover prior to the tsunami but where there is now a strong local support for restoration action should also be identified and recorded in Section C/D of Annex 1. However, there is a need to be careful before proposing or undertaking large-scale restoration activities as these may not be appropriate in some cases, for e.g. in areas where mangroves/ coastal forests were not occurring naturally in the first place and where restoration/ plantation activity can lead to displacement of existing natural ecosystems like mudflats, salt marshes, etc. The potential for successful restoration will also need to be technically assessed in more detail at a later stage and before committing funds for the same.

Assessing the role of Mangroves/Coastal Forests/Sand dunes in Coastal Protection:

- The on-site assessment should also aim to collect some systematic evidence, wherever possible, on the role that sand dunes, mangroves, coastal plantations and other inland forests, etc. may have played in mitigating/reducing the impact of the tsunami, particularly where these have been widely reported by the local population. In such cases, information must be recorded on the height and width of the vegetation in question, its density, its composition (i.e. the species mix - mangroves, tree plantations, what particular species, etc.), its general condition (whether intact, degraded, naturally/artificially restored, etc), impacts on different age stands, what kind of vegetation was reported to provide better barrier protection than others, etc (see section D of Annex 1). Information should also be collected on the nature of the incoming tsunami (height, how far it reached inshore, etc.) and the location and type of the dwellings reportedly saved, wherever possible. It is important to note that in many cases such information may be subjective to a significant extent, and care should be taken to verify them from multiple sources within the same site before recording them. Also it should be kept in mind while collecting the information that there are several factors such as bathymetry, wave energy, structure and topography of coastlines, etc. which influence the extent to which coastal ecosystems can play a buffering role against tidal waves, While too much time should not be spent on undertaking detailed on-site analysis, it should however be recorded if (according to the local people) there were other sites reported along the same stretch of coast that suffered higher losses due to absence of similar vegetative cover or landscape features. Some of those sites should be assessed using the same parameters as well, and it should be noted if protection or restoration action is now a priority there. Photographic /video evidence should be taken and tagged and geo-referenced to support these field observations as these will assist in conducting more scientifically rigorous and multidisciplinary assessments (involving coastal engineers, oceanographers, geologists, etc.) on the protective role of coastal natural/managed ecosystems later on.

4.0 Data management and archiving

Data transfer from field sheets should be simplified as much as possible. Excel spreadsheets matching the Terrestrial Rapid Assessment Form (Annex 1) should be developed for initial storage. It is likely that individual survey groups can analyse adequately from excel spreadsheets, and communication/coordination should occur on efficient analysis modules/macros that can be shared.

5.0 Analysing the Findings and Report Preparation

Once the rapid assessments are conducted and the teams have returned to their base location, it is important for them to sit together to quickly compile, compare and review all the data/information collected and resolve any inconsistencies or gaps in data collection/entry that may have resulted. Some of the initial data compilation work can start in the field itself, if time is available between or after the actual field assessment work.

Once all the data/information collected has been organised and generally agreed upon, the process of analysis should commence without delay, while the field visits are still fresh in one's mind. The analysis should, in the first instance, be carried out location-wise so that inferences can be made on the impact of the tsunami in more specific rather than general terms. Other secondary supporting sources of information such as desk literature, satellite imagery, etc. that may be available on those particular locations should also be consulted. The overall analysis should thus be able to offer a clearer location-wise analysis of the various facets on which the data/information was collected, i.e.:

- the specific type of damage caused to various components of the terrestrial coastal ecosystem
- the livelihood, environmental security and biodiversity impacts of the damage caused to terrestrial coastal ecosystems
- areas where protection or restoration of ecosystems is a priority
- assessing under what circumstances and to what extent, if any, did natural barriers – mangroves, coastal forests play a role in protecting the coastal environment.

All of these analyses should then be compiled together and presented in the form of a concise Rapid Field Assessment Report that can be consulted by, and feed into, both higher-level and future comprehensive assessments. These reports can also provide decision makers and other key stakeholders with the best-organised information available from the field as they plan and influence future reconstruction policies and processes.

6.0 Constraints and Limitations of the Proposed Methodology

There is an inherent subjectivity in the data collected in any rapid assessment methodology. This is true for this methodology as well. Thus while the degree of detail that this assessment methodology covers is more than that being done in some of the immediate post-tsunami satellite/ coarse field assessments, it cannot claim to offer a comprehensive or scientifically rigorous assessment. For the latter, more detailed site-specific assessments and monitoring based on establishing scientific plots will need to be undertaken by multidisciplinary teams of ecologists, soil/water scientists, biodiversity specialists, etc. based on well-established scientific survey methodologies and manuals such as English et al (1997) etc. This rapid assessment methodology also assumes that there will be at least some members in the rapid field assessment team with some prior knowledge and experience on coastal ecosystem assessment and monitoring related to ecology, hydrology, edaphic factors, etc. and expects that this will help in reducing some of the inherent subjectivity associated with rapid assessments.

References:

ICRI/ISRS 2005. Tsunami Damage to Coral Reefs: Guidelines for Rapid Assessment and Monitoring. GCRMN/CORDIO/IUCN/Reefbase/ ReefCheck/AIMS. January 2005. Seychelles. http://www.iucn.org/tsunami/temp/index.htm

English, S., Wilkinson, C. and Baker, V. 1997. Survey Manual for Tropical Marine Resources. 2nd Edition. Australian Institute of Marine Science.

FAO. 2003. State of the World's Forests, FAO Rome

Kelly, C. 2003. Guidelines for Rapid Environmental Impact Assessment in Disasters, Benfield Hazard Research Centre, University College London and CARE International *Version 4.2,* December 2003 http://www.benfieldhrc.org/SiteRoot/disaster_studies/rea/rea_guidelines.pdf

OECS 2003. Technical Manual for Post-Disaster Rapid Environmental Assessment Volume 1 & 2, OECS - Environment & Sustainable Development Unit, Organization of Eastern Caribbean Countries http://www.oecs.org/esdu/

Talbot, F and Wilkinson, C. 2001 Coral Reefs, Mangroves and Sea Grasses: A Sourcebook for Managers, joint ICRI/AIMS/GRCMN/GBRRF/IUCN/CORDIO/WWF publication 2001

UN-ECLAC 2003. Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters, United Nations Economic Commission for Latin America and the Caribbean, 2003 http://www.proventionconsortium.org/toolkit.htm

Wetlands International 2005. Assessment field protocol for rapid wetland and coastal assessment – a guide for staff http://www.wetlands.org/Tsunami/Tsunamidata.htm

Annex 1

IUCN Rapid Assessment Form for Terrestrial Coastal Ecosystems[4]

(A) General Information

Name, Location and Area of Assessment Site:	*Name of Assessment Site*	*Location of site* (Mark on Map and record GPS coordinates)	*Note if site is of special value (Protected Area, RAMSAR site, etc.)*	*Approx. total area of site (ha/sq. km) /length of coastline(km) being assessed*	*What is the type of coast being assessed?* *(see diagram in Annex 2)*
					Coast type number: ______
Date of Assessment: **Start time:** **End time:**					
Name and contact details of Assessor (s):					
Total local population prior to the tsunami		**No. of human casualties caused by the tsunami**			
Main source of Livelihood of local people (indicate by %age).		**Nature of dependence of local people on natural ecosystems** (note them one by one)			
Local description of the tsunami (i.e. height, speed, how far in-shore it reached, etc.) It is recommended that information recorded here is verified from multiple local sources.	Height (m): Distance reached inland from normal high-water line (HWL) (m): Tide-level at time of impact: High/ Low No. of waves: Duration of tsunami[5]: Time of first impact:	Additional description of Tsunami:			

[4] This Rapid Assessment Form incorporates and builds on several rapid assessment methods, including those developed by OECS, Wetlands International, ECLAC, etc. and also from the comments provided by various experts contacted by IUCN. It is important to note that all parts of the form will probably not be relevant at all sites, and can be simplified as required by the assessment teams in the field.

[5] This will be determined on the basis of the time the water remained inland before receding.

Sketch Map of the coastal stretch (location) in which the site is located. Mark the site being assessed on this sketch map																					
	Note the GPS coordinates at the start and end of each habitat/vegetation type along the Vertical Transect																				
Cross-section/profile of the <u>main</u> terrestrial coastal ecosystem types observed during under vertical transect assessment of the site	Height above MSL (m)																				
	12																				
	11																				
Mark coastal features such as rock outcrops, sand dune/ beaches, seashore scrub/vegetation, mangroves (sub-tidal/ inter-tidal/high-tide/ inland zones or sps.), lagoons, salt marshes, river mouths, home gardens, inland forests, casuarina/ coconut plantations, agriculture land, human settlements, manmade structures, etc.)	10																				
	9																				
	8																				
	7																				
	6																				
	5																				
	4																				
	3																				
	2																				
	1																				
Also clearly indicate the level of sea water incursion in this diagram	0																				
	Distance from HWL (m)	0	20	40	60	80	100	120	140	160	180	200	250	300	350	400	450	500	600	800	1 km

(B) Terrestrial Damage Assessment (made through vertical transects from Sea to Land)

A	B	C	D	E	F	G	H		I	J	K
Terrestrial Ecosystem/ Vegetation Ecosystem Type	**Area under assessment** *(est. in ha/ sq. km)*	**Type of Damage**	**Extent of Damage by type** *(as a % of area damaged)*	**Intensity of Damage by type** *(Minor/ Medium/ Major)*	**Overall Damage by type** *(None/ Low/ Moderate/ High/ Extreme)*	**Livelihood Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Environmental Security Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Natural Regeneration Potential** *(None/Low/ Moderate/ High)*	**Restoration Action Priority**[6] *(I-IV Ranking)* *I-most urgent; IV-least urgent*	**Salvage Potential for reconstruction needs** *(None/Low/ Moderate/ Good)*	**Additional Observations/ Comments** *(For e.g. risk of invasives, threatened sps. Information, specific examples of livelihood impact of damage, etc.)*
Sand dune/ Beaches		Loss of land width									
		Sand Migration									
		Composition change									
		Debris									
		OVERALL DAMAGE RATING[7]									
Coastal Scrub/ Seashore Vegetation		Defoliation									
		Breakage									
		Uprooting									
		Salination[8]									
		Sedimentation / Debris									
		OVERALL DAMAGE RATING									

[6] The overall damage rating is a cumulative of the different types of damage that have been caused to the particular habitat/vegetation type. The extent of damage under this will therefore be an arithmetic summation of the various percentages of area that have been affected by different types of damage (i.e. a maximum of 100%).
[7] Based on the Restoration Priority Ranking Matrix (Table 3 of main document) and on estimation of local support available for restoration.
[8] Observed by discolouration or dieback

A	B	C	D	E	F	G	H		I	J	K
Terrestrial Ecosystem/ Vegetation Ecosystem Type	**Area under assessment** *(est. in ha/ sq. km)*	**Type of Damage**	**Extent of Damage by type** *(as a % of area damaged)*	**Intensity of Damage by type** *(Minor/ Medium/ Major)*	**Overall Damage by type** *(None/ Low/ Moderate/ High/ Extreme)*	**Livelihood Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Environmental Security Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Natural Regeneration Potential** *(None/Low/ Moderate/ High)*	**Restoration Action Priority**[6] *(I-IV Ranking)* *I-most urgent; IV-least urgent*	**Salvage Potential for reconstruction needs** *(None/Low/ Moderate/ Good)*	**Additional Observations/ Comments** *(For e.g. risk of invasives, threatened sps. Information, specific examples of livelihood impact of damage, etc.)*
Mangrove Forests Note mangrove species and zonation wherever present under additional observations		Defoliation									
		Breakage									
		Uprooting									
		Salination									
		Sedimentation / Debris[9]									
		Other Stress[10]									
		OVERALL DAMAGE RATING									
Lagoons/ Estuaries/ Salt Marshes/ Mud flats/ Other Wetlands		Filling up due to sand/ Debris									
		Salination									
		Altered channels									
		Toxicity from mass mortality of aquatic fauna									
		OVERALL DAMAGE RATING									

[9] Including smothering/ blockage of pneumatophores
[10] See Annex 3 on 'Recognising stress in Mangroves'

A	B	C	D	E	F	G	H		I	J	K
Terrestrial Ecosystem/ Vegetation Ecosystem Type	**Area under assessment** *(est. in ha/ sq. km)*	**Type of Damage**	**Extent of Damage by type** *(as a % of area damaged)*	**Intensity of Damage by type** *(Minor/ Medium/ Major)*	**Overall Damage by type** *(None/ Low/ Moderate/ High/ Extreme)*	**Livelihood Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Environmental Security Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Natural Regeneration Potential** *(None/Low/ Moderate/ High)*	**Restoration Action Priority**[6] *(I-IV Ranking)* *I-most urgent; IV-least urgent*	**Salvage Potential for reconstruction needs** *(None/Low/ Moderate/ Good)*	**Additional Observations/ Comments** *(For e.g. risk of invasives, threatened sps. Information, specific examples of livelihood impact of damage, etc.)*
Casuarina/ palm/ other plantations		Defoliation									
		Breakage									
		Uprooting									
		Salination									
		Debris									
		OVERALL DAMAGE RATING									
Home Gardens		Defoliation									
		Breakage									
		Uprooting									
		Salination									
		Debris									
		OVERALL DAMAGE RATING									
Other Inland forests		Defoliation									
		Breakage									
		Uprooting									
		Salination									
		Debris									
		OVERALL DAMAGE RATING									

A	B	C	D	E	F	G	H		I	J	K
Terrestrial Ecosystem/ Vegetation Ecosystem Type	**Area under assessment** *(est. in ha/ sq. km)*	**Type of Damage**	**Extent of Damage by type** *(as a % of area damaged)*	**Intensity of Damage by type** *(Minor/ Medium/ Major)*	**Overall Damage by type** *(None/ Low/ Moderate/ High/ Extreme)*	**Livelihood Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Environmental Security Impact of Ecosystem Damage** *(None/Low/ Moderate/ High/ Extreme)*	**Natural Regeneration Potential** *(None/Low/ Moderate/ High)*	**Restoration Action Priority[6]** *(I-IV Ranking)* *I-most urgent; IV-least urgent*	**Salvage Potential for reconstruction needs** *(None/Low/ Moderate/ Good)*	**Additional Observations/ Comments** *(For e.g. risk of invasives, threatened sps. Information, specific examples of livelihood impact of damage, etc.)*
Wildlife/ Species loss[11] This will need to be determined both through observations and interviews with local stakeholders		Mortality									
		Water source contamination									
		Poaching									
		OVERALL DAMAGE RATING									
Agriculture Land		Salination									
		Water logging									
		Debris									
		Groundwater contamination									
		OVERALL DAMAGE RATING									
Aquaculture Ponds											
Others											
Overall Ecosystem/Biodiversity Damage at the site[12]											

[11] Please note under additional observations/comments if there are any IUCN Red List endangered/ endemic species, etc. that have been affected by the tsunami.
[12] This will be an aggregated observation based on the level of damage caused to all habitats/ vegetation types in a given site and the species associated with them.

(C) Additional Assessment Information on future threats and actions

1. What is the destruction caused by tsunami to secondary forest products (e.g. no. of wooden boats, piers, houses and other buildings lost)?	**Boats:** **Piers:** **Houses:** **Buildings:** **Others (Roads, Railways, etc.):**	**If possible, estimate the total timber loss due to the tsunami (cum):**
2. Where are the fuelwood, timber and other forest product requirements for local post-tsunami reconstruction needs being procured from?	**Comments/ Observations:** **Note any locally available salvageable material:**	
3. What is the threat to the local ecosystem from post-tsunami reconstruction/other pressures?	**Indicate:** *None/ Low/ Moderate/ High/ Extreme* **Comments/Observations:**	
4. What is the total potential area available in the site for future restoration?	**Damaged area that can be restored (in ha/ sq. km):** **Additional area that can be restored (in ha/ sq. km):** **Is there local support for restoration action (Yes/ No):**	
5. What is the current tenure arrangement in the area? Who owns the above listed types of lands and who all have access/use rights to it?	**Comments/ Observations:**	

6. What is the immediate priority action as expressed by the local people?	**Overall:** **With respect to ecosystem restoration/rehabilitation (classify by ecosystem type/ zone if required):**
7. What is the employment and enterprise-development potential that ecological (mangroves, plantations, nurseries, etc.) restoration can generate right away for displaced and/or local communities?	**Indicate:** *None/ Low/ Moderate/ High* **Comments/Observations:**

(D) Additional assessment of the role of Mangroves/Coastal Forests/Sand dunes in Coastal Protection

1. Were any of the following terrestrial ecosystem/vegetation types/coastal features widely reported to have played a protective role in reducing the impact of the tsunami at the site?	**Indicate Yes/ No** It is recommended that information recorded here is verified from multiple local sources.	**Height of ecosystem type** *(m)*	**Width of ecosystem type** *(m)*	**Density of ecosystem type** *(est. %canopy cover for mangroves/trees)*	**Pre-tsunami condition of ecosystem type** *(Intact/ Light/Moderate/ Severely degraded)*	**Species composition in ecosystem type** *(list main species and rough %age break-up if applicable)*	**Age Structure of ecosystem type** *(list approx. age of the different stands affected, if applicable)*	**Additional Observations/ Comments**
Sand dunes/ beaches								
Coastal Scrub/ Seashore Vegetation								

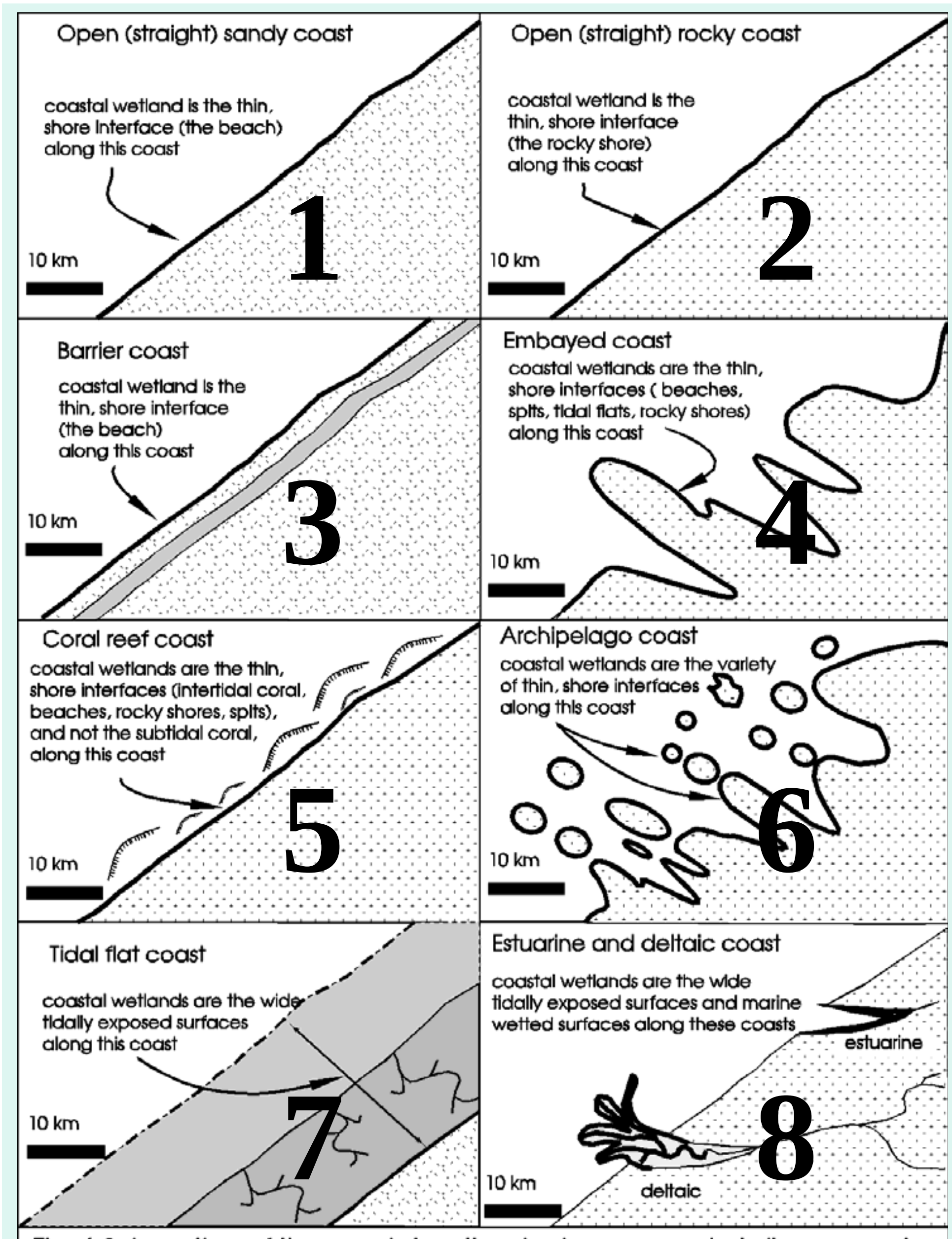
Mangrove Forests								
Lagoons/ Estuaries/ Salt Marshes/ Mud flats/ Other Wetlands								
Casuarina/ palm/ other plantations								
Home gardens								
Other inland forests								
Rock outcrops								
Manmade structures								
Any other (___________)								

2. Was any type of ecosystem/ vegetation less damaged than others?	**Comments/observations:**
2. Topography, bathymetry-related information	**Comments/observations:**
3. Other evidence of protection?	**Comments/observations:**
4. Please note below the names of neighbouring sites/areas which did not have a similar protective ecosystem barrier and more destruction/ loss of life was reported, and undertake the rapid assessment exercise there. Attach those assessment sheets with these.	
NAME/S OF SITES TO BE ASSESSED ALONG SAME COASTLINE FOR COMPARING WITH ABOVE: (i) (ii) (iii) **(In such areas, note if restoration has local support and is a priority)**	

Annex 2:

Recognizing coastal types

In this series of diagrams, the possible types of coast are shown. Not shown are mangroves, shrimp or fish ponds, and types of coastal tree cover, all of which can be present. Please if using the form suggested, use the **numbers** to refer to the coastal types that you see.



Source: Consolidation of guidelines on Ramsar Wetlands Classification System and biogeographic regionalization Presentation by Vic Semeniuk to the Ramsar STRP Mid-term Workshops, June 2004 as represented in Wetlands International (2005)

Annex 3:

Recognising Stress in Mangroves

As damage does not always manifest itself as ‘breakage’, impact on mangrove forests can also be seen in the following ways:

- Branches and trunks may have bark with cracks or crevices
- Leaves and uppermost branches in the sun may be dying at their tips
- There may be no flowers
- Fruits may fall off before they have matured
- Established seedlings may begin to grow abnormally
- The new upright aerial roots (pneumatophores) coming up from the mud may be branched, twisted or curled, and aerial roots may develop on the tree’s trunk
- Siltation/ smothering of pneumatophores
- Absence or disruption of normal or any tidal flows

Source: Adapted from Talbot, F and Wilkinson, C (2001)