World Meteorological Organization

CONDUCTING FLOOD LOSS ASSESSMENTS

A Tool for Integrated Flood Management

ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

March 2007

The Associated Programme on Flood Management (APFM) is a joint initiative of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP). It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management. The programme is financially supported by the governments of Japan and the Netherlands.

The World Meteorological Organization is a Specialized Agency of the United Nations and represents the UN-System's authoritative voice on weather, climate and water. It co-ordinates the meteorological and hydrological services of 187 countries and territories.

The Global Water Partnership is an international network open to all organizations involved in water resources management. It was created in 1996 to foster Integrated Water Resources Management (IWRM).

Note for the reader

This publication is part of the "*Flood Management Tools Series*" being compiled by the Associated Programme on Flood Management. The contained Tool for "Conducting Flood Loss Assessments" is based on available literature, and draws findings from relevant works wherever possible. This Tool addresses the needs of practitioners and allows them to easily access relevant guidance materials. The Tool is considered as a resource guide/material for practitioners and not an academic paper. References used are mostly available on the Internet and hyperlinks are provided in the "References" section.

This Tool is a *"living document"* and will be updated based on sharing of experiences with its readers. The Associated Programme on Flood Management encourages flood managers and related experts engaged in assessing flood losses around the globe to participate in the enrichment of the Tool. *For the purpose comments and other inputs are cordially invited.* Authorship and contributions would be appropriately acknowledged. Please kindly submit your inputs to the following Email address: apfm@wmo.int under Subject: "Flood Loss Assessment Tool".

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This Tool has exploited the works of many organizations and experts, as listed in the references. Acknowledgement is due to the members of the Hydrology and Water Resources Department in WMO and the members of the Technical Support Unit of the APFM for their competent technical guidance and frank discussions on the issues and for bringing various perspectives into focus. The kind contributions of the following persons for enriching the contents are gratefully acknowledged:

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Ms. Natasa Manojlovic, Institute for River and Coastal Engineering, Technical University of Hamburg-Harburg (TUHH)

This Tool has drawn from the works of various organizations and experts, as listed in the references. The ideas have been assimilated with special reference to Integrated Flood Management and no originality is claimed.

Disclaimer

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APFM Technical Document No. 7, Flood Management Tools Series

CONDUCTING FLOOD LOSS ASSESSMENTS

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1. INTRODUCTION

1 During flood emergencies, assessment of the extent of flooding, flood losses and resultant needs of the affected communities is essential for flood relief coordination. Depending on the severity of a flood and the level of preparedness in the affected area, this has to be done under extraordinary circumstances, involving varying degrees of chaotic conditions, contingencies and time pressures. Usually the immediate estimates are drawn arbitrarily due to the chaotic circumstances and mounting public pressure. These flood loss assessments later provide the basis for reconstruction planning and for decisions on flood management policy reform. Nevertheless, certain basic principles can be observed to avoid too unrealistic estimates and resulting repercussions.

2 The importance of assessing potential flood losses becomes evident when policy makers and planners try to strike an optimal balance between the development needs of a particular area and the levels of flood risk society is ready to accept. In this context flood losses become a vital element in assessing the net-benefits society can derive from using flood plains, i.e. the overall benefits like relatively easily exploitable land for economic activity of various sectors, space for settlement, fertile alluvial soils for agriculture, readily available navigation links, etc., minus the expected flood losses, both assessed for the same timeframe.

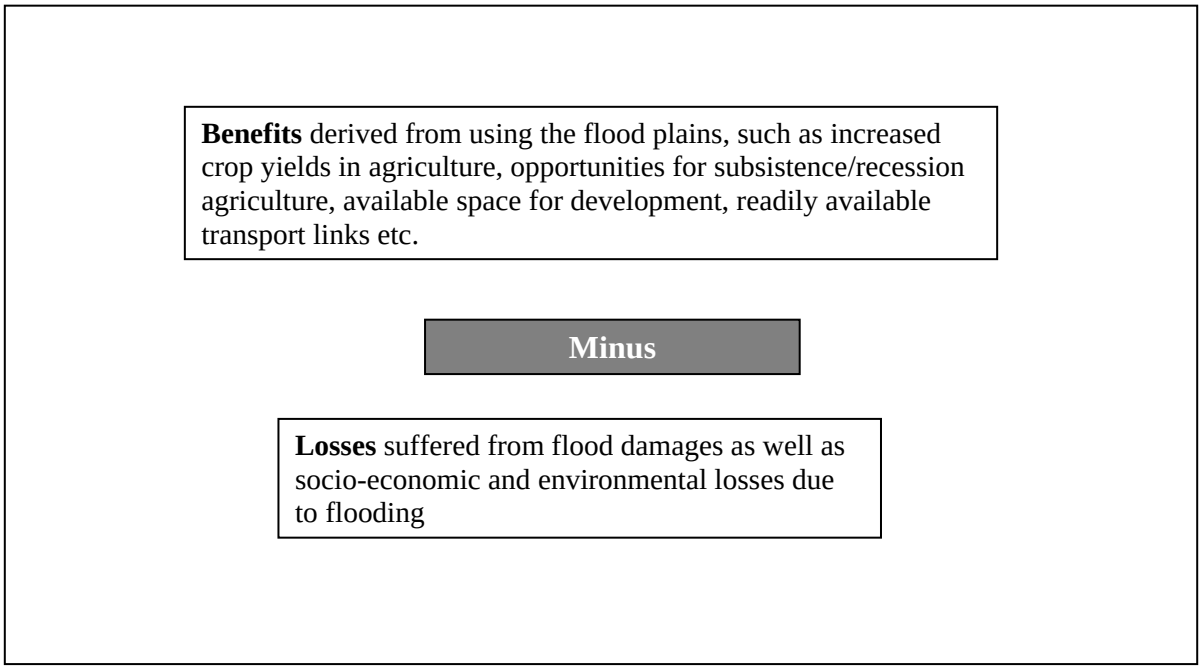

Figure 1. The net-benefits derivable from flood plains (*)

(*) Human losses of life, biodiversity losses or losses of cultural heritage are not sufficiently quantifiable in economic terms but co-determine policy options.

2. WHAT THE TOOL IS FOR AND HOW IT IS PRESENTED

3 This tool sets out to provide for the operational level a lead-in on available concepts and methods to assess flood losses for the activation and facilitation of local and external help and the formulation of recovery plans as well as long-term development planning and policy reform in the realm of flood management. Therefore, the material seeks to contribute to a reduction of cases where flood loss assessments are undertaken arbitrarily due to a lack of readily applicable guidance. As such the tool is considered most useful for the following groups:

- Flood managers[1], i.e. mainly personnel from nationally and locally responsible specialized agencies, mostly with an engineering background
- Public officials in charge of emergency response such as mayors
- Local groups and NGOs working in flood emergency response

4 It is important to realize that flood loss assessments are undertaken for a variety of purposes, and that the different purposes determine the outcome. As illustrated in **Figure 2** this Tool distinguishes several purposes and uses of flood loss assessments, depending on the context in which the assessment is undertaken.

5 The first purpose is the use in form of a rapid assessment for emergency relief coordination during the flood. The second purpose is for an initial assessment of damages in the first few weeks after floodwaters have receded to inform and guide the recovery process, for example in an insurance context, for allocation of recovery funds from national budget or for guidance to external aid agencies. The third purpose is a comprehensive assessment of flood losses 3 to 6 months after the flood to inform policy reform processes as well as the reconstruction efforts within national or sub-national planning. A fourth purpose deals with the use of flood loss data for flood risk assessment and for the appraisal of flood defence and mitigation options. Unlike the above three, this process is not triggered by the flood event and is based on potential losses derived from synthetic stage-damage relationships or empirical data from past floods.

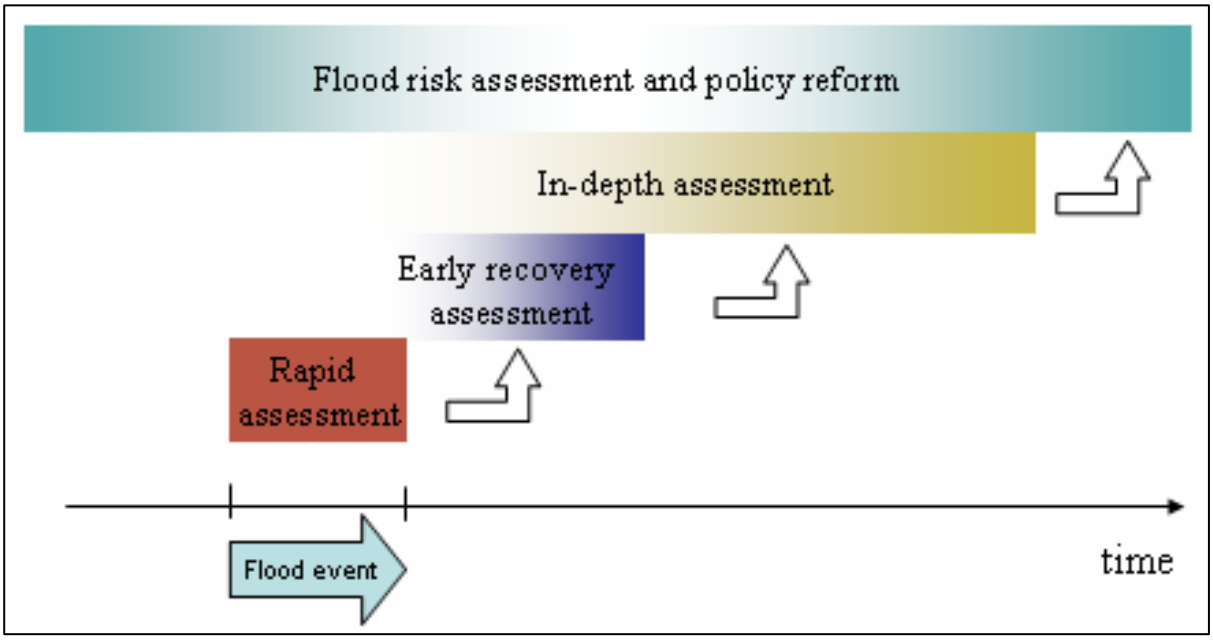

Figure 2. Types of flood loss assessments in various phases

[1] E.g. senior public officials in ministries or departments responsible for flood loss assessments, technical experts in those departments supervising external contractors or actually undertaking the assessment, etc.

3. ESSENTIAL DISTINCTIONS AND CONCEPTS

3.1. TYPES OF FLOODS AND ASSOCIATED LOSSES

3.1.1 Flash floods

6 Flash floods are rapid onset floods that occur 6-12 hours or less after the associated rainfall. Flash floods occur particularly in mountainous or hilly area with rather steep terrain gradients and high surface runoff. They can also be triggered by the failure of hydraulic infrastructure such as dams or levees, outburst of glacier lakes, ice-jams or log-jams. Due to the short lead time for advance preparation, warning and evacuation etc, the losses of human life can be substantial. Due to the force of rapidly flowing water, they pose serious threats to the structural integrity of buildings and infrastructure. Depending on depth and velocity of the water as well as the load of debris the water transports, the destructive forces are varying. **Figure 3** provides some indication about the damage potential of floods depending on flow velocity and water depth. This may vary according to the type of construction, flood proofing measures or structural reinforcements.

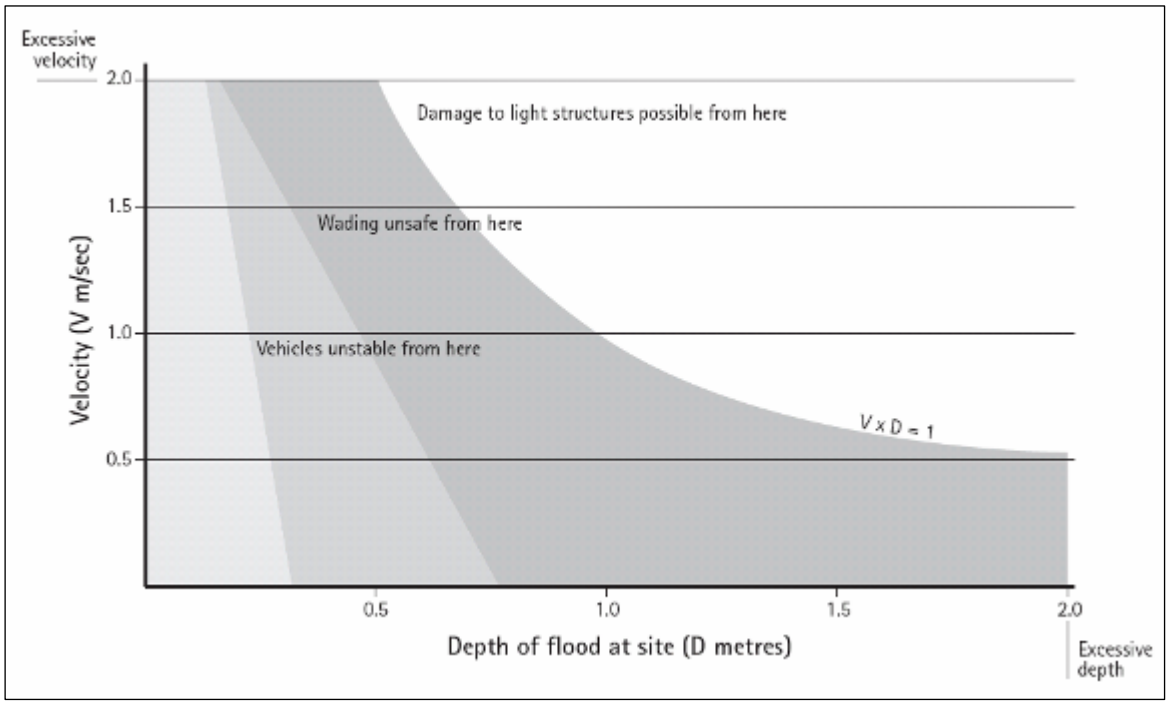

Figure 3. Critical depth velocity relationship (Source: [1]*)

7 Another issue of flash floods relates to the difficulties with predicting the phenomenon and with the short warning lead times. In matter of damages this means there is less time for preparatory action, so that potential losses are closer to actual losses than with other flood types. For details on the distinction between actual and potential losses see also section 3.2.

3.1.2 Riverine flooding

8 Riverine flooding can extend over large areas in the mid and lower reaches of a river system, where terrain gradients are lower. Structural failure of buildings in these reaches is less common due to the lower flow velocities, however, prolonged inundation may result in foundation failures, particularly if the construction is old or not to standard. Locally, and especially where levees fail, the flow velocities are higher as illustrated in **Figure 4**, however, not of the same significance for the loss assessment process as for flash floods.

* [ ] indicate the reference listed at the end of the article

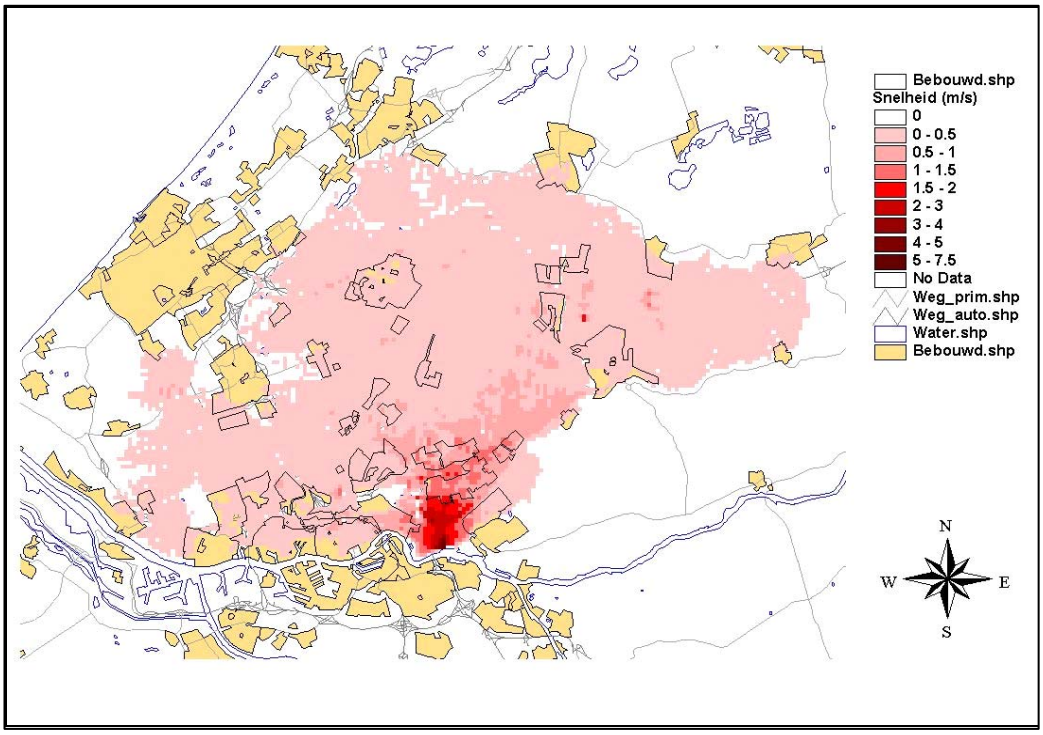

Figure 4. Flow velocities for a dijk breach scenario in the Netherlands (Source: [2])

9 The main parameters influencing the magnitude of flood damage are the depth of inundation and for a number of sectors the inundation time (especially for agriculture), sediment and pollution loads. Due to the heavy economic activity on floodplains in many part of the world, damages and losses of riverine flooding account for substantive parts of the overall flood losses.

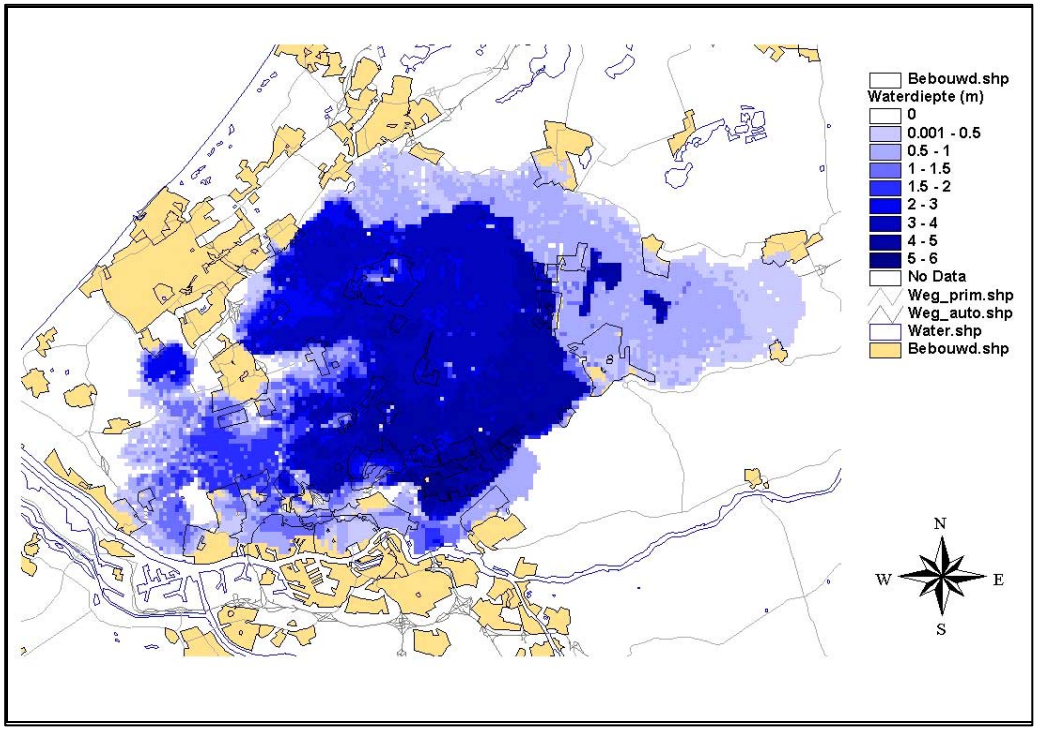

Figure 5. Inundation depths for a dijk breach scenario in the Netherlands (Source: [2])

3.1.3 Coastal flooding

10 Coastal flooding is in most cases induced by storm surges (wind-induced), or as a combination between storm surge, high tide and elevated levels of river discharge, leading to backwater effects in the river delta areas. Tsunamis as sources of coastal flooding are a less frequent phenomenon, however, as has been tragically illustrated in the December 2004 Indian Ocean Tsunami, can have effects on unprecedented scales [3]. The combination of damages induced by contact with flood waters, and wind damage to structures is characteristic for this type of floods.

3.1.4 Groundwater flooding

11 Groundwater flooding occurs as a result of water rising up from the underlying rocks or from water flowing from abnormal springs. This tends to occur after longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive, regional aquifers, such as chalk or sandstone, or may be localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding takes longer to dissipate because groundwater moves much more slowly than surface water and will take time to flow away underground.[2]

3.2 TYPES OF FLOOD LOSSES

12 Conceptually it is important to note the difference between flood damages and flood losses. The term "flood damage" is related to the physical damage of public and private assets such as infrastructure, houses, vehicles, etc., resultant of contact with flood waters. The term "flood loss" has a much broader meaning and depicts also secondary or tertiary losses, as well as intangible losses such as losses to human life and others. To arrive at realistic estimates about the impact of a flood, only considering flood damages, i.e. direct tangible losses, would usually not do justice to the purpose of assessment, and would probably arrive at misleading messages to policy makers about the true impact and consequences of a flood event. Most commonly the following distinction is applied (see also: [4]):

Direct losses: Those losses resulting from direct contact with flood water, to buildings and infrastructure
Indirect losses: Losses resulting from the event but not from its direct impact, for example, transport disruption, business losses that can't be made up, losses of family income etc

In both loss categories, there are two clear sub-categories of loss:
Tangible losses: Loss of things that have a monetary (replacement) value, for example, buildings, livestock, infrastructure etc.
Intangible losses: Loss of things that cannot be bought and sold, for example, lives and injuries, heritage items, memorabilia etc.

13 These distinctions are further illustrated in **Figure 6**. One of the central works on flood loss assessment has been published by the Flood Hazard Research Centre (FHRC) in the UK [5] that together a number of subsequent works of FHRC provides important guidance on the issue.[3]

[2] Source: UK Groundwater Forum available at http://www.groundwateruk.org/html/faq3.htm
[3] For more info see: http://www.fhrc.mdx.ac.uk/resources/publications.html

14 One of the basic decisions to take in flood loss assessment relates to which loss categories to include and how to assess each one of them. This decision will be influenced by the type of assessment carried out, including the time and resources available for its completion. National practices vary as to which categories are included [6].

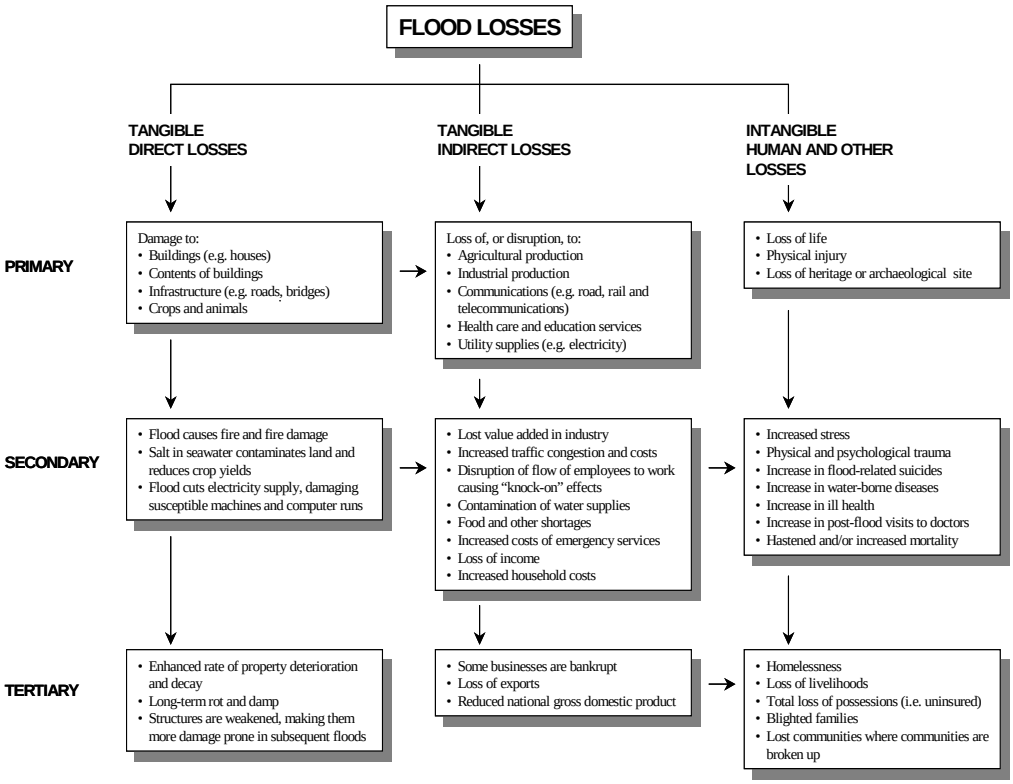

Figure 6. Categorization of flood losses (Source: [7])

Actual and potential losses

15 Another important distinction can be made between actual and potential flood losses. When assessing damages based on the experience of past floods or synthetic stage-damage relationships, the assumption applied is usually that the flood strikes without the household or affected community having taken any preparatory action. Such preparatory action could involve moving cars to higher ground, emptying basement storages and the ground floor, sealing the entrance and windows of buildings etc. The flood awareness and preparedness levels of local communities and households have, however, a significant influence on the level of actual flood losses. **Figure 7** illustrates this effect by comparing the behaviour of an experienced with an inexperienced community based on different warning lead-times.

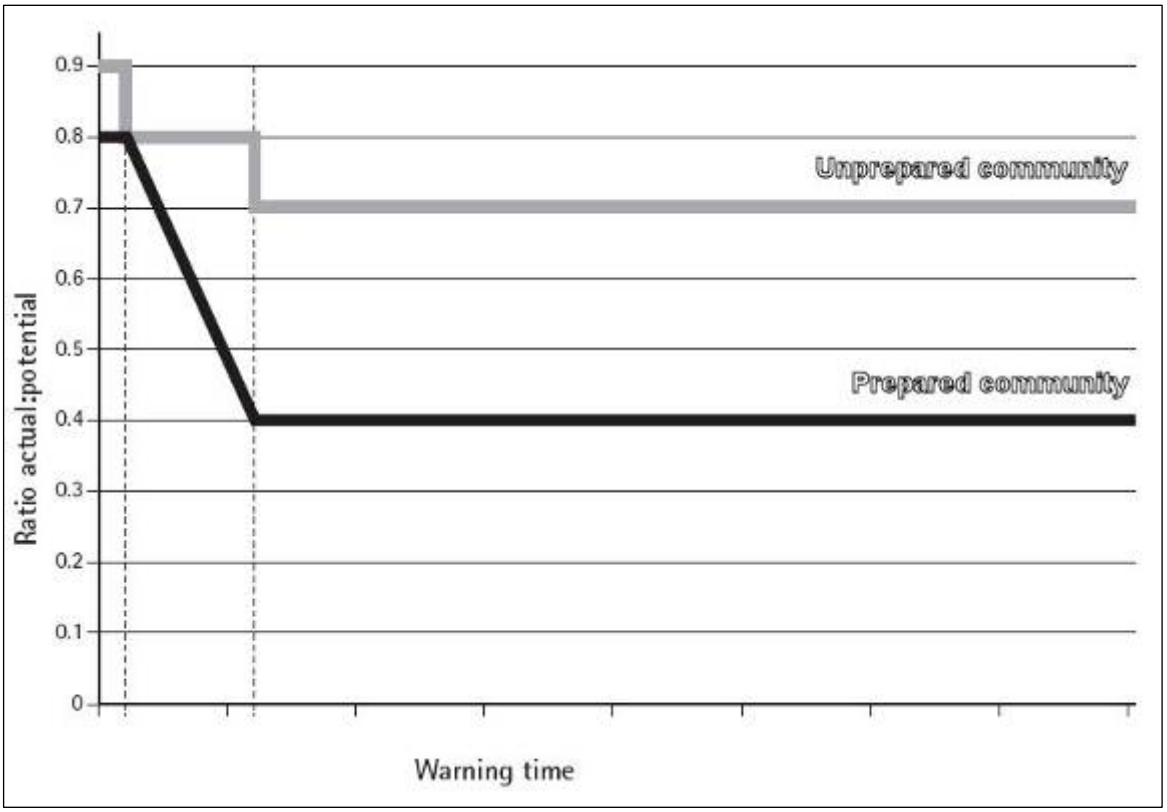

Figure 7. Relationship between actual and potential damages (Source: [1])

16 This illustrates that for an integrated approach to flood management, not only the benefits of flood defences (structural measures) but importantly also the benefits of flood risk awareness, flood preparedness and mitigation measures should be made part of flood management project appraisals.

3.3 ECONOMIC AND FINANCIAL ASSESSMENT

17 "The intention of economic analysis as part of a flood loss assessment is to assess the deviation from likely economic activity as a result of the flood, not to take into account the financial losses to individual enterprises. This is not always easy to do, and you will commonly have to make approximations to this ideal." [4]

18 Financial assessment is concerned with the question of how many losses an individual business, property or household has had due to flooding. The difference becomes clear when looking into an example where, say, a food production facility has suffered income losses as it was not able to transport its goods to its customers due to blocked roads from flooding. However, another competitor was able to substitute the goods from its own stock and therefore had an increased income as an indirect effect of the flood. Therefore, this incidence would not affect the economic impact of the flood.

3.4 STAGE-DAMAGE CURVES AND UNIT LOSS APPROACH

19 Stage–damage curves are graphical representations of the losses expected to result at a specified depth of flood water. Such curves are typically used for housing and other structures where the stage or depth refers to depth of water inside a building and the damage refers to the damage expected from that depth of water [4].

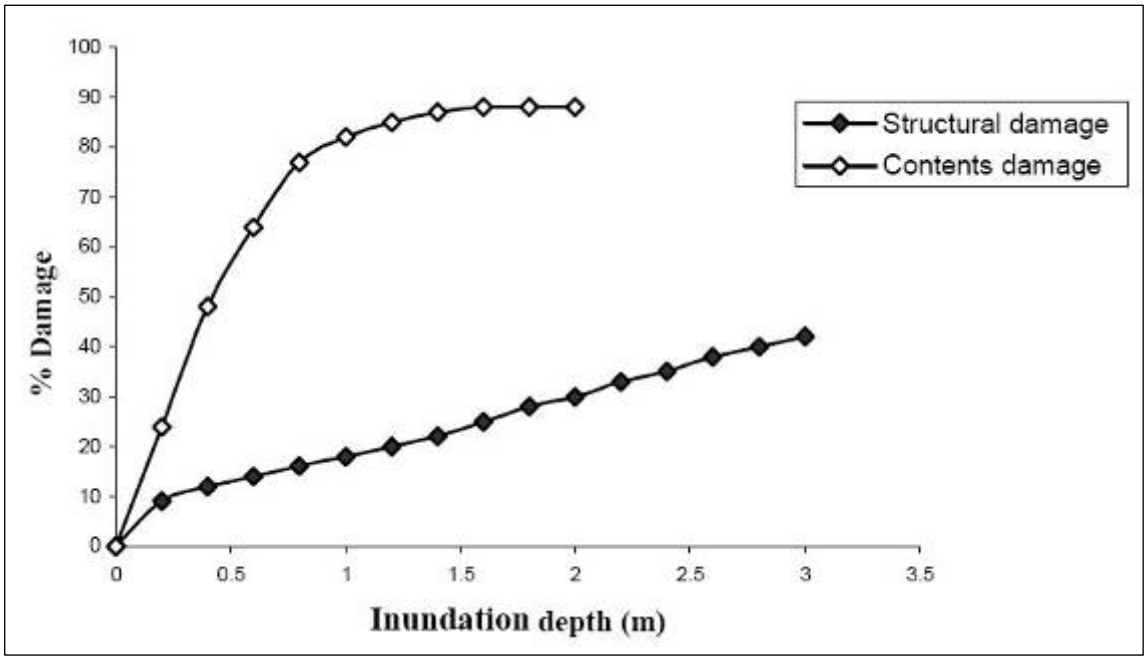

Figure 8. Example of Stage-Damage curves for potential contents and structural damages
(Source: [4])

20 Stage-damage curves can be developed in two distinct ways, namely either by using data on building contents and structure repair costs to produce synthetic or artificial estimates of damage curves, or by using information on losses measured following flooding combined with estimates of water depth. Stage damage curves of actual losses can be constructed according to the latter.

21 The unit loss approach refers to the calculation of loss to individual properties, which are then added together to give a total loss figure for the event in question. For losses from flooding, this usually involves calculating the loss to each property (or unit) by survey, stage-damage curves, or the use of average figures. The losses for each unit (property) are then added together to give an estimate of total event loss.

4. FLOOD LOSS ASSESSMENT PROCESS AND METHODS

4.1 RAPID ASSESSMENT DURING THE FLOOD

22 The purpose of assessment during a flood is mainly to have a factual basis for emergency response and relief coordination. Emphasis of actions during this phase would rather be on having a basis for avoiding (further) losses of life, for minimizing misery and suffering of the affected population and for avoiding knock-on effects (secondary disasters).

23 Importantly a flood assessment during this phase is also the basis for deciding which levels of administration are to be invoked for the response, i.e. if local or regional emergency response forces are in the position to contain the situation, or if assistance from the national level is necessary. It also provides indications for international emergency relief agencies about the possibly needed response from the side of the international community.

24 Assessment at this stage will need to be made with very limited time and locally available assets as well as under unsettled circumstances. Based on the above-mentioned emphasis of action, essential information for the emergency response at this stage would include:

i. People killed, displaced or affected by flooding (including specified needs for the humanitarian response)
ii. Assets that have been flooded (inundation map), search and rescue and evacuation requirements
iii. People and assets at risk of being flooded further (hazard or risk map), based on the status of flood defences and needs for further evacuations
iv. Status of lifelines (evacuation/access roads, hospitals, electricity grid, water and food supply), hospitals and shelters.
v. Current and expected river water levels at various locations as well as weather conditions

25 As such, the focus of assessment during this phase is placed on emergency response rather than loss assessment. The current Tool does not include a detailed discussion on this topic. Further guidance on this issue is available from various sources, especially national and international bodies working on emergency response and relief coordination. A short list of readily available guidance material is provided in the following:

- UNDAC Field Handbook published by OCHA, providing a rapid assessment methodology on a sectoral basis [8]
- UNHCR Handbook for Emergencies provides checklists for initial assessments as well as guidance on the provision of safe drinking water [9]
- Community Damage Assessment and Demand Analysis, by the All India Disaster Mitigation Institute, provides guidance on a staged assessment process for the local level [10]
- Post-Disaster Damage Assessment and Need Analysis, of the Asian Disaster Preparedness Centre, provides ready-made templates for early reporting of damages and needs [11]

26 While in more developed economies the option of air reconnaissance may be readily available to establish the factual basis for emergency response, it may not be in many of the worlds flood stricken regions. In many circumstances, non-availability of inundation maps restricts the response of emergency services. For those areas alternative means need to be utilized or an international response can be triggered through the International Charter “Space and Major Disaster”.[4]

[4] The International Charter aims at providing a unified system of space data acquisition and delivery to those affected by natural or man-made disasters through Authorized Users. Each member agency has committed resources to support the provisions of the Charter and thus is helping to mitigate the effects of disasters on human life and property. For more information see: http://www.disasterscharter.org/main_e.html

27 At this stage a meaningful flood damage assessment is impossible as flood waters have not yet receded and therefore the entire extent of damage may not be possible to be assessed. The realities of international disaster response require, however, even at this stage a preliminary estimation if there are indications that national coping capacities are exceeded. Depending on synthetic stage damage data readily available or experience from earlier floods this estimation can be significantly improved. Developing relevant data and information about potential flood losses in good time, i.e. before the next flood, helps to prevent situations where rapid assessments are way out of dimension.

4.2 "EARLY RECOVERY" ASSESSMENT

28 In the immediate aftermath of a flood event, i.e.1-3 weeks after the flood (peak), the purpose of an "early recovery" assessment lies in guiding the recovery process and in providing early indications for reconstruction in particular with a view to

- facilitate the design of financial mechanisms for speedy recovery (who will bear the cost)
- lay the foundation for priority setting in allocation of recovery assets
- provide indications on the coping capacity of the government to repair key infrastructure, such as important road links and flood defences to withstand the next flood.
- provide early indications on mistakes that have been made in past planning and development practice that need to be borne in mind for reconstruction planning

29 The focus of assessment at this stage is necessarily on tangible and direct losses, as most the of the intangibles need longer times to be assessed and the indirect losses may not yet be fully apparent or might not have fully materialized yet. Especially concerning indirect losses to trade and industry may at this stage not be fully apparent and loss assessments may need to be based on best estimates of affected businesses.

30 A standard and internationally accepted methodology, has been provided by the UN Economic Commission for Latin America and the Caribbean (UNECLAC) [12]. The underlying methodology is based on (i) physical assets that will have to be repaired, restored or replaced or discounted in the future and (ii) flows that will not be produced until the asset is repaired or rebuilt. The UNECLAC methodology further conducts the assessment on a sectoral basis, similar to the distinction displayed in **Figure 9**.

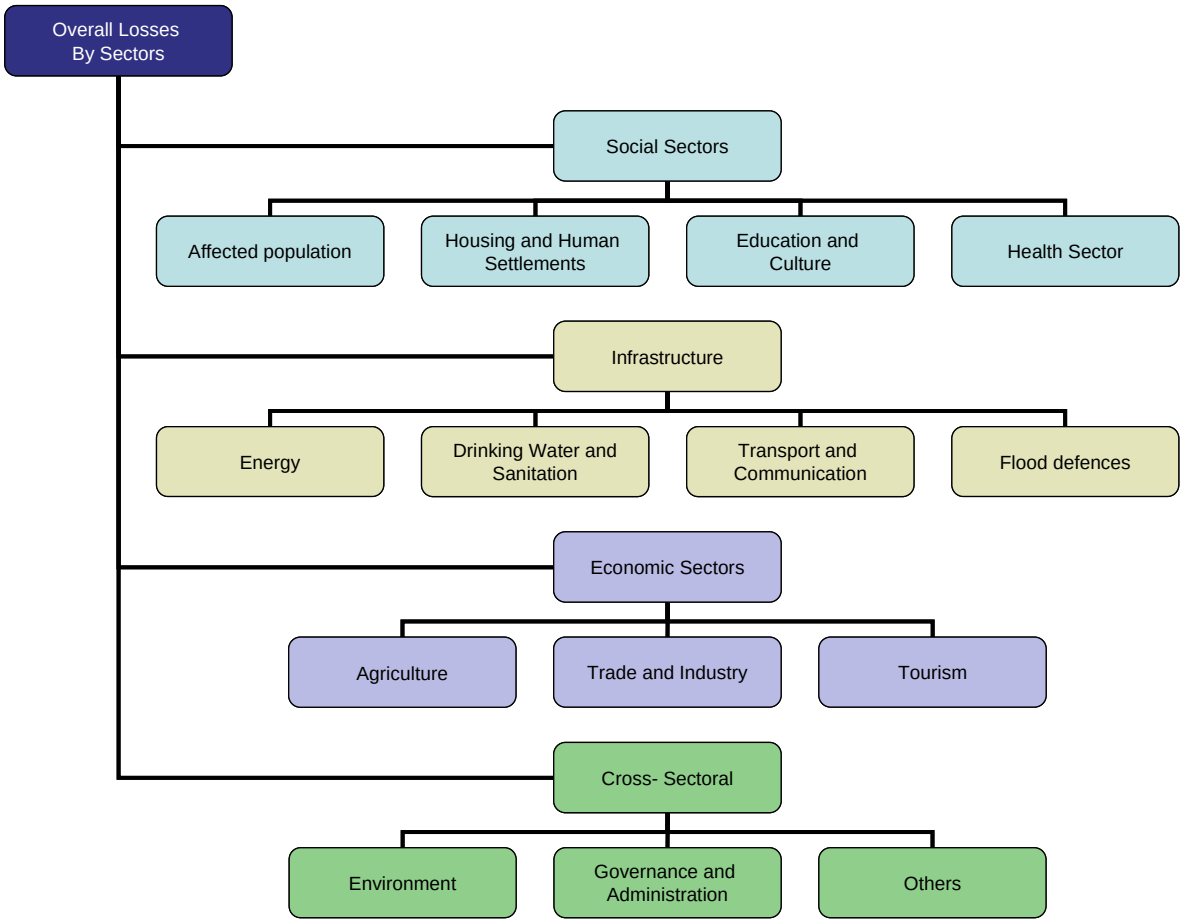

Figure 9. Disaggregation of losses by sectors (based on [12])

31 Detailed methodological guidance for the assessment of losses for each sector is available from the UN Economic Commission for Latin America and the Caribbean [12]. The same methodology has been applied by the UN Economic and Social Commission for Asia and the Pacific (ESCAP) in a practical spreadsheet-based software application called the "Disaster impact calculator" [13].

32 At this stage it is advisable to base assessments on actual costs and damages, i.e. how much it would costs to replace the assets and income lost according to their original specification and location (replacement cost).

33 As can be seen from Table 1 below, when reporting a further distinction can be made between damage to public and private property. It is essential not only to look at the total numbers in relation to the national economy, but to see who is bearing the losses of flooding, for example the economy of a country may be marginally affected whereas the economy of the most affected region or province may exceed that region's coping capacity.

34 From a social point of view it is required to look into which social, groups or classes are affected disproportionately, and this cannot be done by merely counting the absolute value of losses in monetary terms. It is rather necessary to relate these losses to the ability of members of respective groups recover from these losses (e.g. through savings, insurance, reconstruction assets, social support network, income and livelihood). In other terms, a poor family or community without much savings or other recovery assets may have large difficulties in recovering from a nominally small monetary loss, whereas a property owner with flood insurance will not be much affected even though the nominal monetary loss may seem to be very large. Such assessment will help to minimize risks of the most in need being overheard in the recovery efforts.

Table 1. Summary Table of Damages and Losses (in US$ million) on the example of Indonesia after the Dec 2004 earthquake and tsunami (Source: [3])

	Total Impact			Property	
	Damage	Losses	Total	Private	Public
Social Sectors	**1674.9**	**65.8**	**1740.7**	**1440.6**	**300.1**
Housing	1398.3	38.8	1437.1	1408.4	28.7
Education	110.8	17.6	128.4	9	119.4
Health	82.5	9.4	91.9	23.2	68.6
Culture and religion	83.4		83.4		83.4
Infrastructure	**636**	**240.8**	**876.8**	**325.9**	**550.8**
Transport	390.5	145.4	535.9	165.8	370.1
Communications	18.9	2.9	21.8	8.6	13.2
Energy	67.8	0.1	67.9	1.1	66.9
Water and Sanitation	26.6	3.2	29.8	18.3	11.4
Flood control, irrigation and sea protection works	132.1	89.1	221.2	132.1	89.1
Productive Sectors	**351.9**	**830.2**	**1182.1**	**1132**	**50.1**
Agriculture and Livestock	83.9	140.9	224.8	194.7	29.9
Fisheries	101.5	409.4	510.9	508.5	2.5
Enterprises	166.6	280	446.6	428.9	17.7
Cross sectoral	**257.6**	**394.4**	**652**	**562.9**	**89.1**
Environment	154.5		154.5	548.9	
Governance and administration	89.1		89.1		89.1
Bank and Finance	14		14	14	
Total Impact	**2920.4**	**1531.2**	**4451.6**	**3461.4**	**990.1**

35 Further, it advisable to collect data about flood losses also with a view to allow to distinguish between the affection of men, women, children and the elderly, as this yields clues about specific needs to those particular groups in the recovery process.

36 Even though in the first weeks after a large flood event it may be a challenge to establish such kind of information, it is of essence to try, because this information is required for taking decisions on making available required recovery assets, in form of small grant schemes or otherwise. This concept is in literature referred to as "vulnerability assessment" and it is advisable to generate this kind of information for flood prone areas before the next flood occurs. Local institutions, such as volunteer fire brigades, faith-based organizations, citizen associations or community flood management committees can play an essential role in this process.[5]

37 Sources of information could include:

- Strategic sources such as dedicated government institutions, research centres and experts
- Pre- and Post Flood Maps
- Reconnaissance missions by land, air or water
- Surveys
- Secondary data analysis
- Interpersonal communications
- Remote sensing data

[5] In South-Asia models for such Community Flood Management Committees have been successfully created and tested. Further guidance is available from http://www.apfm.info/regional_projects/sastac.htm

4.3 IN-DEPTH ASSESSMENT 3 TO 6 MONTHS AFTER THE FLOOD

38 An in-depth assessment of the full economic impact of a flood event can only be reliably conducted some 3-6 months after the event. Perhaps the best time conduct an in-depth assessment of flood losses is after 6 months, as most losses, including indirect and intangible losses can be assessed with sufficient reliability. At this stage a flood loss assessment needs to guide reconstruction planning as well as future flood management policy adjustments. At this stage the process may receive a number of data collected in the earlier phases as indicated in **Figure 2**. Those data could otherwise be lost but usability of those data largely depends on the planning and delimitations that have been undertaken for the earlier appliances of loss assessments as discussed in chapters 4.1 and 4.2.

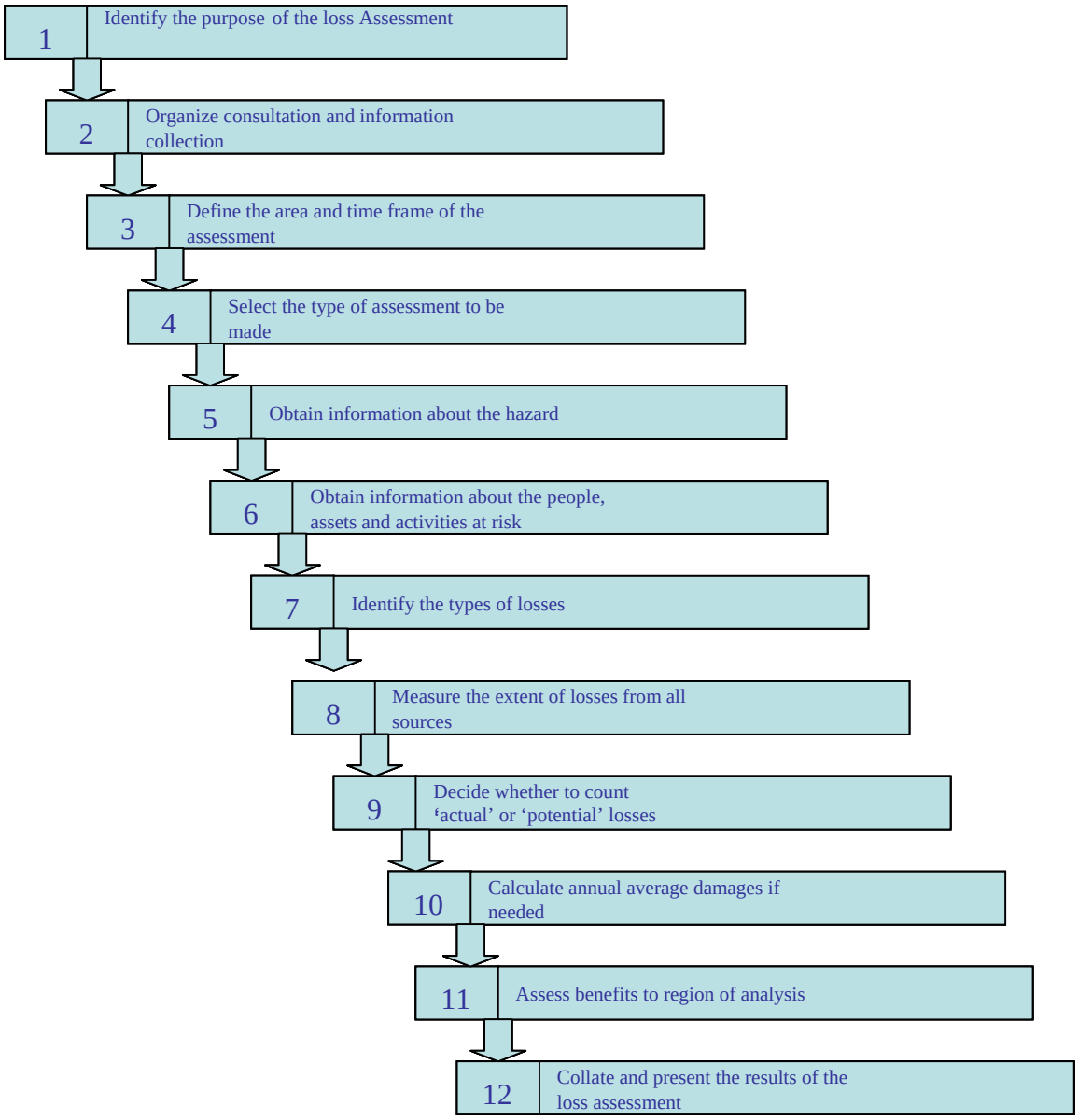

Figure 10. The Loss Assessment Process (Source: [4])

39 For professionals charged with conducting a flood loss assessment, the question on what steps or process to follow in order to deliver the desired result is crucial. **Figure 10** provides a general process overview in 12 steps developed by the 'Emergency Management Australia', which allows a structured way of working as well as monitoring progress, and delivering a transparent and verifiable result.

40 A detailed description of each step is provided in Annex 1. Each assessment case is specific and the required balance between having an accurate assessment result and having a quick assessment result needs to be found.

41 At this stage one can usually base an assessment on reconstruction costs, according to a (preliminary) reconstruction plan that may provide for reconstruction in different locations according to different specifications.

42 Flood loss data represent not only an asset for emergency response, rehabilitation and reconstruction efforts, they are equally important for flood risk assessment and development planning. Even though the details of flood risk assessment cannot be covered in this Tool, one important concept to remember for this type of application is the one of "average annual flood losses". When assessing the losses induced by an individual flood event, this will not give indications about the justified levels of investment into flood mitigation options. This justification should come from the benefits that a particular mitigation option provides over its lifetime. To calculate this, one needs to convert flood loss data into "average annual losses". Those can be calculated by combining the statistic likelihood of occurrence of flood events of different magnitudes in any given year, with the potential losses for each of them. The below example illustrates this concept with the black line for flood events with statistic probability of exceedance of 10%, 1% and 0.01%. The grey line represents this relationship after a levee has been introduced that provides protection against floods smaller than the one that statistically has a probability of 1% of being exceeded in any given year.[6]

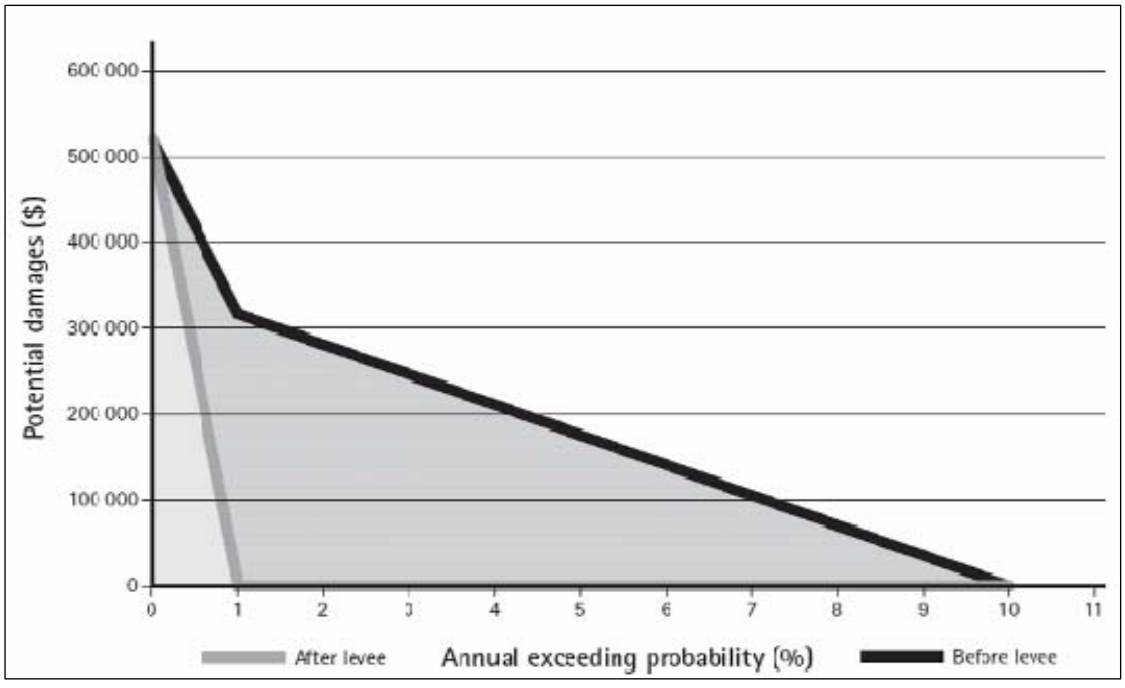

Figure 11. Potential flood damages vs annual exceedance probability (Source: [1])

[6] This has in the past been referred to as the "100-year flood", however, this terminology is misleading as flood events occur randomly.

43 The average annual flood losses prevented by introducing the levee are represented by the dark grey area under the black line. For detailed explanation and calculation examples, see: [1] and [4]. One obvious shortcoming with this way of calculation is that it does not take account of human behaviour, i.e. if a levee is built, an effect called “levee effect” usually leads to a increase of investment in the protected flood plain, and therefore to an increase of potential losses. Especially, for agricultural areas and where food security is still to be achieved, to attract such kind of investments is the main thrust of providing flood protection up to a certain standard.

44 What in most cases is, however, not desirable is to encourage residential or industrial property to be newly located in high risk areas. Floodplain zoning and regulation are the essential tools to prevent unwanted developments on the floodplain, and hypothetical flood loss assessments are one foundation of setting adequate standards of protection and delineating specific zones and uses on the floodplain.

5. CONCLUSIONS AND RECOMMENDATIONS

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- Collection of data and derivation of depth damage curves for specific areas *before the flood* is of prime importance: Governments are well advised to build required capacities within their own ranks for flood damage assessment and communication well in advance of a flood, to minimize confusion and provide the relief coordination with workable estimates. In fact such efforts should be aligned with the efforts for flood risk assessment that are undertaken to inform policy makers and planners with required decision support.
- Close *involvement of local stakeholders*, including volunteer organizations, the private sector, farmers, residents, and other local institutions provides the basis for flood loss assessments, and the assessment process needs to facilitate in its design the inputs of those stakeholders.
- The assessment *purpose defines the outcome* of the assessment, i.e. there is no agreed formula for assessment in all contexts.
- It is not only required to look into the overall economic flood losses, but also at *who* has to bear them, what kind of mechanisms for burden sharing are in place and what does it mean to the development perspective of the particular group.
- It is important to stress that economic flood loss assessments, in particular the in-depth assessment prepared with enough lead time, should be undertaken according to agreed, transparent procedures, clearly indicating the levels of confidence of the assessment results, to allow decision makers to make informed decisions, and to ensure long-term comparability of datasets.
- It is necessary for long-term policy formation in the public domain (concerning both, flood management policy and development policies) to base decision not only on the assessed flood losses but to embed those losses into an assessment of the net-benefits derived or derivable from flood plains.
- Countries should strive to provide relevant institutional support and framework conditions for orderly flood loss assessments. This includes that on the most appropriate institutional scales there are designate institutions, obligated by law to assess flood losses, and equipped with adequate human and financial resources.

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Further reading

Related Tools from GWP ToolBox

- *Tool C1.1 "Water resources knowledge base", available at http://www.gwptoolbox.org*
- *Tool C2.5 "Risk assessment and management", available at http://www.gwptoolbox.org*

Other resources

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ANNEX I

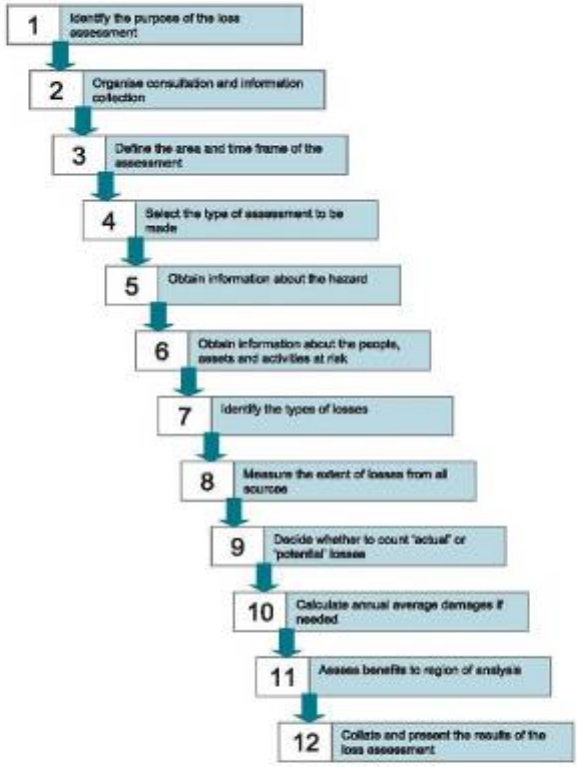
The Loss Assessment Process according to the
Disaster Loss Assessment Guidelines
Emergency Management Australia
Australian Emergency Manuals Series
Part III, Volume 3, Guide 11

3. DISASTER LOSS ASSESSMENT PROCESS

Overview of sequence of actions to follow in the loss assessment process

Every loss assessment should be approached in a logical structured way, getting information directly and by consultation, and setting it out clearly as the study progresses. The process is set out in Figure 2, which will be the key to all the steps in both the Guidelines and the Case Study.

Figure 2: The loss assessment process



The step-by-step assessment process shown in Figure 2 is for use with inundation hazards. Much of the supporting material is generic and can be applied to all hazards. So with minor modifications, the assessment process set out in these Guidelines could be applied to other hazards. The modifications you might have to make are set out in Table 20, which identifies differences in economic analysis for different hazards.

The steps outlined in Figure 2 are in a logical sequence, but this does not have to be followed slavishly. The starting point should always be to identify the purpose of the assessment, but beyond that, progress will often be iterative—especially going back to steps between 1 and 6 as more information emerges to modify what has already been covered.

For example, the extent of resources available may not become apparent until some preliminary scoping work has been done. It may be necessary to collate material on the hazard and other components of the risk, and to make a preliminary assessment of the types of damage, before being able to argue for significant resources for the full assessment task. Some key decisions may be made before or as the assessment commences, such as the approach to be used and whether actual to potential loss ratios are to be considered.

Precis of the loss assessment process—a process guide

Estimates of disaster loss may serve many purposes, and these are set out in the Guidelines. Although they consider losses from inundation, the principles in this Process Guide can be applied to assessments of loss from other hazards. There has to be a standard approach to loss assessment, primarily to:

- ensure that works done to provide mitigation or warning systems etc. produce a sound return on the investment;
- have a common measuring tool for assessing alternative mitigation proposals; and
- assist with post-disaster recovery planning and management-knowing the extent and type of losses to be expected in existing areas is a great help in recovery management by enabling better targeting of resources to identified key areas.

Loss assessments have to be:

- transparent-so the assessment procedures can be followed easily;
- consistent and standardised-to enable meaningful comparisons;
- replicable-to enable the assessments to be checked; and
- based on economic principles-so assessed losses represent properly the real losses to the economy.

There are two categories of loss to be assessed:

Direct losses: Those losses resulting from direct contact with the hazard, for example, flood and wind damage to buildings and infrastructure

Indirect losses: Losses resulting from the event but not from its direct impact, for example, transport disruption, business losses that can't be made up

In both loss categories, there are two clear sub-categories of loss:

Tangible losses: Loss of things that have a monetary (replacement) value, for example, buildings, livestock, infrastructure etc.

Intangible losses: Loss of things that cannot be bought and sold, for example, lives and injuries, heritage items, memorabilia etc.

There has to be a clearly defined area and time-period set for any loss assessment. Structured mechanisms have to be set up for consultation, assembly and processing of data on the hazard and on assets and activity affected by the hazard, so there is a logical progression of work.

Figure 2 listed the 12 steps in making any loss assessment. This Precis sets out each step with a brief introduction, (drawn from more extensive description that follows) and then provides a basic checklist to follow in completing each step. User judgment will prevail in deciding whether every step will apply to, or be needed, in every loss assessment.

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Step 1: Identify the loss event and purpose of the assessment

Define what the assessment is intended to be used for, what problem(s) its results might be used to address, and what level of accuracy it hopes to achieve. Detailed description of the event, its timing and location come later. At this stage there has to be a definition of the event, in sufficient detail to define the area and time boundaries.

So step 1 in the loss assessment should address these issues in whatever detail and form is considered both sufficient and appropriate:

STEP 1 CHECKLIST:

- ➢ Define the primary purpose of the loss assessment.
- ➢ Define what was (or could be) the event generating the loss.
- ➢ Include any other background information that might put the assessment into context.

Step 2: Organise the consultation and information-gathering processes

No loss assessment can be successful unless a clear process has been set up beforehand to define and manage it. There has to be a centre for operations and collecting/processing data; a set work plan with milestones for consultation, assessment, feedback and final reporting; and a timeframe within which all this has to happen. Budget limitations may need to be set and observed.

A loss assessment involves input from a lot of people and organisations, and from assembled bodies of knowledge. This generally needs a committee or board, made up of stakeholders, to advise on the project. The consultation process not only means talking to people, but also covers setting up and running surveys, collecting and manipulating database information, and generally getting access to information in any form that would add value to the overall loss assessment. So consultation and information gathering has three aims:

- Public relations—letting people know who's doing what, when, where and why.
- Sharing information—getting to know the scope of loss and defining losses into the categories mentioned in the introduction to this Process Guide.
- Consultation—not just for this loss assessment, but also where policy or the law requires it to be done.

When setting up the consultation processes and defining what is being sought by such consultation, develop a table similar to Table 3:

Table 3: Defining the consultation processes

Type of information	Source	Method and responsibility
Hazard type		
Direct loss information		
Tangible loss information		
Indirect loss information		
Intangible loss information		

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So these are the steps to follow generally in organising the consultation and information-gathering processes:

STEP 2 CHECKLIST:

- Set up a process to manage and conduct the detail of the assessment, and define its goals.
- Draw up a detailed management process to track inputs and activities, their timing, progress, actual versus budgeted cost, progress reporting, review mechanisms and form of delivery of the assessment.
- Define the processes that will be used to consult and gather different types of information, bearing in mind the purpose of the assessment.
- Prepare a table to define what information is to be collected, where from, by what means and by which person or agency.

Step 3: Define the area and timeframe of the assessment

In any loss assessment there has to be a clear boundary within which the impact of the event on the economy of that area can be defined and evaluated. There may be some information needed beyond that area, and the originally defined study zone may enlarge or contract as adjusting information comes in. It is important to define the area being assessed, especially when estimating indirect losses and benefits in the form of insurance payouts and aid.

When defining the area of the assessment, make sure it represents the local economy affected by the actual or hypothetical disaster—not just a nominal space such as shire boundary, or a convenient topographic line such as a range or a watercourse. The nominated area can be sub-divided for detailed study of some specific loss components, and needs to be able to have flows of goods and services in and out defined clearly. Keep the study area in harmony with the budget for the assessment, and/or the extent of resources available to conduct it.

There also has to be a timeframe set to define how long after the disaster event the assessment will be considering losses associated with it. Clearly, any assessment needs start and finish dates, especially if the event being assessed is one of a sequence in (say) a cyclone season. Use an extended timeframe of at least 3–6 months to assess indirect and intangible losses—unless indirect and intangible losses are judged to be unimportant in the event in question. Ideally, the loss assessment should be conducted six months after the event. If the assessment has to be done much sooner after the event, there may have to be estimates made of the likely indirect losses.

So these are the steps to follow in defining both the study area and the timeframe for the assessment:

STEP 3 CHECKLIST:

- Define the study area in a way that includes the area impacted directly as well as its surrounding local economy.
- Define the core period date from the event's first effects to the end of the assessment period, during which losses from that event will be considered.
- Set the timeframe for the assessment itself to begin and end, allowing time for losses to be counted from any extension of the core study dates.

Step 4: Decide the type of assessment to be made and level of detail

There are three commonly used approaches in assessing losses after a disaster event, or in a simulated event for evaluating the effectiveness of mitigation measures. They are:

- An averaging approach, based largely upon pre-existing data for losses from similar previous events.
- A synthetic approach, based upon predictions of losses technically derived-rather than historical-data and options.
- A survey or historical approach, where surveys after the event being assessed are used to establish actual losses.

Some combination of approaches would normally be used as, for example, surveys are the usual method for assessing losses to large businesses, most infrastructure and intangibles. In selecting appropriate assessment methods, take account of the advantages and disadvantages of each method (set out in step 4). Note any limitations that may have to be considered in meeting the various selection criteria. See Table 4.

Decision criteria	Averaging method	Synthetic method	Direct survey method
Event within last 5 years	✔	✔	✔✔
Need for consistency etc.	✔✔	✔✔	✔

STEP 4 CHECKLIST:

- ➢ Examine the selection criteria in Table 4 and establish which are relevant and how relevant they are.
- ➢ Select the appropriate approaches against the relevant criteria.
- ➢ List and weight the criteria that were considered in deciding on the form of assessment to be followed as illustrated in the table above.
- ➢ Nominate the assessment approaches selected and comment on any limits to the depth of detail or any constraints on using this approach.
- ➢ Remember that more than one approach would normally be used.

Step 5: Describe the extent/timing of the hazard event so affected assets can be defined

Detailed definition of the hazard event is a critical part of any loss assessment. A 'hazard' refers to the natural event, such as flood water, hailstorm or earthquake. It does not include human assets or activities. When combined with information on people, assets and activities, hazard information provides the basic data for loss assessment. Hazard event size and **occurrence probability** is essential for calculating average annual damages (AAD), which in turn are needed for cost-benefit analysis of alternative mitigation options.

The aim of this part of a loss assessment is not to go into precise definition of the extent and characteristics of the hazard event for its own sake, but to focus on key aspects of the hazard in sufficient detail for the purposes of the assessment.

The starting point is generally a map, in whatever format best describes:

- the extent of the affected or assessed area, and
- the route of a moving hazard such as a cyclone.

A map or maps would of course be supported by a wide range of source data from:

- the time sequence or duration of the event,
- automated or manual field measurements during and after the event (such as flood depths and flow rates),
- logs of significant events such as flood heights at key locations, effectiveness of levees etc.,
- photographs, television or private videotape records, and eyewitness accounts, and
- reports on any other secondary disaster impact events (such as resulting contamination events or building/infrastructure failures).

So to address this part of the loss assessment, these are the typical steps to follow:

STEP 5 CHECKLIST:

- ➢ Obtain a map or other descriptions of the hazard for the affected area.
- ➢ Obtain other information on the hazard, as relevant to loss assessment.
- ➢ In the absence of a map, obtain field data or local estimates of relevant hazard characteristics.
- ➢ Record, index and store all documented information about the hazard event, its progress or lifecycle, identifying the source of each item.
- ➢ For a loss assessment this information is needed only in the context of hazard impacts on people, assets and activities.

Step 6: Obtain information about the people, assets and activities at risk

Closely associated with step 5 above is the need to make a record of people, things and activities that were or could be affected by the hazards event. If the loss assessment is being carried out for a hypothetical event, the same kind of information needs to be assembled, but from projections and simulations of the event.

Disaster loss assessment is a measure of damage and disruption to assets and the effect this has on people and businesses in the affected and other areas. Environmental losses may also be important. Unfortunately, loss assessment sometimes also has to measure the extent of death and injury resulting from the disaster event.

There are many details to record in compiling the record from which the loss assessment is made, and the Guidelines describe available data sources (see Tables 6 and 7) to assemble this record. There is no exhaustive list to work through-it just needs a full list to be prepared in consultation with informed parties after an actual loss event, or in preparing a simulated event for study. The outcome should be a database of everything likely to be affected by the actual or simulated event.

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The table in step 2 is a good place to start preparing a list of people, assets and activities at risk. Typical content would be:

STEP 6 CHECKLIST:

- Draw up a list of what has been (or could be) affected under three headings of 'people', 'assets' and 'activities', including environmental assets, within the area.
- Identify sources for all the actual or intended information.
- Identify how all the information is going to be collected, for example, surveys, census data, reports on the event etc.

Step 7: Identify the types of losses

In this step, the information derived in steps 5 and 6 is used to separate losses into categories, generally described as direct or indirect losses, and tangible/intangible. This helps define where the major loss components will be likely to arise and what measurement techniques will be needed. Measurement techniques will depend on the approach selected in step 4. The Guidelines identify many typical loss areas to be considered, especially in the intangible category. Intangibles are often ignored, yet are frequently identified as the most significant losses by the people affected.

The information can be sorted using a table with headings like this:

Usually bought and sold for money?	Direct loss (eg damage from contact with flood water)	Indirect loss (eg no contact with flood water, consequential damage)
Yes-tangible losses		
No-intangible losses*		

* Direct and indirect intangible losses are usually treated as one category.

The steps required in identifying types of loss would be:

STEP 7 CHECKLIST:

- Identify likely losses from the hazard event.
- Prepare a table categorising the losses as direct, indirect and intangible.
- Pay special attention to intangibles.

Step 8: Measure the losses from all sources

This is where the counting of losses starts. Elsewhere in these Guidelines there is detailed information on ways of addressing loss measurement in the 'survey', 'synthetic' and 'averaging' approaches to loss assessment, when looking at direct, indirect and intangible losses. There are tables in step 8 showing typical loss categories with suggested estimation principles for each one, along with the kinds of sources of data needed in each loss category for averaging or synthetic assessment methods.

Rather than grouping all losses by each category of loss (direct, indirect and intangible), it may be more practical to collate them by 'loss sectors', and determine indirect, direct and intangible losses for each sector at a time. For a typical flooding event, loss sectors like these could be used to separate the items into study areas:

- residential (including memorabilia and ill health),
- vehicles and boats,
- commercial (including tourism and hospitality),
- industrial,
- infrastructure,
- cultural heritage,
- environmental, and
- other.

So the steps to be followed in assessing loss by sector would be:

STEP 8 CHECKLIST:

- ➢ Identify and record what the main loss sectors are in the event being studied.
- ➢ Begin by assessing direct losses in the first sector, applying the method selected as most appropriate for use in this sector to derive losses.
- ➢ Continue with an assessment of indirect losses in the same sector, and include estimates from the Guidelines that represent the identified losses.
- ➢ Identify and document the intangible losses in that sector, and where possible quantify these using procedures set out in the Guidelines.
- ➢ Work through all the loss sectors, writing accompanying text to record specific actions and interpretations made from the 'survey', 'synthetic' or 'averaging' approach used to derive the dollar values and the equivalent for intangibles.
- ➢ The result should be a well documented and explained set of assessed losses for further review.

Step 9: Decide whether to count 'actual' or 'potential' losses in the assessment

When data is collected by 'synthetic' or 'averaging' approaches, this is generally part of work to estimate the losses that could occur in a hypothetical hazard event. This is a common approach, because it is rare to experience a real version of something that can normally only be done 'on paper'—like considering the likely outcome of a major storm surge. So you will get 'potential' losses as the outcome of such a study.

In contrast, loss assessments carried out after a real disaster, normally record all of the losses as 'actual' ones. 'Actual' losses already take into account all kinds of measures that people take to minimise the damage wherever possible, such as heeding warnings, moving cattle and valuable items to high ground etc.

This part of the loss assessment considers whether, and by how much, predicted or 'potential' losses should be trimmed back because of known preventive or protective actions that might be taken in a real event. However, the use of 'actual' losses raises a number of issues:

- It is difficult to determine the correct ratio between actual and potential loss (see Table 17 for estimates).
- Actual losses may discriminate against well prepared communities if the loss assessment is used to decide the worth of mitigation options.
- Actual losses may discriminate against poorer communities as they will typically have fewer assets and less economic activity to be damaged by a hazard.

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- The difference between actual and potential losses will change a lot over time as people move and as other circumstances change.

So there are some hard issues to consider in making a loss assessment for a simulated disaster event where different community responses and lifestyles may prevail:

STEP 9 CHECKLIST:

➢ It is recommended that, wherever possible, potential losses should be used rather than actual losses.

Step 10: Calculate annual average damages if needed

Investment in disaster mitigation can be economically justified in terms of losses avoided in an average year, using an estimate of AAD. AAD is calculated by plotting loss estimates for a given hazard at a range of magnitudes, against the probability of occurrence of the hazard event.

So the steps to be followed in calculating annual average damages would be:

STEP 10 CHECKLIST:

➢ Make a table that lists a range of possible events for a given hazard, the annual occurrence probability of each event and a loss estimate for each event.

➢ Using a minimum of three distinctly different events, plot the loss estimates against their event occurrence probability.

➢ The shaded area under the curve is equal to AAD (see Figure 7) and can be obtained mathematically by integration.

Step 11: Assess benefits to the region of analysis

Economic assessment measures the net loss to the economy of the area of analysis. To obtain net loss, any benefits to the economy resulting from the disaster need to be subtracted from the assessed losses. Assessment of benefits is particularly important within a regional context because post-disaster aid and insurance payouts are more likely to partly offset the tangible losses suffered, as the area of analysis becomes smaller. This step is only relevant for economic loss assessment.

So the steps to be followed in assessing benefits to the region of analysis would be:

STEP 11 CHECKLIST:

➢ For a post-disaster assessment, identify the major flow of funds into the region: Commonwealth funds (for example Natural Disaster Relief Arrangements), State or Territory disaster relief payments, and insurance estimates from the Insurance Council of Australia).

➢ For a hypothetical assessment, estimate the likely amount of NDRA funds using the results of a completed assessment. Include insurance estimates from the Insurance Council of Australia, if available, or make estimates through experience with similar events

Step 12: Collate and present the results of the loss assessment

Present the results of the loss assessment in a simple format, such as in Table 18. The table should include all of the assessed losses for each of the loss categories (direct, indirect and intangible) and a total of the benefits to the region of analysis. The benefits are deducted from the losses to give an estimation of the economic cost of the event (or net economic loss). A statement on the importance of intangibles should also be included to ensure they are not overlooked in mitigation proposals.

So the steps to be followed in collating and presenting results of the loss assessment would be:

STEP 12 CHECKLIST:

- Prepare a table that shows the net of the losses and benefits to the region of analysis and calculate net economic loss.
- Include a statement on the importance of the intangible losses.

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ANNEX II

Template for presentation of Flood Losses by Sector

Table 1: Preliminary Estimate Of Disaster-Related Costs (US$ Millions)				
	Costs			
	Direc	Indirect	Relief	Reconstruction
Food aid				
Health				
Education				
Housing and private property				
Government property				
Sub-total: Social Sectors				
Water and sanitation				
Energy and telecommunication				
Roads				
Railways				
Sub-total: Infrastructure				

Agriculture				
Livestock				
Fisheries				
Industry				
Trade				
Tourism				
Sub-total: Productive Sectors				
Sub-total: Environment				
Sub-total: Disaster Prevention				
Grand Total				