

# A Toolkit for Integrated Wetland Assessment

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The World Conservation Union



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This document was produced under the project “Strengthening Pro-Poor Wetland Conservation Using Integrated Biodiversity and Livelihood Assessment”, carried out with financial support from the Darwin Initiative of the UK Department for Environment, Food and Rural Affairs (DEFRA). The views expressed in this publication do not necessarily reflect those of IUCN or DEFRA.

Published by: Freshwater Biodiversity Assessment Programme



Copyright: © 2007 International Union for Conservation of Nature and Natural Resources

ISBN: xxx

Citation: Darwall, W., Emerton, L., Allison, E., McIvor, A. and C. Bambaradeniya (2007) A Toolkit for Integrated Wetland Assessment. Freshwater Biodiversity Assessment Programme, World Conservation Union (IUCN), Cambridge.

Cover Photo: Fishermen in the Mekong River, Stung Treng, Cambodia. © Will Darwall 2006

Design: Niroshan Mirando

Produced by: The World Conservation Union (IUCN), Ecosystems and Livelihoods Group Asia, Colombo

Available from: Freshwater Biodiversity Assessment Programme  
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## Summary

### The reasons for this toolkit:

Wetlands contain biodiversity of exceptional conservation significance, comprising many unique ecosystems and a wide array of globally-threatened species. At the same time they typically form an essential component of local, national and even regional economies, as well as underpinning the livelihoods of adjacent human communities. Wetland goods and services are often particularly important for poorer and more vulnerable groups, who lack alternative sources of income and subsistence and have weak access to basic services. Yet, despite their importance, wetlands are under increasing pressure. According to the Millennium Ecosystem Assessment (2005), the biodiversity of inland waters appears to be in a worse condition than that of any other system; it is speculated that 50% of inland water area (excluding large lakes) has been lost globally. Wetland degradation and loss poses a severe threat to both development and conservation goals, and impacts disproportionately on some of the world's poorest communities.

Weak consideration of wetlands in decision-making remains one of the major factors underpinning their degradation. When decisions are made to invest funds, or to manage land and resources, they rarely take note of the biological, ecological, development or economic value of wetlands. There is seen to be little cost to wetland loss, and few benefits to wetland conservation. While development planners remain largely unaware of the potential impacts of wetland degradation on economic, livelihood and poverty indicators, wetland-managing authorities have traditionally made few efforts to demonstrate or act on these links, or to factor poverty and livelihood concerns into on-the-ground conservation activities.

In turn, methodological and information gaps underpin the omission of wetland values from investment, land and resource use decisions. While techniques exist, and have long been used, to assess wetland biological, economic and livelihood values and trends separately, there is a lack of available methods to assess the interlinkages and connectivity between wetland health and economic/livelihood status, or to express this information in a form and with a focus that can inform and influence real-world conservation and development planning.

### What this toolkit is for:

This toolkit aims to assist in overcoming current methodological and information gaps in wetland planning, and in factoring wetland values into conservation and development decision-making. It provides a set of integrated assessment methods that combine and investigate the links between biodiversity, economics and livelihoods, with a particular focus on strengthening pro-poor approaches to wetland management.

### Who this toolkit is for:

The toolkit is targeted at providing a set of practical and policy-relevant methods for information collection which can be used by those involved in wetland conservation and development planning. It is expected to be of use to wetland site managers, conservation and development planners, and researchers from both natural and social science disciplines.

### The contents of the toolkit:

- A **conceptual and methodological framework** for addressing wetland management issues, especially conservation and development trade-offs, through integrating biodiversity, economic valuation and livelihood assessment (Chapter A).
- **Case studies** of the application of integrated wetland assessment in a management context in Stung Treng Ramsar Site, Cambodia and Mtonza-Msona Village, Tanzania (Chapter C and examples throughout the document).
- **General information and methods sheets** for planning and carrying out an integrated wetland assessment (Chapter G).
- Tools, methods and techniques for **biodiversity assessment** (Chapter B), **economic valuation** (Chapter E), and **livelihoods analysis** (Chapter L) of wetlands.
- Tools, methods and techniques for presenting integrated wetland assessment data through **mapping** (Chapter M).
- **Bibliographies** of key references (throughout the document).



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# Introduction

## A1. Overview of the toolkit

This toolkit presents integrated biodiversity, economic and livelihood assessment methodologies to strengthen pro-poor approaches to wetland conservation. Two case studies are documented to demonstrate how the toolkit can be applied in practice: Stung Treng Ramsar Site on the Lower Mekong in Cambodia, and Mtanza-Msona village on the Rufiji floodplain in Tanzania. As well as outlining the steps in designing, preparing for and carrying out an integrated assessment, the toolkit describes methods for analysing and presenting the information collected, using GIS maps and electronic databases to identify overlaps between threatened species and high human dependence, and to develop site-level action plans for pro-poor wetland conservation and sustainable use.

The toolkit is founded on the premise that an integrated approach to assessment is necessary in order to generate information that is practically useful, and policy relevant, for wetland planning and management. As both wetland values and threats encompass biological, ecological, economic and livelihood aspects, and wetland management responses must simultaneously address and react to each of these factors, a thorough understanding of all — and of the interlinkages and interconnectivity between them — is required.

The main components of integrated wetland assessment are seen as species and habitat-based biodiversity assessment, economic valuation, and livelihoods analysis. Maps and databases provide a useful tool to represent, analyse and share the information that integrated assessments yield, as it can inform both local and global conservation planning and action, and point to management and policy recommendations which support biodiversity conservation, sustain local livelihoods, and reduce poverty.

The toolkit describes a framework for assessment which consists of the following stages:

- **Defining management objectives:** recognising and balancing both conservation and development goals, and promoting a pro-poor approach to wetland management, is a process that requires broad consultation and awareness of a wide range of issues. Developing a shared vision and rooting the assessment in real-world management goals and objectives are both essential to give purpose to the assessment process, and to identify relevant management and policy-related questions for the assessment to tackle.
- **Assessment:** documenting the state of wetland biodiversity, identifying development and conservation pressures and threats, and understanding past, current and future management and policy responses requires the co-ordination of data collection, survey and review, across all relevant disciplines and methods.
- **Analysis and presentation:** analysing the data generated to address needs for management and policy information, to emphasise the interlinkages and connectivity between biodiversity, economic and livelihood factors, and to ensure that information is presented in a practical and policy-relevant form which is both appropriate and useful for planners and decision-makers in conservation and development sectors.

The guiding principles supporting this toolkit are therefore that wetland assessments should:

- Be **integrated** across disciplines and themes;
- Be geared to address a particular **management** issue or question;
- Generate information that can be used to support and improve the **planning** of on-the-ground wetland management, and provide information to make better **decisions** about how to use and allocate investment funds, land and resources in and around wetlands;
- Work to **strengthen** existing wetland management process;
- Serve to **sustain** wetland values, with a particular focus on ensuring the continued generation and equitable access to wetland goods and services, particularly for poorer and more vulnerable human groups.

## A2. The need for an integrated approach: supporting more inclusive and informed wetland decision-making

### *Contextualising wetland assessment*

Assessment is the process of determining and describing the status, characteristics or worth of a particular wetland. It involves measuring particular variables which are considered important in conservation and/or development terms, and can be taken as indicators of the health of the wetland itself, its attributes, functions and workings, of the goods and services that it generates, and the human and natural processes it supports.

Wetland assessment does not take place in isolation. It is prompted by a particular management or policy issue that needs to be addressed, or a particular decision that needs to be made about the use of funds, land or other resources. The information that is generated by the assessment therefore aims to assist in understanding or dealing with this issue, or in making this decision. However academically interesting it is to know the status, characteristics or worth of a particular site, wetland assessment is not an end in itself. It is a means to an end — better and more informed conservation and development decision-making. It is the management or policy issue which determines the scope, objective and parameters of wetland assessment.

This toolkit is founded on the guiding principle that if assessment is to be useful to real-world wetland management planning and decision-making, it must adopt an integrated approach: one which brings together biodiversity, economics and livelihood elements. As explained in the paragraphs below, this involves documenting, through assessment, biological, ecological and socio-economic aspects of wetlands, and their status, trends and threats. To be effective, equitable and sustainable in practice, wetland management responses must be informed by an understanding of all of these elements, including their interlinkages, mutual causality and interconnectivity.

### *Understanding and managing wetland landscapes*

Wetlands are part of broader landscapes which are connected in hydrological and ecological terms. They also exist within a human context, and socio-economic processes and forces both on and off-site influence their status, use and management. At the same time there are linkages between wetland goods and services, the ecological and biological processes which support them, and socio-economic processes both on and off-site.

These interlinkages and interconnectivity mean that the relationships and drivers that affect wetland status are extremely complex, concern both biophysical and socio-economic elements, and involve a series of interactions between them. Without simultaneously dealing with all of these elements it is neither possible to understand the conditions and status of a wetland within the broader physical and human landscape, nor to assess the likely outcomes and implications of different policy and management scenarios.

Such integration reflects an ecosystem approach to wetland management. The ecosystem approach, as established and defined in the Convention on Biological Diversity, recognises the need for a holistic approach to wetland assessment and management. The ecosystem approach is “a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way”. It supports participatory planning guided by adaptive management to respond to the dynamic nature of ecosystems, in doing so involving all stakeholders and balancing local interests with the wider public interest. It advocates the decentralization of management to the lowest appropriate level, to achieve greater efficiency, effectiveness and equity.

### *Addressing conservation and development trade-offs*

There are many competing demands on the land and natural resources that comprise and surround wetlands. Although there is in most cases some level of trade-off between managing wetlands for conservation and for human development needs, there is also a need to understand the nature and magnitude of this competition, and to be able to balance the competing demands to generate maximum benefits for both conservation and development.

It is widely accepted that successful wetland management requires that conservation interests and development pressures be reconciled. There are many ways of attempting this reconciliation. Sometimes, trade-offs have to be made between conservation goals and development objectives that are incompatible. In other cases, conservation and development are mutually reinforcing (Box 1). Whatever the relationship between conservation and development in an individual case, the resolution of management actions and policy debates requires information about both, and an understanding of the linkages between them.

#### **Box 1: Examples of conservation and development goals that are incompatible and compatible**

##### **Incompatible**

- Strict protected area management and maintenance of natural-resource-based livelihoods in the same area (requires displacement of human populations).
- Encouraging improved access to common-property resources and conserving rare species found in those areas
- Regulation of rivers to supply power and water for irrigation may conflict with conservation of wetland biodiversity and wetland-based livelihoods

**Compatible**

- Maintaining river flows and flooding regimes conserves both biodiversity and wetland-based livelihood activities
- Ecotourism can generate additional income to local livelihoods and encourage local people to conserve the species and habitats which the tourists come to see. The aquarium trade and sport fishing may have similar effects.
- Development projects and programmes are focused on either promoting economic growth or reducing poverty and related conditions such as social exclusion and vulnerability. Local-level development assessments focus on improving peoples' assets' and capabilities and enhancing their livelihood options and strategies. There is also a strong focus on understanding the social, cultural, legal and political structures and processes that constrain peoples' opportunities to improve their lives. Livelihoods analysis is often used to inform and guide development programmes (e.g. Livelihoods Connect, 2005).

*Strengthening pro-poor approaches*

A pro-poor focus recognises that poor people not only lack the basic necessities of life, they also lack power and control over their lives. It thus aims to take specific consideration of these needs, and to ensure that any activity carried out in wetlands should not negatively impact on the status of the poor – and wherever possible should attempt to improve it. In order to incorporate an understanding of the specific needs and status of the poor, and their links to wetland ecology and biology within broader livelihood and economic processes, information is needed about all of these factors and forces. An integrated approach to wetland assessment allows and supports pro-poor concerns to be integrated into on-the-ground management and planning, and ensures that the needs of poorer and more vulnerable groups are adequately represented and reflected.

**A3. Integrating when, how and by whom the assessment is carried out***The elements of wetland assessment*

The different elements of wetland assessment have, traditionally, been seen as being distinct from each other — in jargon and approach, but also in their management focus and application. Conservation planning is typically informed by data on biodiversity (for example on species distributions and abundance, habitat distribution and quality), and by information on threats to that biodiversity. In wetlands, these might include over-harvesting, conversion of floodplain and forest land for cultivation, or modification of rivers and floodplains through damming and drainage schemes.

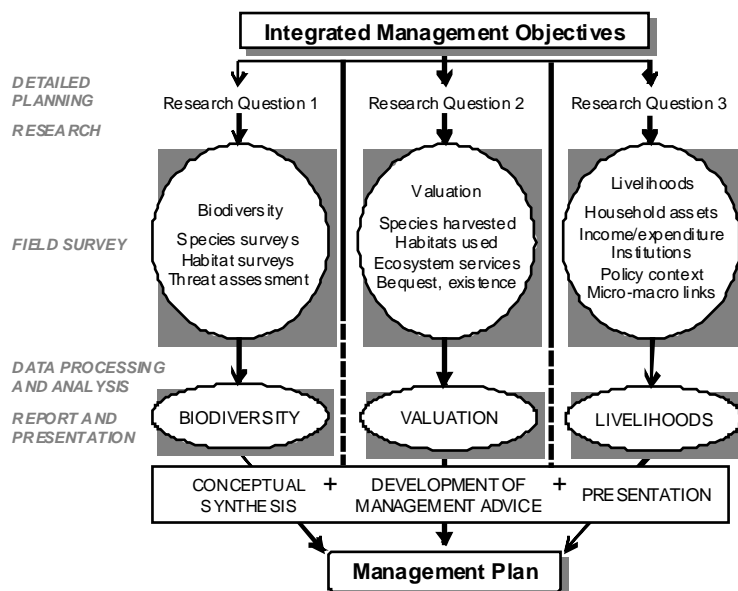
In contrast, the overriding application and focus of economic valuation work has been in relation to assessing the costs and benefits of investment and development projects and programmes. Recently, economic valuation has however been added to the conservation toolkit. Although a large variety of methods are used and goals of valuation vary, in general, valuation studies aim to derive an assessment of the value per wetland site, per unit wetland area, or per species or biotic resource. They are often used to highlight 'hidden' values – the contributions that biodiversity makes to livelihoods and the economy that are not accounted for in conventional economic analyses focussing on market-traded commodities and services. For example, crops and timber are typically included in studies of rural production and consumption, while non-timber forest products and locally used but non-traded resources are not included and ecosystem services provided by forests and floodplains (e.g. local climate regulation, prevention of soil erosion, flood regulation etc) are not valued either.

**Livelihood analysis ...***Disintegrated approaches to wetland assessment*

Although biodiversity assessment, economic valuation and livelihood analysis techniques are each relatively well-developed, and have been extensively applied to wetlands, there have to date been few attempts to integrate them within the context of real-world management and policy issues. There remain very few, if any, examples of assessments which bring together biodiversity, economic and livelihood elements under one framework. At best, a series of assessments are carried out separately and brought together only after data have been collected and final analysis made. More commonly, a single aspect of wetland use or management is investigated in detail, and broad (and often uninformed) assumptions about other elements are made.

While there is widespread recognition that wetland planning and management should take account of both conservation and development objectives, often the approach to informing these activities is not integrated at all. A series of research questions are formulated, investigated and reported on separately by each discipline. It is only when the assessment, analysis and reporting has taken place that some effort is made to draw out combined conclusions and recommendations for management purpose. Figure 1 describes the way programme design, assessment of conservation and development issues and presentation of information is typically carried out in a disintegrated manner.

**Figure 1: A disintegrated approach to wetland assessment**



Even though integrated conservation and development are often both incorporated into the overarching wetland management objective, and an assessment process is instigated in order to identify ways to achieve that goal, the different thematic elements of this assessment tend to remain separated. Individual specialists are commissioned to carry out studies on conservation and development issues, and the process may unfold as follows:

1. The specialists identify research questions pertinent to their particular expertise and terms of reference and then design assessment programmes to address these questions.
2. For logistical reasons, the assessment processes do not often take place in parallel. They may take place at different times, perhaps in different localities, and with limited discussion between groups.
3. Each group collects and analyses its own data and writes its own report, using its own specialist language and discipline-based standards and norms of good practice.
4. Management advice is framed and presented in different ways; some reports make essential use of spatial mapping of some components of the biodiversity, livelihoods and economic assessment. Other reports are largely text-based, while others use complex numerical analyses.
5. The management group then has the task of drawing on these reports to assess different management options. At this point, gaps and discontinuities become apparent. Missed opportunities are belatedly spotted. Arguments over objectives ensue. Value judgments are made as to which report to give credence to in the case of disparities.
6. It is discovered that no one has worked at the same spatial scale, and that the biodiversity survey team and livelihoods team disagree on the root causes of observed or perceived threats to diversity, and therefore on what management actions are needed to address them.
7. Management then either decides it 'needs more research' to resolve the problems before any management action can be recommended, or it makes decisions based on subjective evaluation of the validity of different claims made in each separate report or by each disciplinary group.

This lack of integration makes very inefficient use of resources for assessment and analysis of information, erodes trust between conservation and development advocates and puts the burden of conceptual integration and analysis on decision-makers. It also typically generates a series of confusing, unharmonised, and at the worst contradictory, sets of information and recommendations for decision-makers.

#### *Moving from thematic separation to integrated assessment*

There are various degrees of integration. Although ideally a wetland assessment would be thematically integrated from its very conceptualisation and design right through to the presentation of results to decision-makers, in many cases this is not possible. The assessment is taking place in a situation or context where prior work has been carried out, a programme or project is already underway, or a particular emphasis has already been placed on particular elements of wetland management and information needs. Below we look at three levels of thematic integration in wetland assessment: integrating wetland assessments which are already underway as separate studies, integrating the work of separate field survey teams within a single assessment, and carrying out an integrated assessment with an integrated survey team.

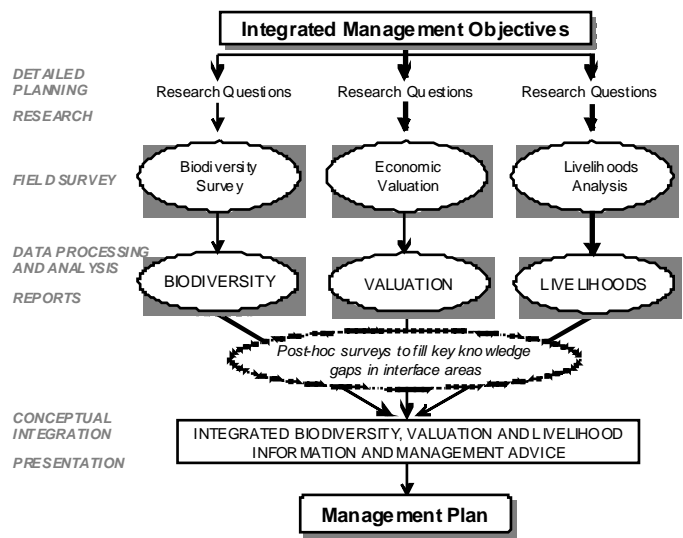
Integration can take place by working with existing project teams to harmonise and synthesise the different components of their workplan (Figure 3). Here, even though separate studies of biodiversity, economic valuation and livelihoods, with separate objectives and methodological approaches, may have already been conducted, greater attention is placed on integrating the findings from these surveys prior to presenting them to management stakeholders. It may also be possible at this analytical stage to identify key gaps in knowledge, which may be found at areas of interface between disciplines, and develop targeted actions to fill these gaps. Although this leaves conceptual and analytical integration rather late in the programme planning cycle, at least it means that decision-makers and other interested parties are able to discuss results that have emerged from a process of consultation and cross-disciplinary testing.

Integration of biodiversity, economic and livelihoods assessment ideally takes place right from the start of integrated programmes – by asking questions that are not restricted to conservation concerns, or development concerns, but relate to both. In cases where programmes are yet to begin, a fully integrated assessment can be designed as an integral part of the programme cycle (Figure 2). This may also be suitable as a method where a project or programme has completed an initial phase and is about to begin another. While this model has the advantage that disciplinary teams understand each others' aims and develop a joint strategy for assessment, there is the disadvantage of a lack of field-level co-ordination and exchange of expertise. This misses opportunities for insight (for example in joint focus groups conducted with biodiversity and livelihoods experts) as well as the chance to build trust and understanding among survey personnel from different disciplines and viewpoints. This model also misses the opportunity for time-saving and reduction of interviewer fatigue through collecting all the relevant information during a single visit to a site or community.

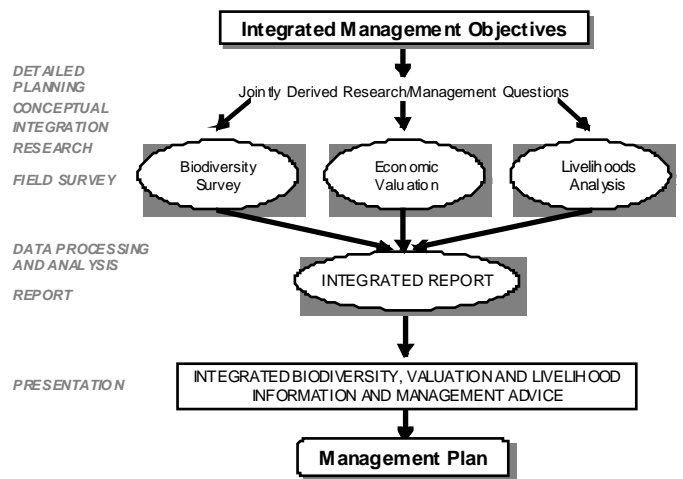
The fully integrated model (Figure 4) has the advantage that exchange of ideas takes place at all stages from defining objectives, through carrying out fieldwork, to data analysis and presentation. Its disadvantages may include the time and difficulty it takes to plan and conceptualise and the intellectual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

project teams to harmonise and synthesise the different

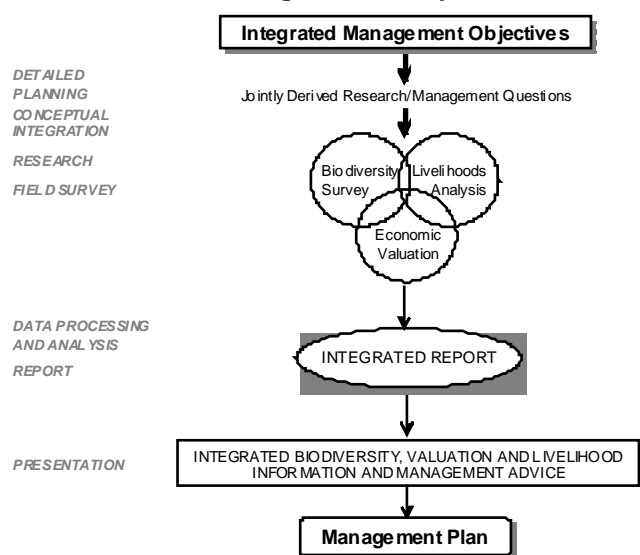
**Figure 3: Integrating wetland assessments which are already underway as separate studies**



**Figure 2: Integrating the work of separate field survey teams within a single assessment**



**Figure 4: Carrying out an integrated assessment with an integrated survey team**



information derived from guesswork, inapplicable generalisations or vested interests.

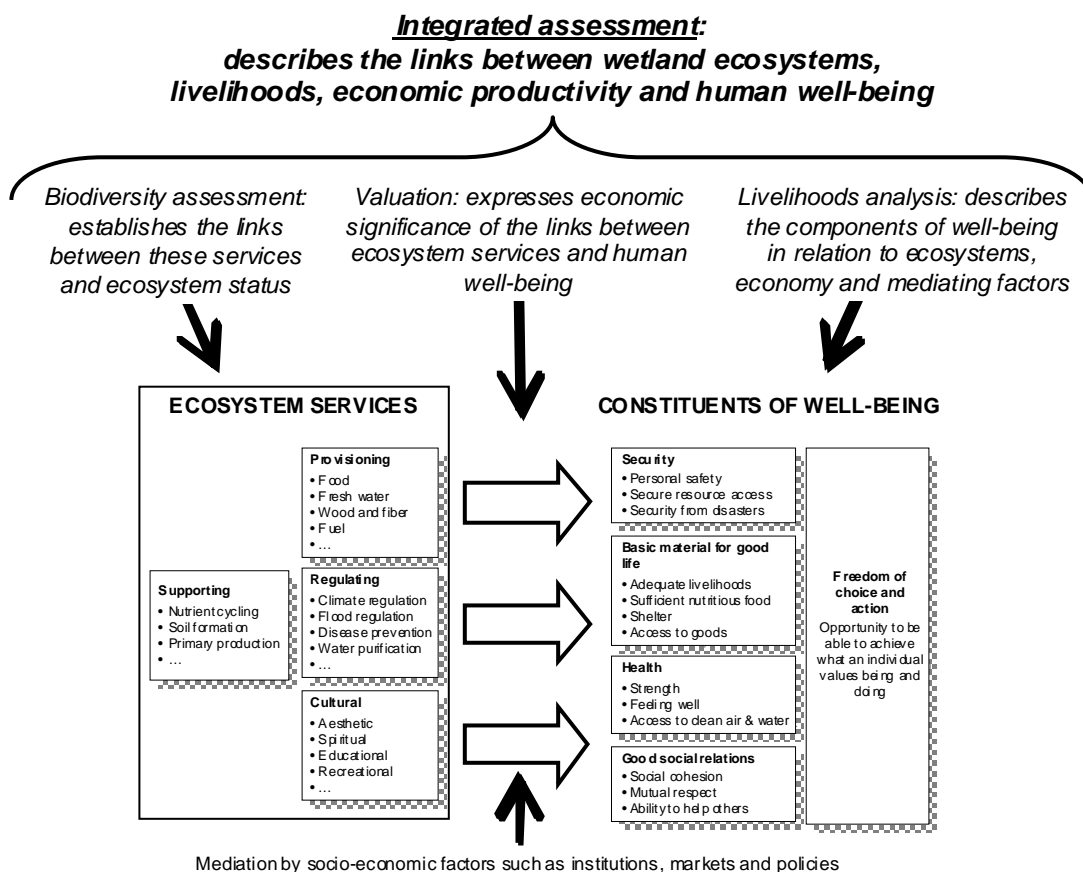
#### A4. Conceptual integration in what is being assessed

*Integrated assessment: understanding and acting on the links between ecosystem services and human wellbeing*

A variety of conceptual models can be used to describe the interconnectivity between biodiversity, economic values and livelihoods. The Millennium Ecosystem Assessment (2005) provides a useful framework with which to describe these linkages — between the supporting, provisioning, regulating and cultural services that wetland ecosystems provide, and the various constituents of human well-being which ensure security, basic materials for a good life, health, good social relations, freedom of choice and action.

As described in Figure 5, while biodiversity assessment provides the means to establish the links between ecosystem health and the provision of particular goods and services, economic valuation expresses the economic significance of these services for human well-being, and livelihoods analysis describes the components of human well-being in relation to ecosystems and the economy. Together, an integrated approach to wetland assessment which incorporates all these elements enables the links between wetland ecosystems, livelihoods, economic productivity and human well-being to be described, and the various institutions, policies, markets and other forces which moderate and shape these links to be understood.

**Figure 5: Using integrated assessment to describe the links between wetland ecosystem services and human wellbeing**



Adapted from Millennium Ecosystem Assessment (2005)

Adapted from Emerton 2006

#### *From the biodiversity point of view*

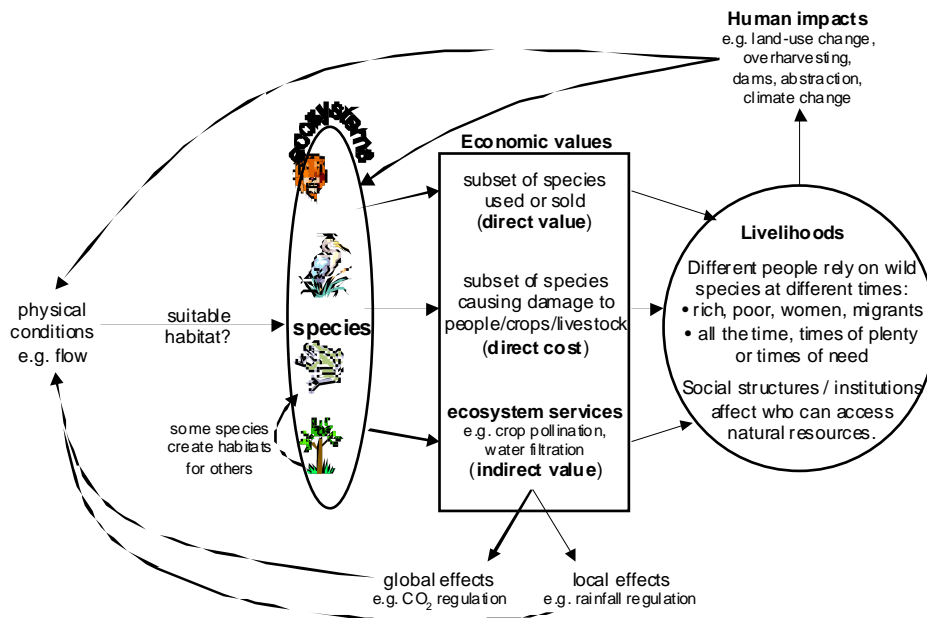
Humans depend on animals and plants for food, clean water for drinking, wood or fossil fuels to cook and keep warm, and materials for building and making products such as clothes. The supply of most of these necessities is provided or influenced by biodiversity (both past and present), be it as insects pollinating crops, as forests providing wood or as bacterial films purifying water. Therefore biodiversity has value to humans, supporting people’s livelihoods in numerous ways.

Understanding and quantifying this value is important, because human activities often result in the loss of biodiversity e.g. when dams are built for hydro-electric energy. The value that the biodiversity contributed and the people whose

livelihoods were reduced or lost are often forgotten. Decision-makers need to consider both the benefits and costs of such projects, taking into account those whose livelihoods will be affected.

This toolkit presents methods to provide this information to decision-makers. Wetland communities are often highly dependent on biodiversity; for example, fishing often provides essential food and income. Such communities are also particularly vulnerable to factors outside their control, as activities far upstream or downstream can affect fish populations and flooding regimes.

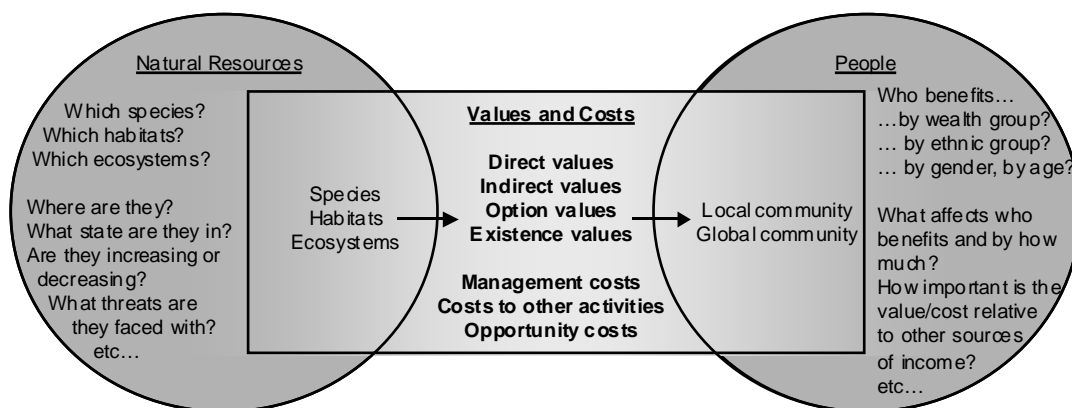
**Figure 6: Species contributions to livelihoods, and how human impacts can in turn affect species**



*From the economic valuation point of view*

Economic valuation seeks to demonstrate and quantify the value of the natural environment, using a variety of methods that can capture both the obvious values, such as the value of timber sold for export, and the hidden values, such as the water purification services provided by wetlands. However such studies rarely tease out the species composition of the resources valued, nor do they often separate out who receives the value. Disaggregating the biodiversity and livelihoods information is a way of incorporating non-monetary values into an assessment, such as the conservation value of particular species which may be locally or globally threatened, and the importance of natural resources to the poorest members of society, who often form the particular focus of development agendas.

**Figure 7: Disaggregating natural resources and their beneficiaries in economic valuations**



*From the livelihoods point of view*

Most wetland communities are largely dependent on wetland resources for their livelihoods, and therefore any changes in the quantity or quality of those wetland resources or in people's access to the resources will affect people's livelihoods. Livelihoods studies usually document this use of natural resources and factors which affect access to resources, noting also local perceptions of change in resource availability and causes of those changes. This information feeds into the development process, which aims to design interventions to increase access to resources

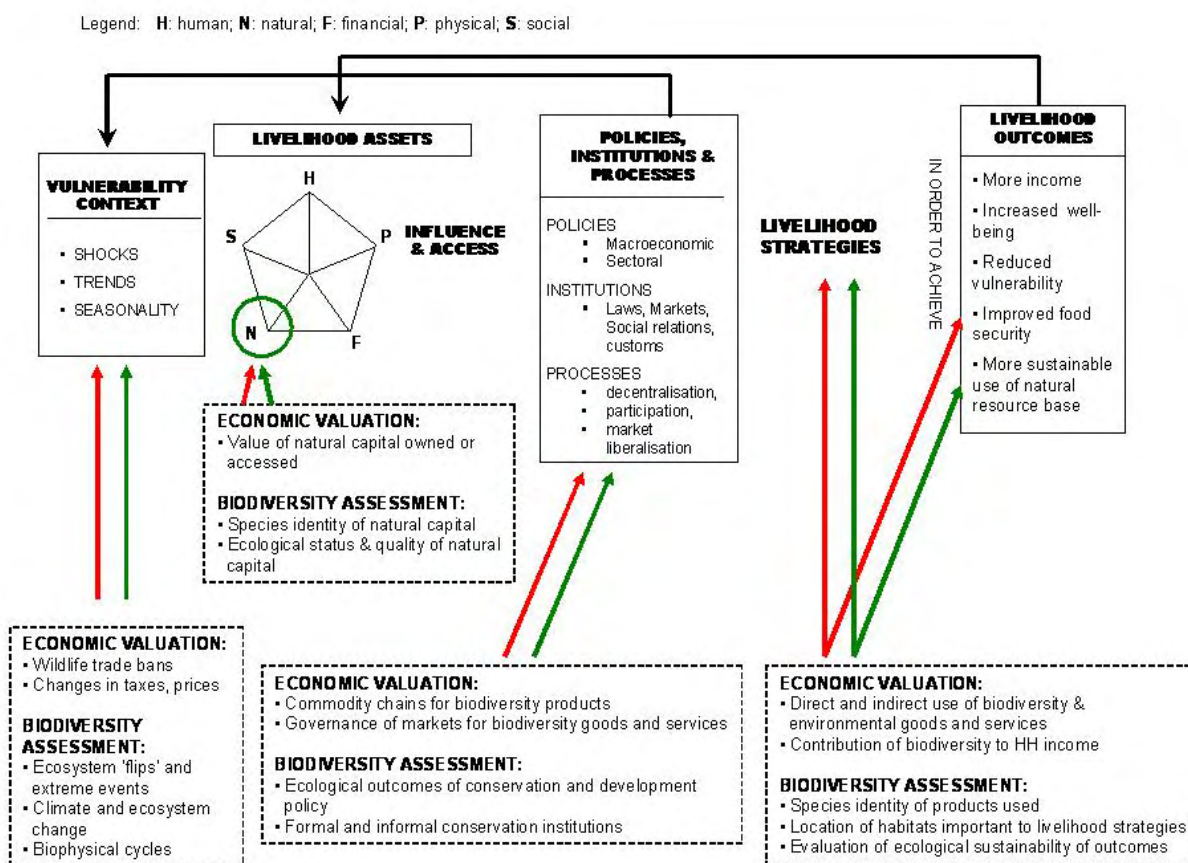
and to reduce factors which are blocking that access, often through encouraging institutions such as local fishing associations, which can report illegal harvesting activities or lobby against threats, such as dams or prawn farms.

Biodiversity information and economic valuation can add value to this process in a number of ways. Identifying the species which make up the resources may help to design sustainable harvesting strategies, based on knowledge of life cycles and migration patterns. Species surveys will help to identify threatening processes, such as invasive species or diseases affecting harvested species, and identifying species distributional ranges allows the management of individual species resources. Documenting the species present provides baseline data with which future changes in species can be compared; if local people notice that some species are disappearing, scientific evidence can be used to back this up. Additionally, threatened species can be used to enlist the support of conservation organisations, who may be able to offer advice, funding or political clout.

The main benefit of putting an economic value on resource use is that we live in a world where money speaks. Quantifying the value of resource use allows the financial benefits of proposed developments to be weighed up against the loss of income that may result. (...cont.?)

The diagram below shows the Sustainable Livelihoods Framework (DFID, 1999), which has been adapted to take into account the need for more detailed information on biodiversity and its economic values. The framework is described in more detail in Sheet L2.

**Figure 8: An adaptation of the Sustainable Livelihoods Framework (DFID, 1999), showing where biodiversity and economic valuation information can feed in**



### A5. Integrated assessment in practice: supporting wetland decision-making and management practice

Putting integrated assessment into practice presents many challenges; most people have technical skills and experience in only part of the process. For integration to work, everyone needs to have an awareness of the whole process. This will involve expanding the boundaries of each person's own study area, feeding into areas with which they are not familiar, and receiving input from researchers in other areas who may not understand the rationale or constraints of their own area. While difficult, such integration presents many opportunities to learn about the wider context of conservation and development, which may lead to new insights into the problems facing conservation and development initiatives. There are obvious overlaps between the approaches already used in the three research



areas, and the challenge here is to maximise the synergies between these approaches, while minimising the costs and complexities of carrying out assessments across such a broad range of expertise.

Below, we present an integrated approach to wetland assessment, in order to demonstrate how the different approaches can be combined, and the natural links between them. The process follows the general schema of an integrated assessment with an integrated survey team, as shown above in Figure 4. Here, all parts of the assessment are integrated, including the definition of the management issue which the assessment will address, the planning stages, carrying out the fieldwork, data processing and analysis, and the reporting and presentation to decision-makers and management stakeholders.

#### *Identifying the management issue to be addressed and the questions to be answered*

Before undertaking a wetland assessment, it is important to understand the management context in which it is taking place, and to clearly define the issues which it aims to address. If these management issues are not clarified, and understood by the whole team, at the start of the study, the assessment runs the risk of lacking focus and cohesion, and of ultimately proving to be of little use to wetland managers and decision-makers. It is critical, at this very initial stage of formulating the assessment, to ensure that the various stakeholders and managers who are involved and impacted by wetland management issues are involved in discussions, and in formulating the aims of the assessment. Formulating and clarifying this management issue forms the first stage of the assessment. The management issue can then be used to generate a number of more specific questions which need to be answered during the study, in order to shed light on the management issue chosen.

The management issue needs to relate to both conservation and development concerns for the wetland under study, and be phrased in an integrated manner (see Box 2). It is likely to relate to current threats to the wetland (see Sheet xx Threat Analysis), such as changes in water level or flow due to upstream dams or abstraction, problems with over-harvesting or destructive harvesting practices, or a proposed development with potential negative impacts on biodiversity and local livelihoods. It is intended that the wetland assessment should be designed so as to demonstrate the wetland values that may be reduced or lost as a consequence of such threats, in order to bring these values to the attention of decision-makers so that informed policy decisions can be made to reduce the loss of value (either by relocating the development project or ensuring that mitigative steps are taken).

### **Box 2: Examples of single discipline and integrated management questions**

#### **Single discipline management questions**

##### *Biodiversity Assessment*

Which areas of wetland have the highest diversity of resident and migrant bird species and should therefore be designated as conservation areas?  
What area of wetland is seasonally flooded?

##### *Economic Valuation*

What is the total economic value of birds harvested from the wetland?  
What would it cost to provide the flood-control services supplied 'for free' by riparian wetlands?

##### *Livelihoods Analysis*

What role does bird-hunting play in household subsistence and income generation?  
How effectively do participatory institutions for wetland resource use represent the interests of the poor?

#### **Integrated management questions**

In the face of plans for alternative use of the wetland that would undermine current wetland use, how can we document the current value of wetland resources to livelihoods in a comprehensive manner, highlighting the potential loss of livelihood value, if the development activities proceed unmitigated?

How can the wetland harvest activities of the poor be regulated to maintain or enhance their contribution to livelihoods without threatening important species or damaging wetland functions?

How can the trade in wetland products be sustained and organised to bring greater benefits to those who actually live in wetlands and depend on them for a livelihood?

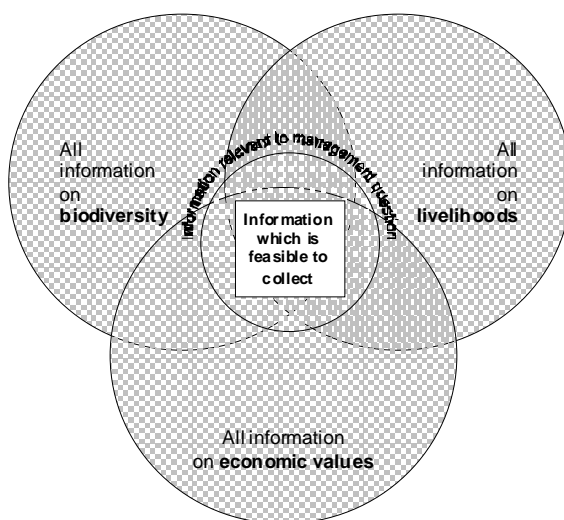
In many cases the conservation and development agendas may be complimentary; for example, the safeguarding of a globally unique habitat type, such as a flooded forest, may also improve livelihood security by maintaining fish stocks which rely on the flooded forest for spawning or feeding grounds. However in some cases the two agendas may be conflicting (e.g. where a threatened fish species is an important food source but current harvests are not sustainable) or the conservation agenda may be of little interest locally (e.g. the conservation of a river dolphin, which does not contribute to local livelihoods in any way). In these cases, considerable effort will be required to define the management issue in a way which has clear benefits for local people while incorporating the external agenda.

Identification of the management issue and definition of the questions to be answered can be achieved during a scoping mission or preliminary workshop, which can also be used to gain permission to work in the area, and to identify people with appropriate expertise to take part in the assessments.

*Identifying the information required*

Having defined the management issue and broken it down into more specific questions, the next step is to identify the information required to answer those questions, and which it is feasible to collect (Figure 9). The information required is likely to include both pure biodiversity, economics and livelihoods information, as well as cross-cutting information which bridges these disciplines.

**Figure 9: The biodiversity and livelihoods information sets, and the subset of information relevant to the project**



Out of all the information which it is possible to collect about biodiversity and livelihoods, there is a subset of information which is relevant to biodiversity, economic values and livelihoods. A particular management issue will relate to a different subset of the information, including some pure biodiversity information (e.g. the species present), some pure livelihoods information (e.g. the ethnic groups present) and information which bridges the disciplines (including information on the value of biodiversity to livelihoods) (Box 3).

**Box 3: The importance of pure biodiversity and livelihoods information to an integrated study**

While biodiversity forms the basis of a household's natural capital, it is nevertheless also important to consider other forms of capital that the household possesses, such as financial and physical capital, both to understand the relative importance of natural capital to the household, and because these other forms of capital may influence the ability of households to benefit from the natural capital (e.g. physical capital such as nets and traps are needed to capture fish and crabs).

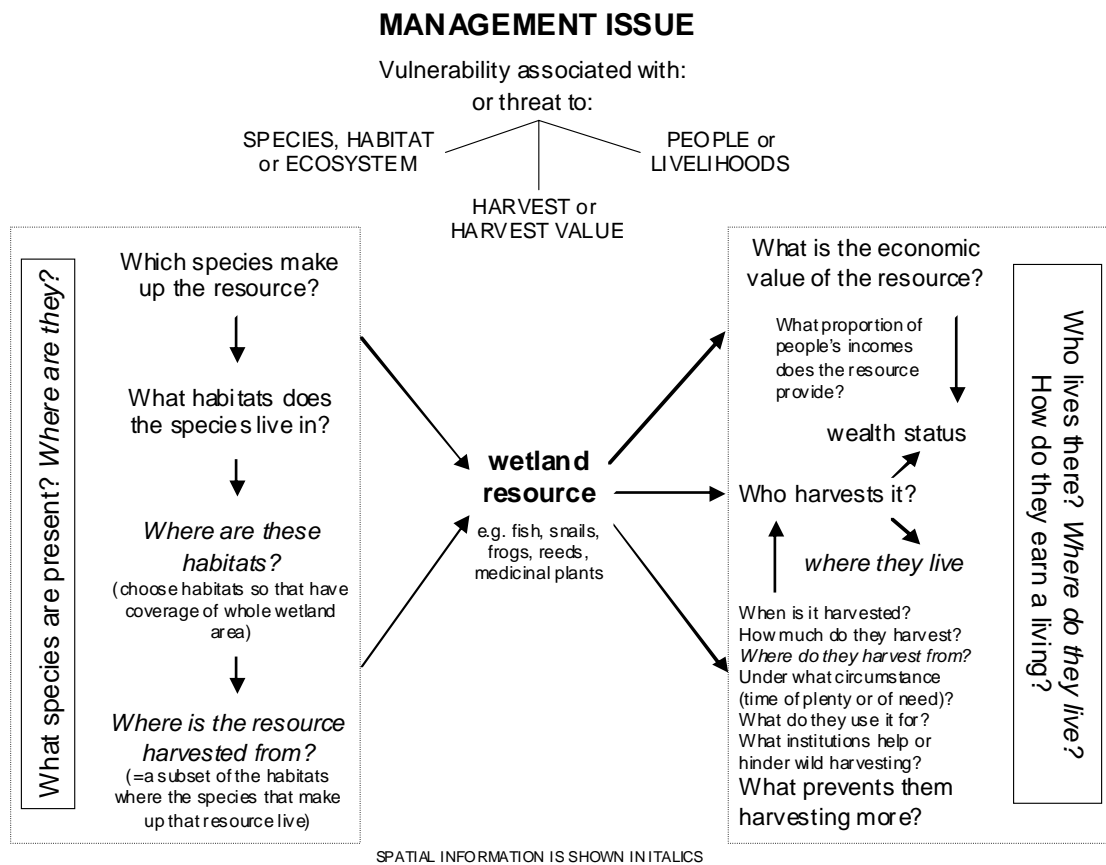
Likewise while households may benefit directly from large fish, crabs and molluscs by eating or selling them, other species groups also need to be assessed to contribute to our understanding of the ecosystem's health and threats to the ecosystem; certain indicator groups such as dragonflies and molluscs can be useful in doing this, although they may have little direct relevance to livelihoods.

Not all the information which bridges the disciplines will be relevant to the management question chosen; for example, the use of mollusc shells to decorate clothes would not be relevant to a management issue relating to food insecurity, unless the clothes could be sold to generate income.

Of the information which is relevant to the management issue, only some of it will be feasible to collect, while much will be beyond the possible scope of the study (e.g. the majority of ecosystem services are very difficult to quantify or value, even though they are important for livelihoods; examples include the provision of drinking water and crop fertilization by insects).

At this stage of the planning process, researchers need to decide which subset of information to collect during the study. This needs to be done in an integrated way, involving researchers from the different subject areas, to ensure that the information collected will link together and contribute meaningfully to answering the management question. Figure 10 shows the main types of information which are likely to be required by any integrated study, and the obvious links between them.

**Figure 10: The main information required as part of an integrated assessment, using wetland resources to link between species and livelihoods information, and highlighting the spatial information components**



Choices which need to be made at this stage of the study include:

- which species groups can be surveyed
- which values need to be quantified
- what aspects of livelihoods to focus on
- what additional information will be needed to link together these first three areas to form an integrated whole.

In order to make these choices, researchers need to have some idea of the situation within the site, so this stage of the planning process should be done either during or after a scoping mission to the area, and after a preliminary review of available data and reports.

*Defining the assessment boundaries*

This step involves defining who and what will be included in the study, at what level of detail. This should be decided based on the management issue being addressed, and by what is feasible given current constraints, such as the budget, timetable, expertise, and natural, political and social constraints (to name a few). It will result in a conceptual demarcation of the physical location(s) and socio-economic group(s) on which the study will focus. This step is closely linked to the previous step, as it involves considering what is possible (see central box in Figure...).

*Defining the geographic boundary*

The study area itself should be clearly defined. Examples of wetland areas that might be used include: the resource-use area of a village or district; a wetland conservation site or protected area (e.g. a Ramsar site or National Park); a naturally defined area, such as a floodplain, estuary, or the catchment of a river or tributary; or an area containing a species or habitat of particular conservation or livelihood interest. Wetland boundaries are often fluid, and may vary between seasons and over time; therefore it is important to agree an exact boundary for the area on which the study will focus by drawing it on a map. This core area will be where the majority of the primary data is collected.

However in almost all cases, there will be a need to collate secondary information from an area which extends beyond this core assessment area (e.g. threats to the area are likely to act over a wider area and be caused by activities outside the area, such as a dam far upstream), or secondary information may only be available over a larger area (e.g. species information may be available for the river catchment or country, and census information may be available at the district or regional level). Also in certain cases, primary data collected may need to extend beyond the core assessment area, such as when people from outside the area come to use the wetland resources at certain times of year.

*Defining a temporal boundary*

The temporal boundary will also depend on the management issue to be addressed. For example, if the management issue is livelihood security and the area experiences seasonal changes in fish populations, then the assessment should aim to cover the usual changes seen within one year. As most tropical wetlands experience seasonal differences in water level and flow with effects on wetland resource use, the study period should usually be at least a year, or long enough to do both a dry season and a wet season assessment.

*Selecting species groups to survey*

It is clearly not possible to survey for all species within a wetland site. We advocate here an approach in which a number of priority taxonomic groups are assessed to represent a wide range of trophic levels within the underlying food-webs that support wetland ecosystems. This approach aims to provide a holistic view by including taxa that are directly utilized, such as fish, as well as other components of the food web essential to the maintenance of healthy functioning wetland ecosystems, even if they are neither charismatic nor often noticed (especially submerged species).

Priority groups selected should include those taxa for which there is thought to be a reasonable level of pre-existing information, and whose identification will be possible. We recommend: fin fishes; molluscs; odonates (dragonflies and damselflies); crabs and crayfish; amphibia, reptile, birds and mammals; and selected aquatic plants. In all cases these taxa provide essential components of the food-web supporting the all-important fisheries. Given the wide range of trophic levels and ecological roles encompassed within these taxonomic groups, it is proposed that information on their distributions and conservation status, when combined, will provide a useful indication of the overall health of the associated wetland ecosystems.

*Defining the socio-economic boundary*

Wetlands typically generate benefits for many stakeholders, both on and off-site, and the human populations who receive these benefits or who impact on wetlands may also vary between seasons or over time. It is important to delineate the populations, stakeholders and levels of scale that the assessment will focus on, and to have a thorough understanding of the policy, institutional and socio-economic context in which the wetland under study is being managed and used. This toolkit has a particular bias towards the poorest members of wetland communities, and the socio-economic boundaries should be chosen taking this into account (for example, this might mean paying particular attention to seasonal migrants).

*Identifying which wetland values to quantify*

Wetlands yield multiple goods and services, and also incur a range of economic costs. In any valuation study, it is important to define and categorise all the costs and benefits that have relevance to the given wetland under scrutiny, in order to present a broad overview of the economic stocks and flows that are associated with it (see Appendix E15, Checklist 1). Only some of these will be valued, and these should be chosen on the basis of their relevance to addressing the management issue (see Appendix E15, Checklist 2).

There is a danger of undervaluing wetlands, leading to alternative developments erroneously seeming to offer more benefit than preserving the wetland; care must be taken to ensure that important benefits are not left out because they are too difficult to quantify.

*Taking constraints into account*

There are likely to be various constraints on when parts of the project can be undertaken; these constraints will include the available time, funding and expertise, and political, institutional, social and natural constraints.

Constraints on timing and funding are familiar to all projects, and include deadlines set by funding bodies for completion of work and limits set by the funding available on the number of people and equipment which can be employed during the project. Related to this is the expertise available; ideally local specialists should be employed, as they will have a good understanding of the culture and can usually speak the local language; if no local expertise is available, it may be necessary to hire specialists from further away, but this will affect the budget.

Political constraints include the need to get permits to work in an area or to get permission from village heads, as well as areas where it may not be safe to go due to on-going conflicts. Institutional constraints relate to the organisations that the project is associated with or is working through, and include issues such as internal communications within the organisation, the working practices of the organisation and the existing relationship between the organisation and the villages where the project intends to work. Social and cultural constraints include religious festivals or observance times such as Ramadan, and times of year when large numbers of habitants are dispersed in their fields or away fishing elsewhere. Natural constraints include seasonal constraints, such as the roads being impassable after the

monsoon, the river being too high at certain times of year to go on it in a boat, or wild animals such as lions or crocodiles making research dangerous in certain places or at certain times of year.

Such issues need to be considered to ensure the success of the project. They can be discussed with local people during a scoping trip to the area, and appropriate provisions made to incorporate any such issues into the planning of fieldwork.

#### *Collation of Secondary Data / Pre-existing literature*

Before fieldwork commences, it is necessary to collate all available secondary data of relevance to the management issue chosen (as identified in Section 3.2). A variety of reports are likely to exist, such as those written by government departments, aid agencies and conservation organisations. Additional information may be available from local or national government (e.g. maps, census data and other government statistics), on-line databases (such as the Red List database of threatened species), people/organisations who have experience working in the area (in particular, they may be able to direct you to less well-known literature), and books and academic papers.

Some of the available information will relate to only one discipline (e.g. biodiversity reports, poverty assessments) but much of it may be of wider relevance (e.g. reports on wildlife trade will give information on the species traded, the people involved in trading them and their value). It therefore makes sense to take an integrated approach to information collation, as this is likely to save time and effort. In particular, an awareness of the information required by the project as a whole will help researchers from each discipline to look out for information of relevance to the other disciplines.

Collating this information will take time, and should be done before the field assessment. During the collation of secondary information, information gaps will become apparent, and where possible, these should be filled using the fieldwork. Additionally the secondary information may point to new issues which also need to be investigated during the field assessment.

#### *Likely sources of secondary information*

The types of information that need to be collated are listed below, with likely sources and an indication of how the information will fit into an integrated assessment.

Species information, to include information on taxonomy, geographic range, population size and trends (e.g. catch per unit effort for fish), habitat preferences, ecology and life history, major threats, conservation measures, ecosystem services provided by species, species utilisation, importance to livelihoods and IUCN Red List status. Sources of information include local field guides, biodiversity reports, scientific papers, wildlife trade reports, livelihoods reports (often the fish and plants that are used are listed, even if only their local names are given), on-line databases (e.g. the IUCN Red List of Threatened Species, the Species Information Service database, FishBase, FAO etc). Although the area of interest may be quite small, when collating species information it will probably be necessary to collate information on a larger area, such as a river catchment or a country, in order to assess threats to species. Collating information at this level will give an idea of the species which you can expect to find, although not all of them may be present in the specific area chosen.

Trade and value of species or species products: CITES, Livelihoods reports

Resource use: Livelihoods reports, FAO

Wealth/Poverty status: census data, livelihoods reports, government/district data, health statistics (from health organisation) or studies from NGOs or medical centres in the area;

Livelihoods information: World Health Organisation, government agencies

Maps: Government mapping agency, aerial photography companies, NGOs that have produced maps as part of their reports, etc See Sheet M2 and M3.

etc etc...To be added to by those with better knowledge of where these types of information may be found.

#### *Reviewing information from the literature*

At the close of this stage, researchers need to have a meeting to review what information they have been able to collect and how far that information goes towards addressing the management issue. They need to identify what remaining information is still needed, and use this to start planning what fieldwork will be required (as described in the next section) in order to fill in the gaps.

*Planning and carrying out fieldwork*

There are two important aspects to the integration of fieldwork:

1. how field work techniques can be adapted or added to in order to ensure that the links between disciplines are made (addressed below);
2. how the field teams can work together and interact with each other so as to share information and make the most of the opportunities to integrate methodologies. This is addressed in Sheet G1 "Forming an integrated project team".

As a starting point to fieldwork, the basic methodologies will remain those traditionally used in biodiversity surveys, economic valuation assessments and livelihoods surveys, and these are described in Sheet B2-12, E2-15 and L3-12.

In order to integrate the methodologies, linking information will need to be collected, such as how the local names of species used by villagers match the scientific names of species collected during the biodiversity survey, or how the habitats where species are found relate to the areas where people harvest them (see section on linking information below). This linking information will ensure that information collected by different team members can be successfully brought together to form a whole.

Once the linking information required has been established, it will become possible to identify who needs to do what, i.e. which team members need to collect which part of the linking information, in order to avoid repetition or omission of data collection. However it may be decided that some repetition in the collection of linking data is actually a good way of cross-checking the information, and may help all team members to take part in the integration and gain a larger perspective of the assessment.

Some methods will contribute information to more than one discipline, such as market surveys, which provide information about biodiversity and economic values. Such methods may be equally well carried out by team members from different disciplines, but as they only need to be done once, decisions need to be made about who will do them. Alternatively, it may be useful if team members from the different disciplines work together on such methods, to encourage understanding of each other's methods and to increase the amount of information that can be collected. For example, if an economist does a market survey, they may not notice if the fish being sold are a single species or mixed species assemblages, and if they are mixed, what proportions of the different species are present; if a biodiversity specialist is also present, they are more likely to notice these things and can take samples to identify the fish species.

The table below shows the methodologies required to carry out the assessments, and how these span across the subject areas.

**Table 1: Assessment methods and the subject areas to which they relate**

Biodiversity	Economic valuation	Livelihoods
Literature review		
Economic valuation tools: E2-12		
Market survey: B8		
Socio-economic methods such as focus groups: L2-10		
Household surveys: L11		
Ethnobiological tools, such as resource use calendars		
Participatory mapping		
Georeferencing species, habitats and resource areas: M6-8		

## Linking information

**1. Resources used → component species**

To link socio-economic information to biodiversity information, it is necessary that when resource use is mentioned during economic valuation or livelihoods work, the component species that form these resources are identified. This requires socio-economic researchers to ask which species (using local names) people are referring to when they talk about resources, and then for biodiversity researchers to go out with local people matching up local names to the Latin names of species (or to specimens which can be identified later).<sup>1</sup>

**2. Resource harvest locations → habitats**

Local harvest locations should be georeferenced using GPS so that they can be mapped, and cross-referenced with the habitats which have been surveyed by the biodiversity specialists. (See Mapping Sheets.)

**3. Resource use → user groups and conditions when used**

When biodiversity surveys or economic valuations get information on who harvests or uses resources and when, they also need to be aware of distinctions which the livelihoods team are interested in making, such as differences in ethnicity, gender, age, household size, home location and migration patterns of the user groups, and when the resource is important according to season, income, health or state of need. Again this may be achieved if the biodiversity or economic researchers pass on information about the species which are harvested (with their local names) to the livelihoods team to bring into their surveys, focus group meetings or key informant interviews.

(This section will probably be extended after the data analysis and mapping from Stung Treng and Mtanza-Mzona, as other types of linking information will probably become obvious.)

#### *Integrated data storage protocols*

Clearly it makes sense to store the data in a way which recognises the links between the different types of data, and facilitates integrated data analysis. The Species Information System has been designed to do this, and can hold detailed information on species, their conservation and threats, their utilisation and value, and their contribution to livelihoods. Additions to this database are still required so that it can hold more information relevant to value and livelihoods; this work will be undertaken as data come in and it becomes clear what forms of data need to be stored, and how these relate to other fields currently in the database. Figure ??? shows how data could be organized, with wetland resources and spatial information providing links between biodiversity and socio-economic information. A summary of the existing SIS database is given on Sheet G2.

#### *Integrated data analysis*

On completion of the assessments the data sets will be synthesised and analysed to provide relevant outputs for integration within the decision making process. The types of analyses and the format of outputs are to be developed as a key component of this project and will be modified and refined in response to feedback from potential user groups.

[Assessing the value of biodiversity to livelihoods in wetlands is not an end in itself. Rather, it is a means of providing information which can be used to make better and more informed choices about how resources are managed, used and allocated. In order for the results of the assessment to influence real-world policy and practice, it is of critical importance that time and thought is given to analysing the data that has been gathered, and presenting it in a form that captures the attention of decision-makers, and is convincing to them.]

Decision-makers, whether in conservation or development sectors, are primarily concerned with choosing between different uses of land, funds and other resources – for example whether to manage a wetland under strict protection or to allow for some form of sustainable use, whether or not to build a dam, irrigation scheme or housing estate, which infrastructure design option to invest in, or whether to zone a wetland for conservation or to convert it to settlement or agriculture (assessing damage to a wetland). We need to present the assessment results in ways that make sense to decision-makers, to help them weigh up the different funding, land and resource management choices that wetland decisions involve.]

The information needs to be presented in such a way that it can be weighed up against alternative values provided by alternative uses of the wetland e.g. hydropower.

[Discussion of the possible value and use of multi-criteria analysis – directing to a 1-pager on this?]

#### *Integrated presentation of results: a GIS-based approach*

Spatial mapping tools allow the integration of information from different disciplines. The overall aim is to use a series of overlay maps to identify areas where conservation and development issues require priority action. This can be achieved using GIS technology, which allows the creation of such maps and the overlaying of different layers of information.

Overlay maps will include information such as species distributions, resource use areas, the value of resources, and where the people live who benefit, on a single map in order to highlight those areas where biodiversity provides an essential resource to local communities, and particularly to the poorest members of those communities. The maps shown on Sheet M1: Mapping Overview demonstrate how this might be achieved.

[A key basic objective is to be able to present maps showing the distribution of species and the distribution of major threats to those species. These data will be overlaid with information on their levels of use, economic value and importance to livelihoods. A typical output might therefore identify critical sites where species are threatened (with the threats identified and mapped where possible), are an essential resource to the poorest communities and have a high economic value.]

Outputs will be tailored to a range of different audiences within the decision-making process. It will be important to spend time finding out which analyses and forms of presentation will be most useful to the target audiences chosen for the project reports.

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## Notes on this chapter

<sup>1</sup> In some cases it may be acceptable to work with morphospecies, either as identified by local people or by researchers who do not have access to suitable taxonomic keys or identification experts. In this case, rigorous survey methods can still be applied to mapping these species and assessing their conservation status. However local names may not have a 1:1 relationship with species as recognised by taxonomists: some species may be grouped under one name, while others may be split. See Sheet B12 for a discussion of alternative methods of biodiversity assessment.



## Case studies of integrated assessment (TO BE WRITTEN)

### C1. Case studies of integrated assessment (TO BE WRITTEN)

This chapter will be written in collaboration with the site teams at each location. We anticipate that the case studies will follow the following approximate structure:

1. Site background (short summary): where it is (maps), who lives there, how many people, what villages and infrastructure, why the site is interesting and why it was chosen for this study (e.g. Ramsar, VEMP), the site history, threats to the site and current concerns, previous work and relevant reports (i.e. a brief literature review), main players in region (i.e. institution, NGOs etc)
2. The management issue chosen to be the focus of this study – why it was chosen and what process was used to choose it.
3. Timeline of main events during the project, including meetings, field trips etc with a brief description of who was involved, what happened or what was decided and why (with web-links to the more detailed reports which came out of these meetings or field trips – these will only appear in the web-version, not the paper version). This section should include events such as meetings with officials to get permission to work there, activity plans as decided at meetings, the workshops, scoping missions etc
4. Project outcomes, how much integration was achieved, how this enabled a stronger case to be made for conservation and poverty alleviation, also difficulties encountered with integration and how these might be avoided in future. Lesson learned. Where hope to go from here.

In each section there should be an emphasis on the aspects relating to integration, and how this was achieved or the problems which were encountered relating to achieving it and how these were resolved. Someone reading this should be able to follow the progression of the project, and it should be written to be of use to someone wanting to use the toolkit to guide them in what they need to do and when.

Also include details of who was involved and their role; how the management worked; accounts and expenses; etc

[In some cases a wetland assessment such as described here will be the first assessment of the area. In this case, researchers will have the freedom to design an integrated assessment from the beginning, identifying what information is needed and which tools are most appropriate to collect that information. Although the first case study in Mtanza-Msona village had actually been the subject of considerable study, nevertheless this was the paradigm used when planning the assessment here.

In other cases, there may be a variety of ongoing assessment procedures, which an assessment using this toolkit will need to work alongside of. In this case, it may not be possible to apply these protocols from the beginning, and integration may have to take place later in the assessment process, when some surveys and studies have already been undertaken, using different procedures for different study components (as shown in Figure ???). This was the case in Stung Treng Ramsar Site, which forms the second case study documented here, and for which there were a number of ongoing/completed assessments using their own established methodologies.]









## General information and methods sheets

### G1. Forming an integrated team and working together

#### *Composition of the project team*

The composition of the project team is important: it should contain both specialists in the component disciplines and people with an overview of all the disciplines as well as with experience or knowledge of on-the-ground wetland planning and management. Ideally the team leader should fall into the second category, so that he or she can encourage integration between those team members who may not yet understand the value of integration or how integration can work.

People with an interdisciplinary background may be hard to come by; it is not necessary that they should be expert in all the different disciplines, only that they should have an appreciation for the value of the information provided by the different approaches and an understanding of how the approaches can be woven together to form a whole, which is hopefully greater than the sum of the parts. One area of study which is already multidisciplinary in this way is ethnobiology (or ethnobotany, ethnoecology).

#### *Roles within the team*

The Team Leader should oversee and coordinate the work to ensure that integration and information-linking occurs, and that large gaps are not left. The team leader should ideally spend some time with researchers using all the different methods, and should encourage researchers to accompany other team members from time to time to gain an understanding of their methods and research aims.

The majority of the team members will be Researchers, with together they should have the following expertise:

- biodiversity survey,
- economic valuation,
- livelihoods survey and participatory research methods,
- possibly ethnobiological methods, and
- georeferencing and spatial mapping.

Some team members may have expertise in several areas, and some areas may be covered by more than one team member.

We anticipate that researchers will work mainly within their area of expertise, but with an increased awareness of the other areas, and that they will take part in research that bridges between the areas and may occasionally borrow methodologies from the other areas. This will be facilitated by regular meetings during the planning, fieldwork, data analysis and reporting stages; in particular, the whole team should be in the field together with daily meetings between all team members, as described below. Working together will generate a greater awareness of the possible synergies between the research areas. This should lead to less repetition, such as where researchers look up the same documents or speak to the same people while looking for answers to different questions. This will save time and effort and also “interview fatigue” of local people.

#### *Suggestions for encouraging the field teams to work together*

We recommend having daily meetings between all team members during the field work. These meetings can be used to:

- share the findings of the day's work: a quick summary of what people have been doing, such as a household survey, a focus group with fisherfolk, a fish survey, so that everyone keeps an overview of what the team as a whole is doing. Too much detail should be avoided as time will be precious, unless other team members request it.
- share any information which will be useful to other teams or which needs to be followed up on by other teams: for example, it is quite likely that during biodiversity surveys, the guides will volunteer information on uses and factors affecting those uses which the socio-economic team members may be able to follow up on, perhaps in focus groups or key-informant interviews. Likewise there may be issues that the socio-economic teams uncover,

which they can ask the biodiversity team to shed more light on, such as factors causing a reduction in resource availability, e.g. invasive plant species clogging up waterways.

- check that linking information is being collected; i.e. local names of resources, such as fish, snails, or plants, as collected using socio-economic methods, need to be passed on to those doing biodiversity surveys to ensure that they find out which species are being referred to. Likewise there will need to be geographical linking, i.e. to ensure that the ecological habitats represented inside resource use areas are described and species assessments carried out in these habitats (although not necessarily within the same resource use areas; see Sheet... for more information on mapping).
- share any issues specific to the area which will affect all team members: these could include religious festivals that will affect when work can be done; local customs or taboos; health and safety issues about where, when and how to work; local issues such as conflicts that need to be handled sensitively and that all researchers should be aware of.
- tell each other about problems that have arisen, and help each other to find solutions to these problems: for example, if it is found that a certain local person tends to dominate focus groups or that others contribute less in their presence, it could be agreed to invite this person to act as a guide to the biodiversity team on one day, allowing the socio-economic team to speak to other people when the person is not there.

These daily meetings will undoubtedly add an extra burden to the work of the team, and therefore they need to be kept brief and relevant to the work of the whole team, and it will be the responsibility of the chair person/facilitator to ensure this. This role can be shared between the team leader and other members of the team who have experience of facilitating such meetings. The importance of these meetings needs to be emphasized to all team members to encourage their participation. The meetings can be held in the mornings or evenings, bearing in mind that in the mornings people will want to get on with their day's work, while in the evenings people will be tired. With time, as the team gets to know each other better on an informal level, much of what needs to be said could be discussed over dinner, although some more formal meetings may still be necessary on a less frequent basis.

## G2. Data management – the Species Information Service (SIS)

The Species Information Service (SIS) provides a tool to collate, store and manage the information for each species. The SIS is a major initiative that aims to make the vast amount of species information held by the IUCN Species Survival Commission (SSC) network easily and quickly accessible to users around the world. All data underlying the IUCN Red List (described in the next section) will eventually be maintained in the SIS. The SIS has an electronic users manual<sup>1</sup> to accompany the software, with a detailed explanation of how to use the SIS Data Entry Module (DEM). The major types of data required are described below:

- **Taxonomy:** This section includes the higher taxonomy of a species (i.e. Kingdom, Phylum, Class, etc), the taxonomic authority, any synonyms and notes on the lower taxonomy of a species (such as whether sub-species or sub-populations are recognised). This information will come from the literature. Also included here are common names for the species, which will be required to link species data with the economic value and livelihoods assessments, and will come from field surveys (such as asking the names of fish being sold in markets, or asking guides for the local names of species when they are seen during biodiversity surveys).
- **General Information:** This includes a number of sub-sections, and should largely be filled in from the existing literature, although for many species, little information may be available. All information given in this section should be referenced to source documents (papers, books) or to experts.
  - **Distribution:** Description of the species distribution within the assessment region and also the global distribution. Also the Area of Occupancy and Extent of Occurrence (in km<sup>2</sup>), the elevation or depth limits for terrestrial/aquatic species, and the biogeographic realm.
  - **Population:** When general information about population size is known, it can be entered here. Alternatively it may be possible to estimate a maximum or minimum population size.
  - **Habitat and Ecology:** This section is for short notes describing where the species lives and aspects of its ecology, such as if it migrates, hibernates, bears live young, is sessile, etc. Particular note should be made of habitats essential to the species' reproduction. You are also prompted for whether the species is terrestrial, marine or freshwater, and whether it is congregatory or migratory. This page then leads on to two more pages on Life History (suitable for all species) and Plant Growth Forms.
  - **Life History:** Information such as age and size at maturity, longevity, average reproductive age and time of gestation, if such information is available.
  - **Plant Growth Forms:** e.g. large tree, small tree, annual, succulent, epiphyte, fern.
  - **Major Threats:** Known threats are entered here, in order of importance, with references; e.g. "1. Overfishing in Lake Victoria (Goudswaard, 2002)."
  - **Conservation Measures:** Conservation measures that are either in place or are recommended (only realistic measures should be included).

- **Extent of Occurrence:** This is the section of the DEM which allows you to create basic GIS maps to show the distribution of a species. The extent of occurrence is defined as “The area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy.
- **Countries of Occurrence:** This is a list of countries, and you can select if a species is native, extinct, reintroduced, introduced or vagrant in each of the countries. It is possible to change the DEM so that only countries within the assessment area are visible.
- **Habitat Preferences:** This is split into two sections, General Habitats and Land Cover.
  - **General Habitats** provides a list of habitats which can be marked as ‘suitable’, ‘moderately suitable’, ‘unsuitable’ or ‘undefined’.
  - **Land Cover** is based on the Global Land Cover 2000 list of land cover options, and species are scored in the same way as in the General Habitats options.
- **Major Threats:** This provides a list of threats to species which can be marked as ‘past’, ‘present’ or ‘future’.
- **Conservation Measures:** This provides a list of possible conservation measures which can be marked as ‘in place’ or ‘needed’.
- **Ecosystem Services:** A number of ecosystem services are listed such as water quality, flood control, nutrient cycling and pollination, and these are given a score from 1 to 5 according to the importance species contributes to providing that service. The geographic spread over which the service is provided can also be given (local, national, regional or global).
- **Utilisation:** This covers the purpose or type of use (food, fuel etc, marked as subsistence, national or international), the primary forms removed from the wild (whole plant, seeds, etc), and the source of specimens (the wild, farming etc). It also covers trends in the amount harvested, the CITES status of the species and the species’ Livelihood Value.
- **Livelihood Value:** This section is currently designed to hold general livelihoods information, as collected by non-experts; in this project we plan to develop the database for expert input, with a module to link to species flagged as important to livelihoods. The section requires information on the amount of a species which is harvested, its monetary value, what products are made from it, who are the main users, and how much it contributes to their livelihoods. It is possible to enter information for two or more products made from the same species.
- **Red Listing:** This leads the user through a Red List Assessment for the species (described in more detail in Section 2.6 below). It allows the user to record the Red List Category of the species, the Criteria it has qualified under, the rationale used to make the assessment and the names of the assessors and the evaluators.
- **Bibliography:** This section contains the references used to put together the species entry, as cited in the various sections. Each species entry must be linked to the relevant references; if the references have already been entered for another species, then they can quickly be found in the bibliography and linked to the current species’ entry.
- **Species Report:** Finally it is possible to print out a summary of the species information entered into the DEM.

### G3. Threat mapping

Where the management question chosen as the focus for a study relates to a specific threat, such as the building of a dam or the establishment of a prawn farm, threat mapping can be a useful tool because it can show what important functions or values may be lost if the threat occurs and over what geographic extent the impacts will be seen<sup>2</sup>.

There are two ways of mapping threats. If the source of the threat is localised, such as a new dam, then it is possible to map the threat itself (i.e. the position of the proposed dam); however some threats cannot be defined geographically in this way, such as climate change.

An alternative way of mapping threats is to map the likely effect of the threat on some item of value. For example, a proposed dam would alter the flood regime downstream, so it might be possible to map areas that will be flooded less frequently or for a shorter time, or to map areas where it was previously possible to grow rice but where that will not be possible if the dam is built, or to map communities that will lose a significant proportion of their income.

The following questions are a guide to the process of threat mapping:

1. What is the ‘item of value’? (e.g. a particular species, all wetlands, income from wetlands)
2. Where is the ‘item of value’? (Draw a map of it.)
3. What threats are there to the ‘item of value’? (e.g. climate change, abstraction, migrant harvesters)
4. Where does the ‘item of value’ overlap with the threats (i.e. where is it threatened)? (Draw maps of different threats, and possibly number of threats summed by area.)

5. How vulnerable is the 'item of value' to the threats? (i.e. How much impact leads to how much response – can you quantify the relationship?)
6. Therefore what is likely to happen to the 'item of value'? If at time  $t=0$ , there is  $x$  amount of the 'item of value', what proportion of  $x$  is likely to be left at time  $t=1$ ?

These questions lead you through making a series of maps, starting with topics for which good data are available, and then moving towards topics about which we are less sure. For example:

- a. A map of the distribution of the 'item of value' (e.g. a species distribution map, a species richness map, a map of tropical dry forest) (WELL KNOWN)
- b. A map of the importance / value of the 'item' (e.g. a map of wetlands of high economic value to livelihoods) (WELL KNOWN)
- c. A map of where the threat is expected to act (e.g. increased temperature, change in precipitation due to climate change, human population pressure, number of invasive species, reduction in river flow) (PARTIALLY KNOWN)
- d. A map of where the pressure from the threat will be strongest, as it is usually graded and may act widely at a low level (e.g. areas of highest temperature change, largest reductions in flow, highest levels of poverty, fastest rates of deforestation) (NOT VERY SURE)
- e. A map of how the value of the 'item' will respond to the pressure (e.g. likely areas where a species or habitat will be lost from, areas where income from fishing is likely to decrease by  $>X$  %) (SPECULATION).
- f. A map of important areas for conservation, defined as areas of high value and high threat (e.g. species rich areas downstream of dams, communities whose livelihoods are highly dependent on non-timber forest products that are within a logging concession).

Issues to consider include that there may be a time lag between the occurrence of the pressure / threat and its effect on the item of value, which may not be possible to take into account or quantify.

In order to speculate about the possible effects of a pressure or threat (and factors such as time lags), it may be possible to look in the literature for historical examples from other areas and extrapolate to the case in hand. If this is not possible (e.g. with climate change), an alternative approach is to get a group of experts together and ask them to qualitatively rank what they think is most likely to happen. This generates anecdotal data of how things might react to a pressure and how much time lag there might be.

Any threat or pressure can be mapped providing some data are available as to how likely it is to affect an 'item of value', where there is data on the distribution of that item.

#### Examples of threat-mapping

- Mountain Watch mapped issues affecting mountain regions, including the ecological and social values of mountain ecosystems and the current and potential pressures facing mountain environments and people. Pressures mapped included seismic hazards, armed conflict, fire, climate change, land cover change, agricultural suitability and infrastructure.
- Miles *et al.* (2006) mapped various pressures affecting tropical dry forests including climate change, forest fragmentation, fire, conversion to agriculture and human population.
- The Globio Project uses distance to infrastructure to estimate likely human expansions in different ecosystems and regions, which can be mapped.
- The Fall of the Water project mapped the likely cumulative impacts of climate change, infrastructure development, land use, forestry and nitrogen pollution on the abundance of biodiversity in central Asia.

#### **Box 4: How might we map the threats from a proposed dam?**

We could look at the effects of similar-sized dams on other similar rivers, as 1000s of dams have been erected, and for at least some of them, data are available on how the hydrology and biota changed. This would give us an idea of the likely response to the dam, which we could then plot onto the downstream area. E.g. if similar dams in the United States have caused a lowering in water temperature of 5 degrees for 3km downstream, we can show that on our maps as a likely outcome. If we know that 40% of the biota are intolerant of temperature changes greater than 1 degree, we can plot these areas as losing 40% of the biota (in all likelihood). We could also look at changes in hydrological variability, maximum and minimum discharges and apply these to what we know about species requirements in order to predict which and how many species are likely to be affected.

## Notes on this chapter

<sup>1</sup> Ref and Link to SIS Users Manual

<sup>2</sup> This section was written following a discussion with Lera Miles, of UNEP-WCMC, Cambridge, UK.



# Biodiversity assessment tools

## B1. Background and overview

### *Background: Why assess the status and distribution of biodiversity?*

'Biodiversity' refers to the diversity of species of plants and animals on Earth. The term 'biodiversity', which did not come into common usage until the late 1980s (Wilson, 1989), includes all genes, species and ecosystems and the ecological processes of which they are a part (Gaston 1996). Species are often taken as the unit upon which assessments of the status of biodiversity are made. They have come to be used as the common currency to express biodiversity as data for species status tend to be more readily available on the global scale, especially for those more charismatic taxa. Ecosystems may also be used as a measure of biodiversity but in particular for wetland systems, they remain poorly classified or mapped.

Wetland biodiversity provides enormous benefits to people through both direct and indirect terms. It is well established that provisioning services from wetlands, such as food (notably fish) and fibre are essential for human well-being. Inland fisheries in developing countries sometimes provide the primary source of animal protein for rural communities and flood plains provide important grazing for many pastoralists (Millennium Ecosystem Assessment, 2005). Supporting and regulating services (such as nutrient cycling) are critical to sustaining vital ecosystem functions that deliver many benefits to people (Millennium Ecosystem Assessment, 2005). At the level of ecosystems, wetlands play an important role in the regulation of global climate change by sequestering and releasing significant amounts of carbon.

Despite the clearly recognised benefits provided by wetlands they continue to be lost at an unprecedented rate and their constituent species are thought more threatened than any other species grouping at the ecosystem level (e.g. Ricciardi & Rasmussen, 1999; Revenga *et al.* 2005). The main threats to global freshwater species include: overexploitation; water pollution; flow modification; destruction or degradation of habitat; and invasion by exotic species (Dudgeon *et al.* 2006). Overexploitation primarily affects vertebrates, mainly fishes, reptiles and some amphibians. Pollution problems are pandemic. Flow modifications are ubiquitous in running waters, most often in regions with highly variable flow regimes where people have the greatest need for flood protection and water storage. Habitat degradation is brought about by an array of interacting factors such as conversion for agriculture, forest clearance and resultant changes in surface run-off and general wetland drainage. Invasion by exotic species adds to the physical and chemical impacts of humans on fresh waters by changing the ecological balance through predation, competition and in some cases habitat destruction. Finally, the high degree of connectivity throughout aquatic systems often means that impacts, such as pollution or invasive species, spread far more rapidly than would be expected in terrestrial systems.

Even given this knowledge that wetlands and their associated species are a highly valuable resource undergoing a serious decline globally, the ecological requirements for their maintenance and continued productivity are seldom included in decision-making processes for the development potential of wetlands. For example, in China and India, where approximately 55% of the world's large dams are situated (W. C. D., 2000), hardly any consideration has been given to the downstream allocation of water for biodiversity (Tharme, 2003). Given the high priority now placed on the development of wetland systems for provision of water for drinking, sanitation, agriculture, and hydropower, it is essential that the potential impacts of such activities on wetland biodiversity be considered within the development planning processes. One of the major bottlenecks in bringing wetland ecosystem needs into the decision-making process is a lack of readily available information on the distributions and ecological requirements of species. Even where such information is made available it must be presented in a suitable format if the impacts of wetland development are to be minimised or mitigated for. The required information on species can be made available through the methodology given below.

In summary, the purpose of assessing the threatened status and distribution of species is to present information on species in a format that can be integrated into the decision-making processes. The information set will also serve as a baseline for monitoring the impacts of any development or management interventions and will enable adaptive management and evaluation of any mitigation measures put in place.

### *Overview of biodiversity methods*

In order to demonstrate the value of freshwater species to livelihoods, we first need to know what species are present and where they are found. This section describes the methods needed to collect, store and display this information.

The methods used to assess the species' risk of extinction are also described, in order to assign each species with a Red List status.

Having defined the management issue to be addressed and the bounds of the study area, it is necessary to choose which taxonomic groups to focus on; these should be chosen in collaboration with the rest of the project team, in the context of the management questions which form the focus of the study. The available information on these species groups then needs to be collated. Much of this will be found in the literature; additionally some data may be available in existing databases. These sources will provide preliminary species lists for the area, as well as information about the life history, habitats and ecology of species, known threats to the species and current conservation measures. All this information can be stored within the Species Information Service (Sheet G2).

Fieldwork will be needed to supplement the species lists and to collect information on where species are found. For the different species groups, a variety of sampling methods will be required. The help of local taxonomic experts may be needed for species identification. The species can then be mapped to the freshwater habitats that they are found in.

The species data collected will be used to assess the risk of extinction to the species, using the Red-Listing methodology (Sheet x). The species information, maps and Red List status can then be combined with information from other parts of the assessment, using linking information such as the local names for species and the habitat areas where species are harvested from. Following suitable analysis, it will be presented in a suitable format for decision makers, including maps which integrate the information in a visually accessible and easily understandable way.

## B2. Planning a field survey

Field surveys will be required to provide the species information that is not available in the existing literature. It is unlikely that much information will be available on the location of species within the study area, so an important component of the field survey will be to provide information on the local distribution of species.

Once the species groups to be included in the survey have been chosen and the survey boundaries have been defined (as described in Sections 3.3 and 3.4), the field survey can be planned. The sampling protocols required for fish, molluscs, odonates, amphibians, reptiles, birds, mammals and aquatic plants are detailed in Sheets B4-B8, and general notes on species surveys are given in Sheet B3. If other groups need to be surveyed, relevant protocols can probably be found on the internet, or by contacting experts on those species (to locate such experts, contact the IUCN Freshwater Biodiversity Assessment Programme).

### *Choosing survey sites*

1. Find out how much time is available for biodiversity work i.e. number of days in the field and number of people with biodiversity expertise.
2. Decide what other activities are needed in addition to the biodiversity surveys, such as documenting conservation issues and threats to biodiversity, market surveys, mapping habitats (if required – See Sheets M1-M7), collecting linking information such as the local names of habitats and species etc. How long will these activities take and who needs to do them?
3. Choose appropriate biodiversity survey methods and make an estimate of how long they will take.
4. Given the time needed to survey each site (and to travel between sites), how many sites can be surveyed? Choose survey sites such that all wetland habitat types present are surveyed (see Sheet M6-7).
5. Draw up a timetable of work. This will need to be finalised in conjunction with the other members of the team. It is important to leave time for team meetings to share information, discuss issues that come up and check that sufficient linking information is being collected.

### *Getting equipment together*

This should be done early, as some equipment may take time to order or make. Go through the species protocols that you intend to use noting the pieces of equipment that will be needed. The most important pieces of equipment will be a GPS with spare batteries, a camera, field guides, the pots and vials to store specimens in, preservative fluids to put in the pots, and labels. Sheets on which to record information should be made (e.g. the one shown on Sheet B3).

Ideally all species protocols should be tested before going into the field (or during the scoping trip) to ensure that all equipment needed is present and working and that everyone knows how to use it.



### B3. Conducting species surveys

This section describes general protocols for field surveying. The subsequent sections describe field survey methods specific to the different species groups.

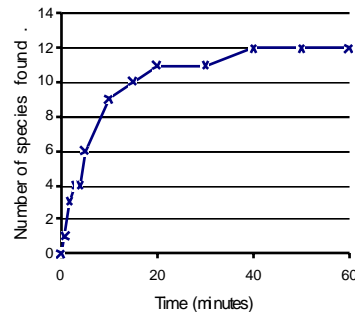
#### *Choosing sampling protocols*

A standard sampling protocol should be chosen for each species group, which will be followed in the same way at each site. The methodology chosen will depend on the nature of the area and on the time and equipment available for sampling. The methods described in the following sections have been organised by taxa, but in reality each sampling method is likely to collect many different taxa, and taxa of interest can be recorded even if caught opportunistically while sampling for another group.

#### *Sampling intensity / duration*

For some groups (e.g. for birds, plants), a predefined area or transect length may be used to standardize sampling between sites. For other groups, timed searches may be more appropriate e.g. for molluscs. Ideally the time given to searching should be chosen by sampling a small number of sites more intensively and recording how many species are located per unit time (see graph below). In this case, after 10 minutes 75% of species have been located, so you might choose to sample for 10 minutes at each location, or 20 minutes to find more than 90% of species present.

**Figure 11: Sampling intensity and duration**



#### *What to record*

The following information should ideally be recorded for each species found:

- the name of the recorder and date of sampling
- the exact location (as measured with a GPS – if the GPS data can be downloaded later, only the waypoint number need be noted in the field)
- if the species cannot be identified on site, then a voucher specimen reference number or a photo number
- the habitat the species was found in and any other useful notes on the ecology of the species, such as its abundance
- the local names for: the species, the habitat type it was found in and the location (if local guides are present to give this information)
- additional information on the use, value and cultural role of the species if local guides can give this
- the sampling method used and the effort/time spent sampling.

An example recording sheet is shown below; this will need to be tailored to meet the needs of individual surveys.

**Figure 12: Example of biodiversity data collection sheet**

Suitable for use if there are few species at each location	<h2 style="margin: 0;">BIODIVERSITY DATA COLLECTION SHEET</h2>	Sheet no. <input style="width: 30px; height: 15px;" type="text"/>						
Name of recorder <input style="width: 150px; height: 20px;" type="text"/>	Date <input style="width: 80px; height: 20px;" type="text"/>	Wetland Habitat Type <input style="width: 100px; height: 20px;" type="text"/>						
Taxonomic group(s) being sampled <input style="width: 100px; height: 20px;" type="text"/>	Sampling <b>methods</b> used and time/effort put in: <input style="width: 300px; height: 30px;" type="text"/>							
<b>Records</b>								
ID / no.	Location GPS Lat./Long /Way Point no.	Species identified?	Specimen collected?	Photo(s) taken?	Species name OR Specimen no. AND/OR Photo no.s	Habitat where found and notes on ecology	Local name(s) for species, habitat, location	Notes on use, value, any other information

**Collecting or photographing specimens**

Species which can be identified in the field need not be collected. Species requiring identification should either be collected (storage protocols are described for each species group in the following sections) or photographed. Generally large animals such as birds and mammals should not be collected, nor distinctive species which will be readily identifiable from photographs. However species which are more difficult to identify (such as fish, molluscs and dragonflies) will probably need collecting. When taking photographs of species, it is important to ensure that key diagnostic features are visible, and to include something for scale, such as a ruler.

Collected specimens should be labelled in a standardized way; the collector, date, location and unique reference number should be written on a piece of paper with a pencil or permanent pen and either stuck onto the specimen container, attached to the specimen or placed in the container with the specimen. It is important to check that the labels remain intact, legible (the paper must not disintegrate or the pen ink dissolve) and associated with the correct specimen/container. For brightly coloured specimens (e.g. dragonflies and flowers) it is useful to either note the colours or take a photo, as the colour may be lost when the specimen is preserved. If the same species is encountered a number of times, only one specimen need be collected and this can be referred to when the species is found at other locations.

**Identification to species**

If good keys to species groups are available, it may be possible to either identify species in the field or later using specimens or photos. Taxonomic experts can also be contacted for help; one way to find such experts is through the IUCN Species Survival Commission specialist groups. Ideally this should be done early in the planning stages because the taxonomic experts will be able to give advice on the best ways to collect and store the species, and if taxonomic experts are not available, then it may be preferable to focus on other species groups. Alternatively it may be acceptable to use lower levels of taxonomic identification (e.g. to family or genus) or to classify specimens into 'morphospecies' (species which clearly look different); this will require less expertise and take less time (this is discussed further in Section ?).

**B4. Fish survey sampling methods**

A range of fishing techniques will need to be employed to obtain a complete inventory of the fish species present in the survey area. For practical considerations, such as costs and available time, it is strongly advised that local fishers be employed, using a range of locally designed fishing gears, to conduct the initial survey. Gaps in the area surveyed can be filled later, using additional gears (for example to capture less commercial species) and in additional locations, possibly fishing at times not normally fished by local fishers (e.g. at night). Fish need only be collected if identification is not possible on site; fish may be stored in alcohol or formalin.

**Market and fishery surveys**

A good start to any fish survey is to visit the main fish markets in the area to build up a picture of the species being traded; this is also a good opportunity to collect integrated data, e.g. on the value of different fish species (see Sheet Bx: Market Surveys). Photographs should be taken to make a library to use when asking local people when and where species are caught.

Following these initial surveys, researchers can accompany fishermen to the fishing sites to sample their catches, and to collect location data on where species are caught using a GPS.

*Using local knowledge and expertise*

If areas already have fishery monitoring programmes, researchers can seek permission to use the data collected. Alternatively local fishers can be paid to record their catches, or a representative from the fishing community can be employed to collect examples (voucher specimens) of the species caught. These specimens can be stored in individual plastic bags, which can be pricked with holes and placed in a plastic bin of formalin<sup>1</sup>. A label giving the local name of the fish and the capture location (written in pencil) should be placed inside each plastic bag. Periodically the fish should be collected and identified to their scientific names. This is an efficient way of making an inventory of local fish species.

*Conducting a fish survey*

The local fishers may not fish in all the habitat types present, so some habitats may have to be sampled separately. Either local fishers can be employed to collect fish samples in these areas, using their own gears under the guidance of the survey leader, or separate fish surveys can be done.

A variety of fish survey methodologies are summarised below (adapted from Backiel and Welcomme, 1980). The choice of method and how the method is employed will depend on the habitat being sampled; depth, clarity, vegetation and flow will need to be considered (Côté and Perrow, 2006). The most suitable methods for an area are likely to be those already used by local fisherfolk, so it may be wise to borrow or rent equipment from them. It is desirable to use a range of sampling methods to overcome method-specific biases, to conduct day and night sampling, and to sample in places with only small, less commercial species.

**Gillnets** are versatile, low cost and easy to operate. They can be used in lakes of any size, in deep or shallow water, over bottoms too rough for seine nets, and on a large or small scale. For example, one man can carry a canoe and a few gillnets to sample remote lakes inaccessible by road. Their main disadvantage is that they may not catch largely sedentary species, and a wide range of mesh sizes are needed to ensure capture of the full range of fish sizes present. They are suitable for collecting qualitative information on the species present, as required during rapid species assessments, and can easily be placed in the range of freshwater habitats present.

Gillnets vary widely, both in their physical structure (dimensions, colour, mesh size, twine material and thickness, hanging and rigging of weights and floats) and in how they are set (perpendicular or parallel to shore; in straight lines, zig-zags or looped to form traps; anchored in place or drifted with currents; left alone or having fish scared into them by beating the water). The choice of net types and method will depend on the type of water and species of fish to be sampled. Initially it is probably best to follow the example of local fishermen.

**Traps** come in a wide range of sizes and designs including small "basket traps" and "fence traps" which direct the fish into baskets. Local fishermen will often have designed traps most suitable for the area to be surveyed, and it is recommended that such traps are either borrowed, rented or purchased for the survey.

**Seine nets** are suitable for collecting rapid samples but can only be used where the river or lake shore grades into a hard, gently sloping bottom with no obstacles such as rocks or submerged branches. When skilfully employed, they can capture the majority of fish within the sample area. However they are expensive, unless they can be rented from local fishermen. They also normally require a boat to take out the net in a sweep of the area being sampled.

**Cast nets** can be employed to fish in most wetland habitats but they require a certain degree of skill for effective use.

A **hook and line** is one of the most common methods used for catching fish, requiring only a single baited hook and fishing rod, making it cheap and easy to use. Alternatively long lines of hooks can be used, and these may be left tethered to posts for a period of time or overnight. This method is selective for carnivorous species that readily take the bait.

**Electrofishing** requires specialised equipment operated by trained personnel. It is quick, requires few people and little physical exertion; however it is dangerous for both fish and operators, and the equipment is expensive. It is mainly suitable for use in flowing water less than 2m deep; in still water, fish can escape in all directions, reducing its effectiveness.

**Poison** such as rotenone and **explosives** are considered to be too destructive for use in ecological surveys whose aim is the conservation of species.

*Where to sample and how to standardise fishing effort*

The full variety of wetland habitats present should be sampled, as described in Sheet M5. Within each habitat type, it is recommended to sample from as many sub-habitats as possible to get comprehensive species lists (e.g. within a lake, there may be shallow vegetated areas, deep areas and rocky shores).

Fishing effort is usually standardised using Catch Per Unit Effort, e.g. by fishing for one man-day in each habitat using all suitable fishing techniques and in the greatest variety of sub-habitats possible.

#### *Collecting and storing fish*

Where fish can be identified to species on site, there is no need to collect specimens. If there is uncertainty as to the identification of the fish, one specimen of each species should be collected. Fish should be killed, using an anaesthetic such as **Benzonocaine if this is available**, before being placed either in formalin or in alcohol. Formalin is simple and cheap, but very toxic (see footnote on previous page), so alcohol may be preferred. Fix fish in 70% alcohol before storing them in 40% alcohol (Sutherland, 2000). Placing fish and labels in pierced plastic bags within a larger container of formalin or alcohol (as described above) avoids the need for several individually labelled containers (be sure to write labels in pencil as the ink will be washed out in the alcohol). If using individual containers, make sure they are alcohol proof (many will dissolve in alcohol or will leak). The colours of fish should be noted or photographed, as they will soon be lost in alcohol. Fish colours are often particularly vivid a couple of minutes after applying anaesthetic (Sutherland, 2000). For large fish which cannot be collected for practical reasons, photos should be taken, including diagnostic features and an object for scale (such as a ruler).

#### *Further information*

Backiel and Welcomme (1980) and Côté and Perrow (2006) provide excellent overviews of fish sampling methods, with much additional information.

#### *References*

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Côté, I.M. and Perrow, M.R. 2006 Fish. In: "Ecological Census Techniques: A Handbook" (ed. W.J. Sutherland); 2<sup>nd</sup> edition. Cambridge University Press, Cambridge, UK.

Sutherland, W.J. 2000 The Conservation Handbook: Research, Management and Policy. Blackwell Publishing, Oxford, UK.

## B5. Mollusc sampling methods: Gastropods

### *Gastropods*

Gastropods can be collected using quadrats, sweep netting through vegetation, dragging a hand-net over the underwater substrate surface and washing/scrubbing rocks. The different methods are suited to different environments as described below.

**Quadrat Sampling:** This is suitable for shallow slow-flowing areas. In coarse substrate areas such as cobble-boulder bars, molluscs should be either hand collected or brushed from individual stones into a tray or sieve. In areas with rock or embedded cobble-boulder substrate, the bedrock or stones should be scrubbed underwater with a brush so that dislodged snails are swept into a submerged net or sieve placed downstream. Cobble-boulder substrates may be lifted into a tray underwater and carried to a more convenient location for processing, with material dislodged as the stones are collected being caught in a net positioned downstream.

Areas with fine substrate (such as muds, sands, or silts) are sampled by excavating small areas of bottom sediment to a depth of about 3 cm using a dip net or sieve with an effective mesh size of 0.5mm or smaller. The sample should be washed several times through a sieve to remove as much mud, silt, and sand as possible. If the sample is placed in a bucket and the contents swirled and then decanted, most of the fines will be flushed out as well as detritus and vegetation while leaving the heavier snails at the bottom of the bucket with the coarser and heavier sediments. Generally a 0.25 – 0.5 litre volume of sieved "concentrate" from each such site is an adequate sample.

A series of quadrat samples, ranging from a minimum of eight to as many as 16, should be collected from within each sampling site to produce a total area sampled equal to about 0.5-1m<sup>2</sup>. Quadrat samples may be: 1) concentrated in areas perceived as representing the most suitable habitat to enhance the possibility of detecting the target species, or 2) placed systematically along a river reach if the area appears to be relatively homogeneous or the surveyor is inexperienced and wants to achieve a more objective approach. Quadrat squares may be fabricated from wood or strong wire painted white, to aid underwater visibility.

**Sweep-netting:** Areas with rooted aquatic macrophyte vegetation may contain large numbers of gastropods. In shallow areas, a hand net can be swept through the vegetation, its contents placed in a bucket of water, and any vegetation can be vigorously shaken to dislodge molluscs. In deeper waters a grapnel (weighted 3-way hook on a rope) will bring vegetation to the surface, which can then be washed into a bucket to retrieve attached gastropods.

**Other methods:** Some gastropods will also be found using the methods for sampling small bivalves, as described below.

**Preparation of specimens for relaxation, storage and identification:** Mollusc samples should be cleaned after collection and prior to relaxation to remove as much debris and as many other organisms as possible. Specimens are more easily observed and sorted if they are submerged. 'Relaxation' is used to encourage the snail body to come out of the shell, making the soft parts available for species identification: the sample of snails should be covered with cool, clear, preferably well-oxygenated water collected from the site; they should be placed in as many flat-based containers as necessary to avoid individuals frequently touching one another; next add a small amount of menthol and/or propylene phenoxylol to each container and leave the specimens undisturbed in the dark over night at room temperature; after 8-12 hours, replace the water with 4% formalin to fix the specimens (this step is necessary because many species will contract considerably if placed directly into alcohol). Snails left for longer than 24 hours may die and contract. In 1-2 days, replace the formalin with 70% isopropyl or ethyl alcohol. If larger molluscs are present, they should be removed and relaxed separately.

Where samples contain large volumes of substrate (sand-fine gravel) and small numbers of molluscs, separation and relaxation of specimens is not practical, and the sample can be preserved in the field. The sample should then be resieved in the laboratory to remove fine sediment and plant and animal detritus, and the full volume picked through under a low-power binocular microscope, especially if small or inconspicuous species are present.

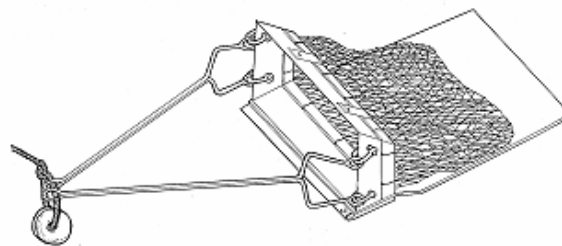
For long-term preservation, the specimens should be placed in 70% ethyl alcohol-15% glycerin-15% water, and buffered to pH 7. While it is preferable to keep the soft-parts of snails, if it is considered sufficient to only identify gastropods to genus or family (e.g. in a rapid assessment), then it may be easier to just keep the shells. To remove the soft parts, place the snails in boiling water and then pull the soft parts out of the shell with forceps.

#### *Large Freshwater Bivalves (> approx 25mm in length)*

Large bivalves tend to be found in shallower areas, although they may be found at lower densities at greater depths. A variety of sampling methods are possible, as described below. If a motor boat is available, dredging is probably the quickest and easiest method. Otherwise hand-sampling (if the water does not contain dangerous diseases or animals) or using a hand-net from the bank are the best methods.

**Dredging:** A dredge (Fig. B5.1) can be used to collect large freshwater bivalves, either by throwing it into the river from the bank or by pulling it along behind a boat travelling upstream. The mesh size defines the size of the smallest bivalve collected. Its use may be limited by the substrate, depth and flow of a river. To standardize sampling, it is recommended to drag it across a standard distance (e.g. 10m) a fixed number of times (e.g. 5 times) at specified points in the river. Alternatively a fixed sampling time can be used, and then Catch Per Unit Effort can be calculated. It is not a very quantitative sampling method, but is generally quick and easy in shallow waters (i.e. < approx. 8m, where most of the mussels are often found – but this may vary a lot with different rivers).

Figure 13: A hand-dredge (mouth: 46 x 21cm, weight 1kg, mesh size 2.5cm)



**Using a grab:** Grabs are more quantitative than dredges but collect over a smaller area of substrate, so more grabs are required to sample the substrate sufficiently to detect most of the species present. They work at greater depths and higher flows. They are less effective on some substrate types such as very firm substrates. A standard number of grabs are taken from each sampling point, and the area sampled can be calculated from the area of gape of the grab. Problems with grabs are that they are often heavy and unwieldy, so need to be used from a relatively sturdy boat and need a lot of strength to lift; typically some kind of winch or pulley system is needed (the weight is needed to ensure the grab scoops into the substrate).

**Hand-sampling:** This is only possible in the shallowest margins of rivers where it is possible to reach the substrate. However these areas often contain the highest densities of mussels. It can be made quantitative by either sampling within quadrats or doing timed searches. It is suitable for very turbid rivers with muddy substrates as well as clearer waters, where mussels may be located by sight (e.g. using a glass-bottomed bucket). Where mussels are at relatively high densities, it is the quickest and easiest method of sampling.

**Using a hand-net:** If the water is shallow and easily accessible, mussels can be sampled using a standard hand net with a relatively large mesh bag, which is dragged across the substrate surface either from the bank or from within the water. However if mussels are present at low densities, they may not be found at all using this method. The only way to make this method quantitative is to do timed-searches.

**Scuba-diving:** This is expensive and often not practical, requiring a lot of expertise, expensive equipment and presenting various safety issues. It is widely used in North America in relatively shallow rivers with very low turbidity so that mussels can be searched for by sight, using timed searches.

**Storing mussels for later identification:** Mussels should be rinsed with water to remove any mud. Mussel identification is often by shell characters, so the soft parts may not be needed: check identification keys for local species. If the soft parts are required, mussels can be placed in 95% ethanol, which should be changed after a couple of days as the mussels contain a lot of water (70% can be used). If only the shells are required, live mussels can be placed in boiling water until they open, and the soft parts removed. Recently-dead mussels are often found, so it may not be necessary to kill live specimens. Both valves (shells) should be kept, attached together by a rubber band or string around the shells.

#### *Smaller Freshwater Bivalves (< approx 25mm in length)*

Smaller bivalves can be collected by a wide range of sampling methods including netting, sweeping submerged vegetation (as described for gastropods) and kick sampling (see section B6).

**Hand-netting:** An ideal hand net to use for this purpose is a robust, aluminium-framed pond net with a 2m handle (in two 1m long sections, attached together with a screw joint) and frame (approximately 0.4m square), equipped with a nylon mesh bag (0.3m deep, 0.5mm mesh) (Fig. B5.2). Most bivalves live close to the surface of the substrate and can be collected by skimming the sample net across the top 2-3cm of sediment, either from the bank or from a small boat. Agitate the net in the water to sieve out mud and silt, taking care not to lose the sample. The material can then be washed into a white sorting tray or bucket, before passing it through a 4mm sieve to collect the larger specimens and to remove coarse debris, and then through a 0.5mm sieve to collect remaining bivalves; shake the sieve in water to remove as much mud as possible. The material can be further reduced by gently swirling it in water and decanting off any remaining organic detritus. Specimens can be picked from the sediment by examining a small quantity in a petri dish under a binocular microscope at x6 to x10 magnification. The sediment should be covered with water to disperse the sample in the dish.

Figure 14: A hand-net for sampling small bivalves



**Dredging:** For water bodies deeper than 1.5m, samples can be collected using a hand dredge (as described above). Although these are usually equipped with a relatively coarse-sized mesh (>4mm), on soft substrates they rapidly become clogged with fine sediment, which can then be passed through sieves in order to pick out smaller bivalves.

**Processing and storage of samples:** Samples can be stored in water or preserved in alcohol. They will remain fresh for 3-4 days when stored in 0.5 litres of their native water and kept in a refrigerator. If live specimens are to be returned to their original habitat, they should be examined under a cold light source; a short period out of water will not kill them. If the samples are not examined within a few days, they should be preserved in 70-80% alcohol (Industrial Methylated Spirit, IMS). Material may be fixed initially in 4% buffered formaldehyde. However, it should be washed and transferred to alcohol as soon as possible, as deterioration of the shells is often rapid, and diagnostic shell surface features may be lost. Addition of glycerol to prevent alcohol evaporation is not recommended as the specimens will not completely dry and will retain an oily layer which hampers examination of surface textures and sculpture. Alternatively specimens may be placed on absorbent paper and allowed to dry.

Internal examination of the hinge features requires the separation of the two valves. For freshly collected specimens and those preserved in alcohol, the valves may be opened and the animal removed by immersing in boiling water. Articulated specimens that are totally dry can also be boiled to separate the valves but some may require chemical treatment by placing them in a solution of domestic bleach (50/50 with water); this will dissolve the hinge ligament, periostracum and soft parts of the animal although such treatment can result in shell degradation. As soon as the treatment is complete, the separated valves should be washed in water to remove the bleach and allowed to dry. The bleaching will whiten the shell and enable features of the hinge line to become more clearly defined, but the exterior lustre of the periostracum will be lost.

### Further information

A comprehensive guide to sampling for freshwater mussels is given by Strayer and Smith, 2003. For further details and diagrams about how to make a dredge, contact Anna Mdivor (IUCN, Cambridge, UK) or David Aldridge (Dept of Zoology, Cambridge University, UK). The information on collecting smaller bivalves has been taken from Killeen, Aldridge and Oliver, 2004; it is the protocol used for sampling small bivalves in the UK, so may need some alterations to adjust it for use in a much larger tropical rivers. The information on gastropod sampling has been taken from a document by the US Bureau of Land Management by Furnish, Monthey and Applegarth, 1997.

## B6. Odonate sampling methods

### Adults

**Habitats:** Dragonflies and damselflies occur in all types of freshwater habitats and in nearby habitats. They like sunny places where they can bask, but there are also many species which live in shade (but even these are more likely to be out when the sun is shining). Widespread species will be found even around temporary or disturbed habitats such as puddles, rice fields and ditches; specialist and endemic species are likely to be found in pristine forest wetland habitats and small special habitats such as seepages (where water oozes from the ground), the spray-zone of waterfalls, wet trickles on rock faces, torrents, small pockets of water in tree holes (phytotelmata) or small pools and swamps in forest (K.-D. Dijkstra and V. Clausnitzer, pers. comm.). As many of these likely habitats should be sampled as possible.

**Survey methods:** They may be surveyed either by catching them or by observing them with close-focus binoculars (M. Samways, pers. comm.). To catch them, use a large hooped net on a long stick; a 40 – 75cm diameter hoop with a handle 1 – 2m long is suitable; extendable poles are very useful (Dijkstra, 2006). The netting is usually white, green or black and the bag of the net needs to be deep enough to fold it closed, so that the dragonfly is not able to escape when you flip the rim over the net to trap it in the bag.

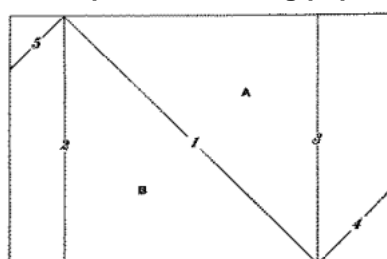
The best way to catch a dragonfly is from behind – if you try to catch them head on, they are likely to avoid the net entirely or, if caught, to be damaged in the attempt. The most effective technique is to wait until the adult dragonfly is just past you, and then swing the net from behind. Some species are more easily caught when they alight on a perch or while basking on logs, or at certain times of day. Watching the habits of a species before trying to catch it will yield greater success. Only sample mature males (M. Samways, pers. comm.).

Initially it will be necessary to build up a reference collection of what species are present by catching and preserving them; once familiar with the local species, it may be possible to record species by observation only, or by catching them and re-releasing them. Even if a species' scientific name is not known, the species may be recorded using either a local name or by referring to a reference specimen which will be identified to species later.

Once caught, dragonflies are best held with the wings folded together between the thumb and forefinger; larger species can be held at the thorax or legs, provided at least three legs on one side are grasped. If handled carefully, most individuals will fly off unharmed if released (Dijkstra, 2006).

**Preservation:** To preserve specimens, first make a note of the colours (particularly the eye colour) or take a photo, as the colours are likely to fade, and then place them briefly in acetone to kill them and to soften them so that the wings can be placed together and the abdomen straightened. Then place the specimens in porous paper envelopes or triangles (Fig. B6.1; newspaper is suitable to make these) to hold them in position. Make sure the envelope is labelled in pencil (pen inks tend to be washed out by acetone or alcohol), including the photo number and unique specimen number to match up with other notes on the species. Place in a jar of acetone for 12-24 hours; then remove from the acetone and allow to air dry in a breeze or in the sun for as long as necessary (up to several days). Beware ants and other consumers! Silica gel may help with the desiccation process. Acetone is usually available from chemical supply stores in large towns and cities, but otherwise specimens can be placed in 70% alcohol which should be changed frequently.

Figure 15: Template for making paper triangles



### *Exuviae*

Exuviae are the cast larval skins of the penultimate instar of Odonata; as the larval characters are quite evident, most exuviae are identifiable to species level. They can also provide useful information about where species live and where they emerge. Good places to look for exuviae include rocks along the edge of the water, debris sticking out of the water, emergent aquatic vegetation such as reeds and rushes, tree snags and branches, wooden posts, bridge abutments, pilings etc. Generally exuviae are found only a few inches above the level of the water, but occasionally they may be up to 2m above the water level. They are easier to find by looking from the water towards the shore than the other way round. No special equipment is needed to collect them – only pots in which to put them so they remain intact and do not get crushed; make sure they are dry before storing them.

### *Larvae*

Damselfly and dragonfly larvae are aquatic and are most commonly found in ponds, marshes, lake margins, shallow areas of streams and the slower reaches of rivers and streams; a few species occur in brackish pools and estuarine habitats. Larval Odonata are most easily collected by kick-sampling in shallow areas or sweep-netting in amongst aquatic vegetation. Some will also be caught by dredging (e.g. when surveying for bivalves).

**Kick-sampling:** Small pools are best sampled with a small dip-net, while rivers are best sampled with a hand-net or kick-seine. Place the net downstream about 1 foot from your feet, and then disturb the substrate with your feet. Organisms that are dislodged will be collected by the net or screen. Empty the net into a pan or screen to pick out the organisms. The hand-net can also be used to sample underneath undercut banks, and to swept through aquatic vegetation growing in slow-moving or still-ports of the stream or river. It is a good idea to sample among and underneath woody or leafy debris accumulations, as these habitats often harbour a great number of Odonata (Bright, 1999).

Place specimens in 70% alcohol. Do not put too many specimens in a container, as they may damage each other before they die. If a lot of debris is placed in the container with the organism, it is probably best to use 95% alcohol to compensate for dilution. In either case, replace with 70% alcohol frequently.

### *Further information*

There is extensive information on the internet describing how to sample for odonates. The Asia Dragonfly web-site provides an excellent guide by Viola Clausnitzer, KD Dijkstra and Vincent Kalkman, downloadable from <http://www.asia-dragonfly.net/> (follow the link labelled "How to: Studying Tropical Dragonflies and Damselflies"). The Michigan Odonata Survey (<http://insects.ummz.lsa.umich.edu/MICHODO/mospubs/>) has several useful technical notes, such as [Collecting Specimens for the Michigan Odonata Survey](#); [Odonata Collecting Instructions](#); [Sampling Protocol for Juvenile Odonata](#); and [Preserving Adult Odonata](#).

The International Odonata Research Institute Odonata Information Network (<http://www.iodonata.net/>) has several useful pages, particularly their "Collecting and Preserving Dragonflies Frequently Asked Questions" page, which has extensive discussions on what are the best nets to use and how best to preserve adult specimens so that they keep their colour. Notes on kick-sampling can be found at [www.environment.fi](http://www.environment.fi) and the [Western River Basin District Project](#).

### *References*

- Bright, E. (1999) Sampling Protocol for Odonata Larvae. Michigan Odonata Survey Technical Note No. 2., Insect Division, Museum of Zoology, University of Michigan, U.S. <http://insects.ummz.lsa.umich.edu/MICHODO/mospubs/MOSTN2.pdf>
- Dijkstra, K-D. B. & Lewington, R. (illustrator) (2006) Field Guide to the Dragonflies of Britain and Europe. British Wildlife Publishing. Gillingham, Dorset, UK.

## B7. Sampling methods for non-fish vertebrates associated with wetlands (herpetofauna, birds and mammals)

The species richness of non-fish vertebrates such as herpetofauna (amphibians and reptiles), birds and mammals can be used as indicators of the ecological integrity of wetland habitats. They can be used to prioritize wetland habitats for conservation, and also highlight the relative importance of different sites (for breeding, feeding, resting etc.). In most instances, local communities depend on these groups as supplementary food resources. A variety of standard sampling techniques can be adopted to document the species composition, richness, density and relative abundance of non-fish vertebrates associated with wetlands, where sampling needs to be carried out during both day and night (especially to record herpetofauna and mammals). It is also necessary to have field identification guides for different groups of vertebrates, to facilitate the identification of individual species in the field itself. If a species (especially herpetofauna) cannot be identified in the field, a specimen needs to be collected, and/or it should be photographed, for subsequent identification.



*Sampling methods for herpetofauna*

Most species of herpetofauna in general tend to be active at night time, hence the need to conduct nocturnal sampling. One has to also consider the fact that amphibians in particular may be low in abundance during the dry season, hence the need to conduct sampling especially during the wet season, which coincides with their breeding. Some standard sampling techniques to record herpetofauna are highlighted in Table 2 (adapted from Heyer *et al.*, 1994):

**Table 2: Standard sampling techniques to record herpetofauna**

Technique	Information gained	Time <sup>x</sup>	Cost <sup>y</sup>	Personnel <sup>z</sup>
Visual encounter surveys	Species richness	Low	Low	Low
Quadrat sampling	Density (also relative abundance and species richness)	High	Low	Medium
Transect sampling	Density (also relative abundance and species richness)	High	Low	Medium
Drift fences and pitfall traps	Relative abundance (species richness as well)	High	High	High

<sup>x</sup>Relative time investment

<sup>y</sup>Relative financial costs: High – expensive; Medium – moderately expensive; Low – relatively inexpensive

<sup>z</sup>Personnel requirements: High – more than one person required; Medium – One or more persons recommended; Low – can be done by one person

A visual encounter survey (VES) is the easiest and lowest cost technique to document herpetofauna associated with wetlands. This involves one or more field personnel walking through an area or habitat for a prescribed time period, systematically searching for amphibians and reptiles. Time is expressed as the number of person-hours of searching in each area to be compared. A VES can be easily carried out in a plot, along a transect of specified distance, around a pond or along a stream/river.

Quadrat sampling consists of laying out a series of small quadrats (or strip quadrats) at randomly selected sites within a habitat and thoroughly searching these quadrats for herpetofauna. The quadrats should be separated by adequate distance to avoid presampling disturbances. The size of the quadrats to be used could vary from 1 x 1m to 8 x 8m, according to the density of species in a particular locality (large size if density is low).

In general, herpetofauna (especially amphibians) tend to respond differentially to environmental gradients governed by moisture, vegetation cover etc. The transect methodology can be used to sample either across these habitat gradients or within habitat types, where randomly located narrow linear strip transects (i.e., 2 x 50m or 2 x 100m) are laid out, and the portions of habitats within the transect are thoroughly searched for herpetofauna.

The drift fences and pitfall traps involve the use of drift fences which are short barriers (up to 1-2 feet in height and 5-15m in length) that direct animals into traps placed on either side of the barriers. The traps can be pitfalls, funnel traps, or a combination of the two. The traps could be prepared from plastic tubs or pipes. The drift fences and pitfall traps can be placed around ponds, marshes, and in stream/river banks, arranged either in a linear manner, or in a combination of arrays.

*Sampling methods for birds*

Birds, being generally conspicuous, make them easy to be surveyed and counted. Some standard sampling techniques to record birds are highlighted in Table 3 (adapted from Sutherland, 2000, and Sutherland *et al.*, 2004).

**Table 3: Standard sampling techniques to record birds**

Technique	Information gained	Time <sup>x</sup>	Cost <sup>y</sup>	Personnel <sup>z</sup>
Species discovery curves	Species richness	Low	Low	Low
MacKinnon lists	Species richness	Low	Low	Low
Timed point counts	Density (also relative abundance and species richness)	High	Low	Medium
Line Transects	Density (also relative abundance and species richness)	High	Low	Medium

<sup>x</sup>Relative time investment

<sup>y</sup>Relative financial costs: High – expensive; Medium – moderately expensive; Low – relatively inexpensive

<sup>z</sup>Personnel requirements: High – more than one person required; Medium – One or more persons recommended; Low – can be done by one person

The species discovery curves (SDC) and MacKinnon lists (ML) involves similar techniques, where the cumulative (total) number of species recorded is plotted against sampling effort (i.e., number of observer hours/days – for SDC, and number of lists of 20 bird species – for ML). The MacKinnon lists method in particular enables to compare birds species richness in different sites, through the curves in the plot. The species discovery curve for a particular site shows the point at which further effort is unlikely to reveal further species in a particular locality.

A point count is a count of species (and individuals) undertaken from a fixed location for a fixed time period (i.e., 10-20minutes). Points should be at least 200m apart to prevent double counting. Line transects involves observer(s) moving along a fixed route and recording the birds they see on either side of the route. Transects can be carried out by walking on land (i.e., along river banks), or by sailing in a boat (i.e., along a river). The total length of the transect could vary according to the size of the wetland, and range from 100m to 1000m. It is also possible to conduct timed point counts, at fixed distances along a line transect.

### References

Heyer, W.R., M. A., Donnelly, R.W., McDiarmid, L.C. Hayek & M.S. Foster (Editors) (1994). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution. 364pp.

Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Publishing. 278pp.

Sutherland, W.J., I Newton and R.E. Green (2004) *Bird Ecology and Conservation: A Handbook of Techniques*. Oxford University Press. 386pp.

## B8. Plant survey methods

Because of the high diversity of wetland plants, it will probably be necessary to restrict surveys to aquatic plant species of importance to humans. In order to discover which wetland plants are used, researchers should go to local markets, interview people in their homes about wetland plant use and, perhaps most importantly, visit the chosen wetland habitats with local people and ask them which plants are used and what for (using standard ethnobotanical techniques). Plants which they point out as being important to local livelihoods can then be identified (if a taxonomic expert is present), or collected for later identification (as described below).

Such an approach is recommended where time is limited. This approach will provide information which is suitable for integration with the economics and livelihoods data.

If more time is available, it may be possible to do a more thorough survey of the aquatic plants of the area. The aquatic flora may be roughly divided into macroalgae, submerged vascular plants, emergent vascular plants and bank-side vegetation, with a possible fifth category of seasonally-flooded terrestrial plants.

Bank-side flora and seasonally-flooded terrestrial flora may be surveyed by laying out transects with a rope and identifying all plants to a certain distance on either side of the transect. The transect length and width will depend on the time available for the survey; a standard length is 100m. Ideally several shorter transects widely spaced throughout a habitat are preferable to one long transect, but a long thin transect is preferable to a short fat transect. Alternatively quadrats may be marked out at randomly picked locations across a site and all plants with their roots within the quadrat recorded. Again, a larger number of smaller quadrats is preferable to a small number of large quadrats.

Similar approaches may be used for submerged and emergent vegetation, where transects may be marked out in the water using buoys (these can be made from an empty bottle or a balloon attached to a rock with a rope whose length is approximately the same as the water depth), and then all plants that are visible from a boat or collected with a grapnel along the transect recorded. Alternatively, sampling can be done from predetermined randomly-chosen locations in the water located using a GPS, either from a set area (e.g. an imaginary 3 by 3m 'quadrat' next to the boat) or with a standardized number of throws of the grapnel (Madsen, 1999).

It would also be possible to survey along transects laid out perpendicular to the shoreline, thereby encompassing all forms of aquatic vegetation.

Emergent, bank-side and terrestrial plants may be collected by hand (gloves are recommended as some plants may be poisonous and biting/stinging insects may live amongst the plants). Macroalgae are often found in mats at the surface and may also be collected by hand. Submerged vegetation and deeper algae may be collected using a grapnel or any kind of weighted hook or rake attached to a rope. Alternatively a dredge or grab may be used; these are likely to damage plants, but may bring up tubers or rhizomes which could be useful in plant identification. Diving is also an efficient method of surveying submerged aquatic vegetation, although it may be costly and requires divers who are sufficiently qualified and experienced; in particular diving in very turbid water or flowing water is challenging and potentially dangerous.

### *Collection and storage of plants (adapted from Sutherland, 2000)*

Plants which cannot be identified in the field should be collected for later identification. They should first be dried in a press by placing the plant between sheets of newspaper, with layers of corrugated cardboard between the plants to allow air to get into the stack (the cardboard should be cut so that the corrugations run along the width and not the length of the stack). The plants should be arranged as they are intended to look in the herbarium (if this is where the specimen will end up), or in a way which demonstrates the characteristics necessary for identification, i.e. showing both sides of leaves and the underside of flat flowers. A sheet of paper, felt or foam rubber (if the specimen is bulky) is placed on top before the next specimen. In damp areas, or if pressing succulent plants, the paper should be replaced every few days. Laying each plant out so that the features can be observed when flattened takes time, so it is best not to collect more plants than can be pressed.

The pile of specimens can be compressed with weights such as books but a flat press made of hardwood or plywood (softwood tends to crack under the strain) is much better and essential for serious collecting. These are commercially available but can be easily made. They consist of a wooden grid (typically 20 x 45cm) at each end of the stack of specimens. Kneel on the entire stack and tighten with straps running round the press. Adequate small presses can be made from wire grids, such as cake trays and strong string. The press may be kept above a stove or above oil or gas lamps to aid drying, ensuring that it is not a fire hazard. Creating a skirt around the press but with a gap at the base for air to enter will funnel the hot air upwards.

If drying is really impossible in the field, stacks of plants pressed within newspaper can be sprayed with alcohol or a litre of 70% alcohol can be poured over a 20cm pile of plants and kept in a plastic bag. The resulting specimens tend to be blackened and brittle. This is also a fire hazard.

Succulents should be killed by submergence in boiling water for a few seconds (up to a minute for bulky cacti) as the tissue will then dry more quickly and it will also prevent them growing new shoots in the press.

Fruit may be dried or sliced and pressed, or preserved in 70% alcohol and stored separately. Cones and wood are dried.

Mosses are usually placed directly into a paper packet for drying and are not pressed. Liverworts tend to shrivel so some gentler pressing is sensible. Lichens are best dampened before pressing otherwise they break. Mosses, liverworts and lichens are usually stored in paper packets and well-pressed material can be rehydrated for examination by placing in boiling water or water with a drop of detergent. Macroscopic algae can be pressed and dried, freeze dried or stored in 40% alcohol (although they lose their pigments in alcohol). Flimsy algae are best placed on a herbarium sheet under water and then gently lifted. Dry by pressing gently with a doth.

Once dried, plants are usually attached to heavy duty white paper onto which the details are written. Acid-free paper is best, and specimens can either be glued on, taped on using gummed paper or cloth adhesive tape or sewn on if the specimen is thick. If the plant is too large to fit on one sheet of paper (a herbaceous sheet is usually 29 x 42cm), the specimen may be folded or cut to fit. It is important to ensure that the specimen includes representative parts. Packages or envelopes containing seeds or other parts of the plant can be attached. Other features such as the plant size, bark and branching should be noted.

*Further information*

For more information on line transects and point sampling, see Madsen (1999).

For the identification of aquatic plants, Cook's "Aquatic Plant Book" (1996) is an excellent resource, with a key covering the vascular aquatic plants of the world.

**B9. Market surveys (to be written – see B4 Fish)**

**B10. Documentation of wetland conservation issues through field surveys**

**Table 4: Degradation and deterioration of habitats and ecosystems (qualitative/quantitative)**

Contributory factors	Methods of verification (Indicators)	Links to driving indicators
Reclamation	Land fills (area); Draining activities	Increased demand for land
Pollution of water from agrichemicals (fertilizers, pesticides etc.) and other effluents (oil etc.)	Dead/dying aquatic organisms in water; Eutrophic conditions – growth of algal mats	Mis-use/over-use of agrichemicals; harmful practices related to handling/application of agrichemicals
Clearance of riparian vegetation	Area of riparian vegetation cleared	Agricultural activities (i.e. river bank cultivations)
Regulation of water flow	Upstream dams, diversions etc. (related reductions in water levels)	Demand for irrigation water and energy (hydropower)
Garbage disposal	Area of garbage dumps	Ribbon development (settlements etc.) bordering wetlands

**Table 5: Spread of Invasive Alien Species**

Contributory factors	Methods of verification (Indicators)	Links to driving indicators
Deliberate and/or accidental introduction of invasive alien plants and animals	Presence and distribution/spread of invasive alien plant and animal species	Expansion of agriculture, aquaculture, ornamental fishery etc.

**Table 6: Over-exploitation and destruction of species**

Contributory factors	Methods of verification (Indicators)	Links to driving indicators
Illegal poaching of animals (birds, mammals,	Animals displayed for sale in local markets;	Demand for bush meat

reptiles etc.)	traps observed; presence of hunters; information from locals etc.	
Harmful fishing practices	Blast fishing, poisoning, electro-fishing etc.	Demand for fish
Logging (riparian trees)	Logged areas; transit timber depots etc.	Demand for timber
Collection of plants and animals for ornamental purposes (commercial trade)	Collections observed; Specimens in local markets	Demand for animals and plants in the ornamental trade
Wanton/deliberate killing (i.e., reptiles)	Information from local communities	Fear/mythical beliefs

### B11. Assessment of species threatened status (IUCN Red List)

Once all data have been collated and entered into the SIS database the threatened status of each species can be assessed according to the IUCN Red List Categories and Criteria (see [www.iucnredlist.org](http://www.iucnredlist.org)).

#### The IUCN Red List of Threatened Species

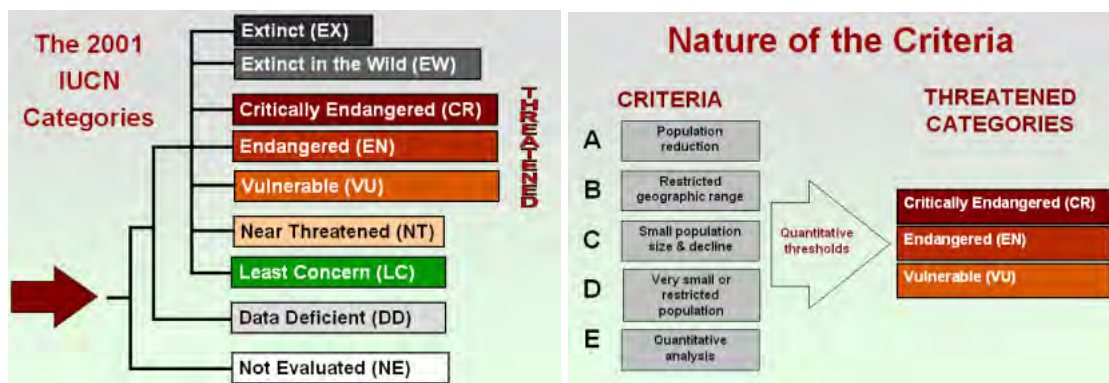
The IUCN Red List of Threatened Species is the most comprehensive resource detailing the global conservation status of plants and animals. It is produced by the IUCN Species Survival Commission (SSC), a network of some 8,000 species experts working in almost every country in the world, using data from a number of partner organizations. Collectively, this network holds what is probably the most complete scientific knowledge base on the biology and current conservation status of species.

With its strong scientific base, the IUCN Red List is recognised as the most authoritative guide to the status of global biological diversity. The Red List, in conjunction with the comprehensive data compiled to support it, has become an increasingly powerful tool for conservation planning, management, monitoring and decision-making (e.g. Rodrigues *et al.* 2006). The Red Listing methodology can be applied to assess threats to species at any geographic scale, from the site level to the global level.

#### How is the Red List compiled?

There are nine categories in the IUCN Red List system: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient, and Not Evaluated. Classification into the categories for species threatened with extinction (Vulnerable, Endangered, and Critically Endangered) is through a set of five quantitative criteria that form the heart of the system. These criteria are based on biological factors related to extinction risk and include: rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation.

Figure 16: IUCN Red List categories and criteria



#### The Categories and their application

**EXTINCT (EX):** A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

**EXTINCT IN THE WILD (EW):** A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.

**CRITICALLY ENDANGERED (CR):** A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Red List Categories and Criteria booklet for details) and it is therefore considered to be facing an extremely high risk of extinction in the wild.

**ENDANGERED (EN):** A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see [Red List Categories and Criteria booklet](#) for details), and it is therefore considered to be facing a very high risk of extinction in the wild.

**VULNERABLE (VU):** A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see [Red List Categories and Criteria booklet](#) for details), and it is therefore considered to be facing a high risk of extinction in the wild.

**NEAR THREATENED (NT):** A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.

**LEAST CONCERN (LC):** A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

**DATA DEFICIENT (DD):** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that a threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

**NOT EVALUATED (NE):** A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

#### *The Red List Process*

The process of Red Listing involves compiling data on a species (either globally or within a defined region) and then assessing that species against a set of criteria to predict the risk of that species going extinct. This process is described in detail in the [Red List Categories and Criteria booklet version 3.1](#), and a one-page summary of the criteria used for the threatened categories is also available (Table \*).

#### *Regional Assessments*

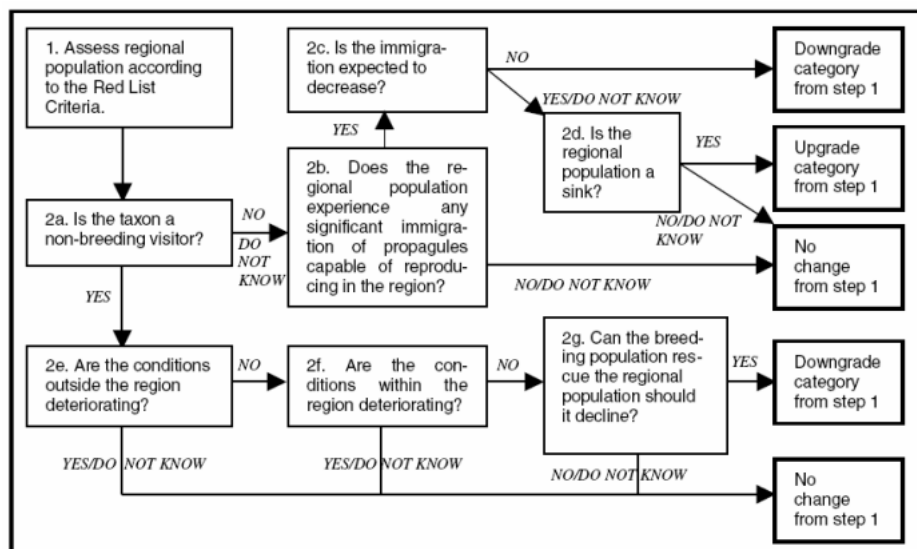
This toolkit describes methods for use at the regional rather than the global level. Red-Listing is also possible at the regional level; certain changes are needed to the methods used for global assessments, but the process is otherwise the same. Two additional categories are included for regional assessments:

**NOT APPLICABLE (NA):** Taxa that have not been assessed because they are unsuitable for inclusion in the regional Red List (e.g. a taxon that occasionally breeds in the region under favourable circumstances but regularly becomes regionally extinct; see [Guidelines for Application of IUCN Red List Criteria at Regional Levels](#) for other examples of when this category might be used).

**REGIONALLY EXTINCT (RE):** Taxa that are considered extinct within the region but populations still exist elsewhere in the world.

The following diagram shows a conceptual scheme of the procedure for assigning an IUCN Red List Category at the regional level. In Step 1 all data used should be from the regional population, not the global population. The exception is when evaluating a projected reduction or continued decline of a non-breeding population; in such cases conditions outside the region must be taken into account in Step 1. Likewise, breeding populations may be affected by events in, e.g., wintering areas, which must be considered in Step 1.

**Figure 17: Conceptual scheme of procedure for assigning IUCN Red List category at the regional level**



In Step 2, various conditions relating to external factors affecting the population (e.g. immigration) are evaluated to decide whether to upgrade or downgrade the Red List category assigned (see diagram above).

If the regional population is a demographic sink and the extra-regional source population is expected to decline, the preliminary category from step one may be upgraded: i.e. EN upgraded to CR; VU upgraded to EN; NT upgraded to VU. Other categories (EX, EW, RE, CR, DD, NA and NE) cannot be upgraded.

If the regional population experiences a “rescue effect” through immigration from outside the region, the preliminary category from step one may be downgraded: i.e. CR downgraded to EN; EN downgraded to VU; VU downgraded to NT. Other categories (EX, EW, RE, DD, NA, NE and LC) cannot be downgraded.

See Table 1 in the [“Guidelines for Application of IUCN Red List Criteria at Regional Levels”](#) for further details on the procedures to follow, especially for the second step.

#### *Applying the Red List Categories to Wetland Species*

The Red List methodologies were designed for all species, but in practice certain adaptations are necessary when assessing riverine species and creating distribution maps of these species. For example, the area occupied by river species is, strictly speaking, only the width of the rivers they are found in multiplied by the length of those rivers; the area thus calculated is usually much smaller than that of most terrestrial species, and could result in all river species being categorised as Threatened. In order to take account of such issues, a “Red Listing Freshwater Issues Protocol” document has been prepared.

#### *Further Literature on the Red List Process*

For more details on how to apply the Red List process, see the [Red List Categories and Criteria booklet version 3.1](#) and [Guidelines for Application of IUCN Red List Criteria at Regional Levels](#).

## B12. Alternative methods for biodiversity assessment

While species-based methods of assessment are widely used and accepted, they also encounter difficulties such as the lack of available taxonomists, problematic definitions of species and even the species concept itself (e.g. Mishler and Donoghue, 1982; Turner, 1999; Wheeler and Meier, 2000). Species diversity may not be the most important diversity-related attribute of an ecosystem (Bengtsson, 1998; Schwartz *et al.*, 2000), leading some to move away from species-based conservation approaches to approaches with a broader focus on environmental conservation (Pickett *et al.*, 1997).

The choice of conventional species-based measures of diversity has both advantages and disadvantages. The main advantages include that the results will be comparable with past and future surveys of the same type and that the survey outputs are likely to be broadly acceptable to a wide range of people. Importantly the species based approach makes it possible to link with Red Listing procedures, which currently provide the basis for most conservation planning.

The disadvantage of using conventional taxonomic-based measures of biodiversity is that the limited knowledge of formal taxonomy of many poorly studied areas, and the scarcity of specialists in possession of that knowledge, is always going to constrain the number of taxonomic groups that can be chosen for survey.

Alternative approaches commonly used in major biodiversity projects that can be considered for site-level assessments include:

1. The **use of non-specialist technicians as 'parataxonomists' to distinguish morphologically 'recognisable taxonomic units'** (Oliver and Beattie, 1993; 1996a; 1996b) for sorting large samples. Expert time is expensive and there is not enough time and experts available to carry out the large amount of routine sample processing required of major biodiversity surveys and monitoring programmes. Trials with insect species showed that with a few hours training, non-specialist technicians and students performed with 87% accuracy compared to formally trained taxonomists (Oliver and Beattie, 1993). This level of accuracy may be inadequate for the production of a definitive monograph, but is likely to suffice for purposes of conservation management, where error variances and bias associated with sampling techniques are likely to over or under-estimate species richness by greater margins. Most major biodiversity projects in rainforests make extensive use of veritable armies of parataxonomists (Tangley, 1990; Cranston and Hillman, 1992; Kaiser, 1997).

2. **Participatory biodiversity assessment and monitoring.** Wetland resource users and fishermen generally have a great deal of non-scientific or 'indigenous knowledge' about their environment and the species in it. Colonial-era scientists seemed to make greater use of local knowledge than subsequent fishery experts have done. Worthington, who visited Lake Victoria in 1927 to carry out biological research in support of fisheries development, narrates:

"In addition to the fish themselves, I became deeply interested in the indigenous native fishing methods and was surprised at their variety....adapted to what was a clear understanding of the fish themselves."

"The Luo fishermen we employed had a better eye for a species than we had and pointed out that the "ngege", as served for breakfast in Nairobi, was in fact new to science"  
pp 659-660 in Worthington (1996)

Involving people living in wetlands in biodiversity assessment and monitoring has other advantages besides being a cost-effective use of existing information. It minimises the requirements for expensive expert input; it involves resource-users, who have a larger stake in the future of the resources than any government official or visiting scientist; and it serves to maintain dialogue and build co-operative understanding between resource users, researchers and resource managers. The importance of using indigenous understanding of natural resource systems to assess, manage and monitor natural resources, including biodiversity (e.g. Hellier *et al.*, 1999), is now widely recognised (see a review by Sillitoe, 1998) beyond the boundaries of ethnobotany where it has long been a legitimate research method (Martin, 1995). This approach has been used in the Lower Songkhram River Basin in Thailand, where the methodology has been named "Tai Baan" (see Box 5).

#### Box 5: Participatory research on fish species and fishery related

The Mekong Wetlands Biodiversity Programme worked with local villagers to document fish species and fishery related issues in the Lower Songkhram River Basin in Thailand<sup>2</sup>. 240 people from four villages took part between May 2003 and April 2005. Within the flooded forest on the river floodplain, Tai Baan researchers identified 208 types of vegetation and fungi that local people consume or use. 28 types of riverine sub-ecosystems were distinguished according to local terminology, many of which are important fish habitats particularly for spawning. 124 species of fish, 6 species of turtle, 4 species of shrimp, 10 species of molluscs and 4 species of crabs were identified and photographed, and notes were made on their ecology, such as whether they migrate, how far they migrate and when. The researchers also considered the status of fish species, noting that 14 species are now rarely caught (considered "endangered") and 12 species are never seen anymore, and likely to be locally extinct. Local people are uniquely placed to collate this information, as they adapted their livelihoods over many years to utilise the fish resources based on a deep understanding of fish migration patterns, feeding and spawning, flood patterns and fish habitats.

3. **The use of higher-taxon approaches.** If the hierarchical taxonomic classification system has any objective validity, then it is obvious that higher levels of taxa provide integrative summaries of diversity within each level of classification. Thus, in principle, any level of taxonomic classification can be chosen for comparative analysis. By convention, the species level is chosen, but where identification to species is not possible, it is common to use higher-taxon approaches. There is some experience indicating that correlation between diversity at different taxonomic levels can be established (Balmford *et al.*, 1996), although this is likely to be highly variable (Gaston and Williams, 1993; Williams and Gaston, 1994; Prance, 1994; Anderson, 1995). Balmford *et al.* (1996) found that using woody plant genera and families, rather than species, yielded comparable estimates of relative conservation value of tropical forest, for 60-85% less cost than a species-based survey. Exploration of area-specific relationships between generic or family-level diversity and species diversity would be worthwhile. It may be possible to use a much wider range of taxa, for lower sample processing effort, if the principle of higher-taxon comparisons proves acceptable. Biotic indicators of ecosystem health (which should be related to diversity) in aquatic systems are usually based on identification of macro-invertebrates to higher taxonomic levels, such as genus or family (Chessman, 1995; Hilsenhoff, 1988).

4. **Rapid assessment techniques.** In recognition that the task of determining a conservation strategy is urgent in areas where biodiversity is both threatened and poorly known or difficult to survey, a number of techniques for rapid assessment of conservation value have been developed (reviewed in Groombridge and Jenkins, 1996). These techniques, which employ some of the approaches outlined above, vary in their data requirements, cost, and suitability for application for different purposes and at different spatial scales. The methodology developed by the Darwin

Wetland Project is most closely related to the 'Rapid Assessment Programme', developed by Conservation International for surveys of poorly known areas using 'surrogate' or 'indicator' groups identified to species level by small teams of national and international experts (See Table 3.2 in Groombridge and Jenkins, 1996). These surveys are then used to assess conservation value by assuming a relationship between these 'indicator' groups and total diversity and habitat quality. The main drawbacks of the methodology are the reliance on specialist taxonomic expertise (beyond standard field identification skills) and the assumptions made about relationships between indicator diversity and total diversity.

Other rapid assessment methods include Conservation Biodiversity Workshops, Conservation Needs Assessments, Gap Analysis and Biodiversity Information Systems (Groombridge and Jenkins, 1996). Some of these methods do not require additional survey work, and aim to make best use of existing information, including socio-economic data that can be overlooked by biodiversity specialists.



## Notes on this chapter

<sup>1</sup> Warning: Formalin is highly toxic and should be labelled as being dangerous, kept away from children, and stored in containers with strong child-proof lids. Waste formalin and preserved fish should be disposed of properly (check local regulations; keep away from all water resources).

<sup>2</sup> Fish Species in the Wetlands of the Lower Songkhram River Basin - Local Knowledge of the Fishers in the Lower Songkhram River Basin. Published by IUCN and WANI. Available in Thai with an English introduction from:

[http://www.mekongwetlands.org/Common/download/Thai\\_Fish\\_Book\\_2.pdf](http://www.mekongwetlands.org/Common/download/Thai_Fish_Book_2.pdf).



## Economic valuation tools

### E1. Why value wetland goods and services?

#### *The problem of under-valuation*

It would be extremely naïve to deny that an inherent tension exists between economic development and wetland conservation. This tension is fundamentally to do with making choices about how, where and why to produce, consume and invest; and balancing the trade-offs that will inevitably arise in the impacts of development activities on conservation goals, and of conservation activities on development goals.

Economic measures and indicators are an important factor when choices are made about how to use and allocate funds, resources and lands. They have a strong influence on how development and conservation trade-offs are conceptualised and decisions are made. Yet the economic calculations that underpin wetland development decisions have tended to be flawed, and fundamentally incomplete, because they typically omit an important set of costs and benefits — the values associated with ecosystem goods and services.

For the most part, calculations of the returns to different investment, land and resource use options in wetlands, or concerning the activities that take place in and around wetlands, do not factor in wetland values. Although conventional analysis decrees that the “best” or most efficient allocation of resources is one that maximises economic returns, measures of the returns to different land, resource and investment options have for the most part failed to deal adequately with wetland costs and benefits. Most cost-benefit analyses, investment appraisals and other economic calculations are therefore misleading in their conclusions as to the relative costs, benefits and returns to different uses of land, resources and investment funds.

From an economic viewpoint, wetland ecosystems remain some of the world’s most under-valued resources. Decision makers and land use planners have long perceived there to be little economic benefit to conserving wetlands, and few economic costs attached to their degradation and loss. In particular, the non-marketed goods and services associated with wetlands (most notably local use of wetland resources, and the ecosystem functions that they yield) are typically excluded from consideration when decisions are made about managing and using land, water, funds and other resources in wetland areas. This does not just underestimate the importance of wetlands as a stock of natural capital and flow of economic services, it also marginalises the (often poor) groups who depend on these values.

As a result, decisions have tended to be made on the basis of only partial information, thereby favouring short-term (and often unsustainable) development imperatives or leading to conservation and development choices that fail to optimise economic benefits. At the worst, in the absence of information about ecosystem values, substantial misallocation of resources has occurred and gone unrecognised (James 1991), and immense economic costs have often been incurred to the coastal populations who depend on ecosystem goods and services.

Given a tendency to under-valuation, it is hardly surprising that wetlands all over the globe have been modified, converted, over-exploited and degraded in the interests of other seemingly more ‘productive’ or ‘profitable’ land and resource management options. Wetland under-valuation has also been a persistent problem in environmental planning and practice. In all too many cases it has been difficult to justify conservation in development terms, or to make sure that the resulting activities are economically viable, socially equitable or financially sustainable.

#### *Factoring wetland values into decision-making*

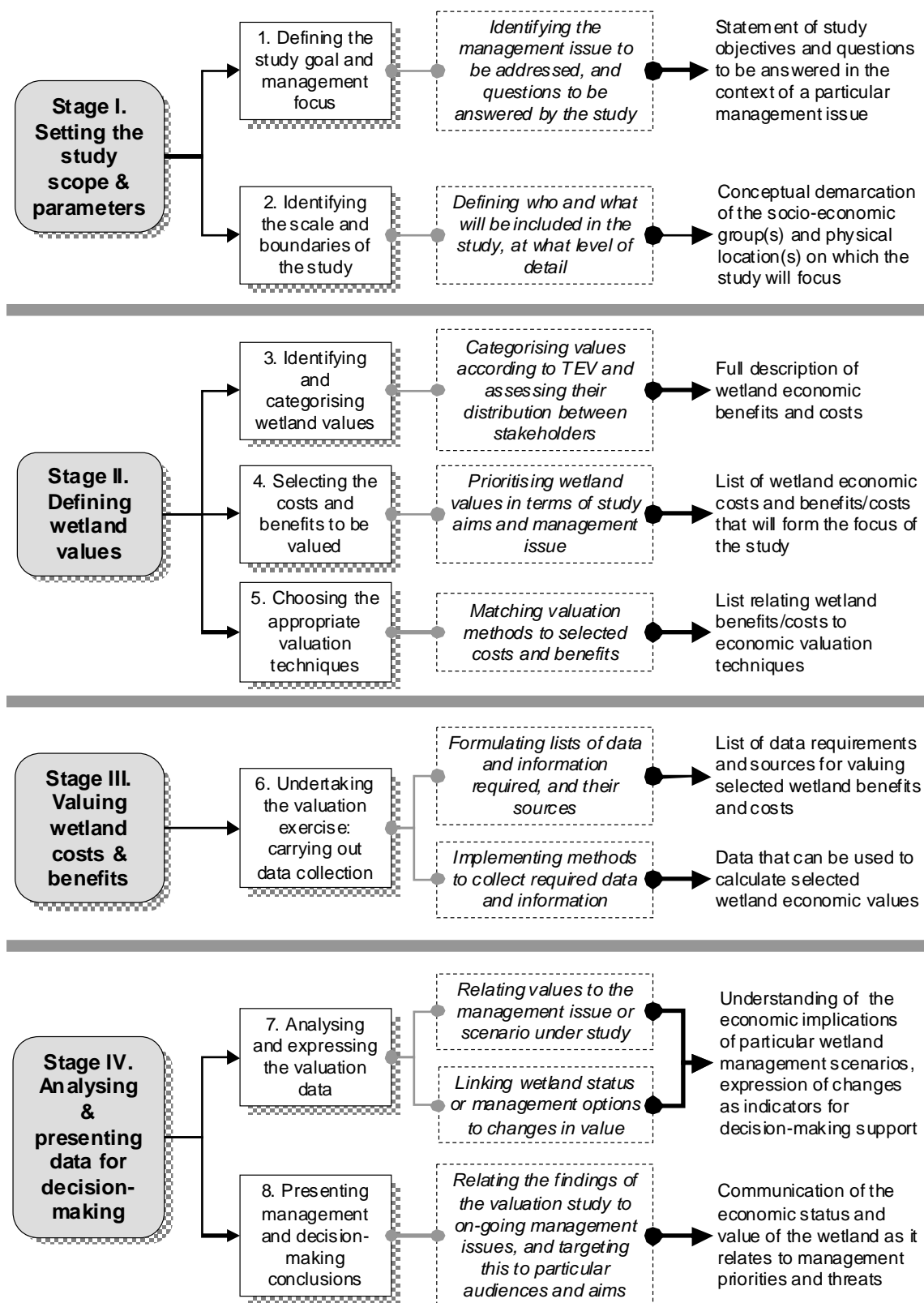
In fact, the problem is not that wetlands have no economic value, but rather that this value is poorly understood, rarely articulated, and as a result is frequently omitted from decision-making. The aim of wetland valuation is to determine people’s preferences: how much they are willing to pay for ecosystem goods and services, and how much better or worse off they would consider themselves to be as a result of changes in their supply.

By expressing these preferences, valuation aims to make ecosystem goods and services directly comparable with other sectors of the economy when investments are appraised, activities are planned, policies are formulated, or land and resource use decisions are made. When properly measured, the total economic value of ecosystem functions, services and resources frequently exceeds the economic gains from activities which are based on ecosystem conversion or degradation (Barbier 1994). Although a better understanding of the economic value of ecosystems does not necessarily favour their conservation and sustainable use, it at least permits them to be considered as economically productive systems, alongside other possible uses of land, resources and funds.

## E2. Summary of steps in wetland valuation

This chapter describes the stages in carrying out wetland economic valuation, as part of an integrated economic-biodiversity and livelihood assessment. As illustrated below (Figure 18), economic valuation follows a series of iterative steps that are complementary, and run parallel, to those carried out in biodiversity and livelihood assessment (see chapters B and L). The rest of this chapter traces through these steps, and describes how to carry out an economic assessment of wetland values.

**Figure 18: Summary of stages and steps in wetland valuation**



### E3. Setting the study scope and parameters (Stage 1)

#### *Step 1: Defining the study goal and management focus*

However academically interesting it is to know the monetary value of a particular wetland good, service or site, wetland valuation is not an end in itself. It is a means to an end — better and more informed conservation and development decision-making. Economic valuation does not take place in isolation: it is prompted by a particular management or policy issue that needs to be addressed, or a particular decision that needs to be made about the use of funds, land or other resources.

The information that is generated by a valuation study aims to assist in understanding or dealing with this issue, or in making this decision. It is the management or policy issue which determines the scope, objective and parameters of the valuation study — what it will include, what it will exclude, which values will be considered, and to what ends.

The very first step in wetland valuation is therefore to define and understand the management context in which the study is taking place, and the management need and issue it addresses. This in turn determines the questions which have to be answered by the valuation study, and the information it needs to generate.

It is impossible to pre-determine what these questions will be — obviously the specific management issue that is being addressed by the valuation study will vary in different cases. There are however certain types of issues and trade-offs which are commonly faced by wetland managers, and for which valuation studies can provide important information to assist in decision-making. For example:

- Justifying or making a case for wetland conservation;
- Identifying wetland financing needs and mechanisms;
- Assessing the impacts of upstream developments on wetland status;
- Choosing between particular wetland management regimes;
- Assessing the profitability of different sustainable use options;
- Looking and needs and niches for local benefit sharing;
- Setting fees for wetland use, or penalties or fines for illegal activities;
- Estimating the relative profitability, or returns, to different investment, land and resource use options in and around wetlands.

#### *Step 2: Identifying the scale and boundaries of the study*

In summary, this step involves defining who and what will be included in the study, at what level of detail. It should result in a conceptual demarcation of the socio-economic group(s) and physical location(s) on which the study will focus.

It is rarely necessary, or practical, for a valuation study to consider each and every value, stakeholder or unit of area associated with a given wetland. In line with the overall objective or management/policy focus, it is necessary to define the boundaries of the valuation study, and to demarcate the area it will actually work in. The second stage of a valuation study is therefore to identify the scale and boundaries within which the study will focus, including the geographic boundary of the site to be studied, its socio-economic boundary or user/beneficiary population, as well as the time-period to be incorporated in the study.

### E4. Defining wetland values (Stage 2)

#### *Step 3: Identifying and categorising wetland values*

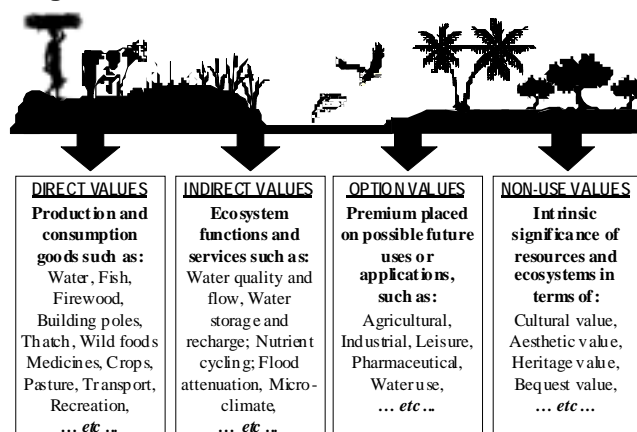
In summary, this step involves prioritising wetland benefits and selecting those which will be valued in the study. It should result in a list of wetland economic costs and benefits that will form the focus of the study. Field checklists (#1 and 2) for identifying, listing and selecting wetland costs and benefits to be valued are provided at the end of this chapter.

Wetland yield multiple goods and services, and also incur a range of economic costs. In any valuation study, it is important to define and categorise all the costs and benefits that have relevance to the given wetland under scrutiny, in order to present a broad overview of the economic stocks and flows that are associated with it.

### Benefits

One reason for the persistent under-valuation of ecosystems is that, traditionally, concepts of economic value have been based on a very narrow definition of benefits. Economists have seen the value of natural ecosystems only in terms of the raw materials and physical products that they generate for human production and consumption, especially focusing on commercial activities and profits. These direct uses however represent only a small proportion of the total value of ecosystems, which generate economic benefits far in excess of just physical or marketed products. The concept of total economic value has now become one of the most widely used frameworks for identifying and categorising ecosystem benefits (Barbier *et al* 1997). Instead of focusing only on direct commercial values, it also encompasses the subsistence and non-market values, ecological functions and non-use benefits (Figure 19). As well as presenting a more complete picture of the economic importance of ecosystems, it clearly demonstrates the high and wide-ranging economic costs associated with their degradation, which extends beyond the loss of direct use values.

**Figure 19: The total economic value of wetlands**



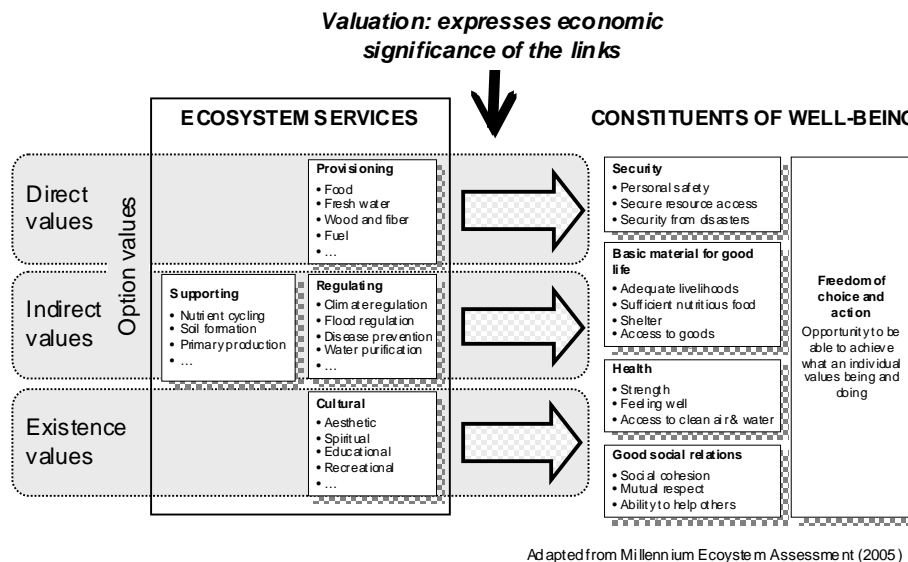
From Emerton 2005

Looking at the total economic value of an ecosystem essentially involves considering its full range of characteristics as an integrated system — its resource stocks or assets, flows of environmental services, and the attributes of the ecosystem as a whole (Barbier 1994). Broadly defined, the total economic value of water ecosystems such as wetlands and catchment forests includes:

- **Direct values:** raw materials and physical products which are used directly for production, consumption and sale such as those providing energy, shelter, foods, agricultural production, water supply, transport and recreational facilities.
- **Indirect values:** the ecological functions which maintain and protect natural and human systems through services such as maintenance of water quality and flow, flood control and storm protection, nutrient retention and micro-climate stabilisation, and the production and consumption activities they support.
- **Option values:** the premium placed on maintaining a pool of species and genetic resources for future possible uses, some of which may not be known now, such as leisure, commercial, industrial, agricultural and pharmaceutical applications and water-based developments.
- **Existence values:** the intrinsic value of ecosystems and their component parts, regardless of their current or future use possibilities, such as cultural, aesthetic, heritage and bequest significance.

The total economic value of wetlands can also be usefully conceptualised in relation to the schema of ecosystem services provided by the Millennium Ecosystem Assessment (see above, section A.4). From an economic perspective ecosystem services correspond to different elements of total economic value, including direct values (provisioning services), indirect values (supporting and regulating services), cultural services (existence values), and their possible uses and applications in the future (option values) — as illustrated in Figure 20.

**Figure 20: Ecosystem services, human well-being and the total economic value of wetlands**

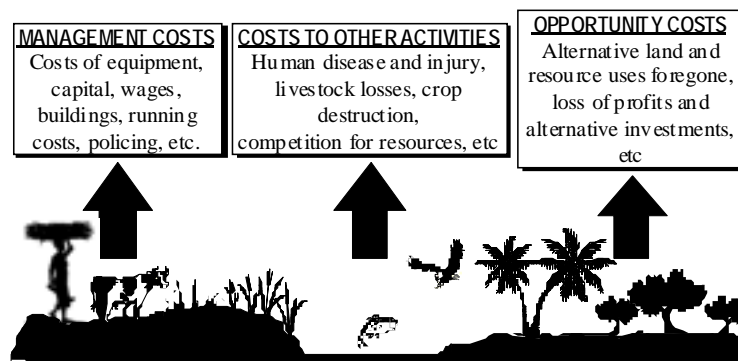


Adapted from Emerton 2006

**Costs**

There is a tendency, especially in conservation-based assessments, to ignore the fact that wetlands generate a wide variety of costs, which impact on people’s livelihoods and economic activities. As in the case for benefits, wetlands costs have tended to be defined narrowly in the past, focusing only on investment and recurrent costs incurred to the institutions concerned with wetlands management. Wetlands give rise to costs because they preclude, diminish or interfere with other economic consumption and production activities. Valuation must take account of the full range of economic costs associated with wetlands as illustrated in Figure 21.

**Figure 21: The total economic cost of wetlands**



- **Management costs:** management costs are direct physical expenditures on the equipment, infrastructure and human resources required to manage wetlands;
- **Opportunity costs:** opportunity costs are the alternative uses of time, land, money and other resources required for wetlands conservation which could have generated income and profits had they been used differently or allocated elsewhere such as agricultural land uses or unsustainable resource utilisation activities foregone in wetland areas, wetlands polluting industrial technologies and production processes precluded or upstream water developments prevented;
- **Costs to other activities:** costs to other activities are the damage and interference to human and economic activities caused by wetlands resources and species, including human and livestock disease and injury, crop pests and sources of competition over resources.

All of these costs lead to economic losses because they require cash, necessitate expenditures, decrease income or reduce livelihood options. Valuation, in addition to making a monetary estimate of wetlands benefits, attempts to quantify the total economic costs associated with wetlands.

#### Step 4: Selecting the costs and benefits to be valued

There are limited data, time and other resources with which to carry out a valuation study. In most cases it is impossible to value each and every economic benefit and costs associated with a particular wetland. For this reason, it is necessary to decide on the coverage of the study — which benefits and costs it will value, and how. Once the major characteristics and values have been identified, they need to be prioritised in terms of their importance to the overall goal and objectives of the study (which, in turn, is determined by its management focus).

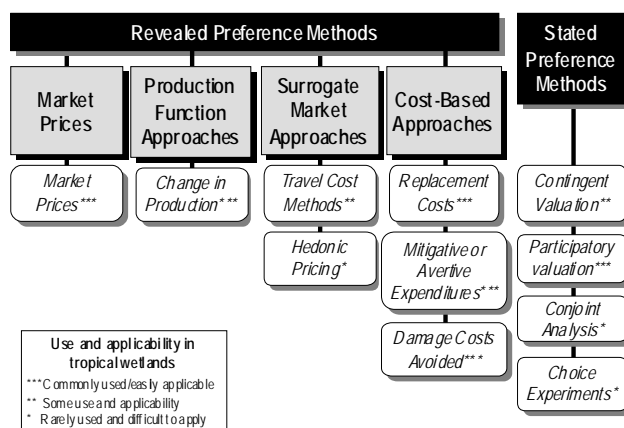
#### Step 5: Choosing the appropriate wetland valuation techniques

In summary, this step involves examining the economic methods and techniques that will be used to value selected wetland benefits/costs. It should result in a list relating wetland benefits/costs to economic valuation techniques. A field checklist (#3) for choosing wetland valuation techniques is provided at the end of this chapter.

A wide variety of methods are now available with which to quantify wetland values. Each method has different data and analytical requirements, is more or less applicable to different types of wetland costs and benefits, and has varying suitability in different contexts and situations. For this reason, having defined and prioritised which costs and benefits the valuation study will focus on, it is necessary to decide on which method(s) will be used to determine the value of each.

After identifying the values and the costs and ranking them, the values and the costs need to be assigned a monetary value. There are a number of techniques that are used to do this, which can be categorised in a number of ways. One way of classifying wetland valuation methods is to distinguish between revealed preference methods (those which rely on observing people's behaviour to ascertain the value of wetland goods and services) and stated preference methods (those which directly ask people the value they place on wetlands). These are illustrated in Figure 22, and described below.

Figure 22: Methods for wetland valuation



From Emerton and Bos 2004

- **Market prices:** This approach looks at the *market price* of ecosystem goods and services as they are bought or sold in the market.
- **Production function approaches:** These approaches, including *effect on production*, attempt to relate changes in the output of a marketed good or service to a measurable change in the quality or quantity of ecosystem goods and services by establishing a biophysical or dose-response relationship between ecosystem quality, the provision of particular services, and related production.
- **Surrogate market approaches:** These approaches, including *travel costs* and *hedonic pricing*, look at the ways in which the value of ecosystem goods and services are reflected indirectly in people's expenditures, or in the prices of other market goods and services.
- **Cost-based approaches:** These approaches, including *replacement costs*, *mitigative or avertive expenditures* and *damage costs avoided*, look at the market trade-offs or costs avoided of maintaining ecosystems for their goods and services.
- **Stated preference approaches:** Rather than looking at the way in which people reveal their preferences for ecosystem goods and services through market production and consumption, these approaches ask consumers to state their preference directly. The most well-known technique is *contingent valuation*, *participatory valuation* is gaining currency particularly in situations where wetland use is primarily for subsistence purposes, while less commonly-used stated preference valuation methods include *conjoint analysis* and *choice experiments*.



All of these methods are elaborated in detail below, in section E6. Different categories of method are more or less suitable for different kinds of wetland costs and benefits. Market price and surrogate market price techniques are most suitable for wetland direct values, while wetland indirect values are commonly measured using cost-based and production function approaches. Stated preference methods are in principle applicable to any category of wetland benefit, and provide some of the few available methods which can be used to estimate option and existence values.

## E5. Valuing wetland costs and benefits (Stage 3)

### *Step 6: Undertaking the valuation exercise: carrying out data collection*

In summary, this step involves formulating a list of the data that must be collected to enable the economic valuation of wetland benefits. It should result in a list of data requirements for valuing selected wetland benefits and costs. A field checklist (#4) for identifying data needs and sources for the valuation exercise is provided at the end of this chapter.

Having prioritised the wetland costs and benefits to be valued, and selected the most appropriate methods by which to do this, it is necessary to determine what data will be required to apply the chosen valuation methods and to identify how these data will be collected. It should be underlined that before commencing valuation fieldwork, it is important to have thought through what data will be required, and how it will be sourced. Typically, a valuation study will use various data collection techniques and information sources, including both primary and secondary data collection:

- **Literature review:** including a review of similar valuation studies carried out in other areas or countries, as well as of documents and reports that contain information on the wetland under study such as project reports, government statistics and records, scientific articles and publications.
- **Expert consultation:** including with technical experts (e.g. sociologists, hydrologists, biologists and ecologists, civil engineers) as well as with the various stakeholders who are involved in managing and using the wetland (e.g. government officials, NGOs, community leaders, local households, wetland user groups).
- **“Traditional” socio-economic information gathering techniques:** such as questionnaires, interviews and statistical analysis.
- **Participatory techniques:** such as focus group interviews, Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) techniques.

Having identified the data sources and collection techniques, the next thing to do is to actually apply the selected valuation methods. A detailed description of each of the main valuation techniques is given below, which is primarily drawn from IUCN's toolkit for valuing water-based ecosystem services (Emerton and Bos 2004).

## E6. Applying wetland valuation techniques (Stage 3)

### *Market price techniques*

#### Overview of the method

The simplest, most straightforward and commonly-used method for valuing any good or service is to look at its market price: how much it costs to buy, or what it is worth to sell. In a well-operating and competitive<sup>1</sup> market these prices are determined by the relative demand for and supply of the good or service in question, reflect its true scarcity, and equate to its marginal value<sup>2</sup>.

In theory, market price techniques are applicable to any ecosystem good or service that can be freely bought or sold. They are particularly useful for valuing the resources and products that are harvested from water-dependent ecosystems, for example timber, fuelwood, fish, or non-timber forest products. In the example of the Zambezi Basin given below, the study estimated the value of wetland products including crops, livestock, fish and tourism using market prices.

#### Data collection and analysis requirements

There are three main steps involved in collecting and analysing the data required to use market price techniques to value ecosystem goods and services:

- Find out the quantity of the good used, produced or exchanged;
- Collect data on its market price;
- Multiply price by quantity to determine its value.

These data are generally easy to collect and analyse. Market information, including historical trends, can usually be obtained from a wide variety of sources such as government statistics, income and expenditure surveys, or market

research studies. In most cases it will be necessary to supplement these secondary sources with original data, for example through performing market checks or conducting some form of socio-economic survey.

When applying this technique it is important to ensure that the data collected covers an adequate period of time and sample of consumers and/or producers. Factors to bear in mind include the possibility that prices, consumption and production may vary between seasons, for different socio-economic groups, at different stages of the marketing or value-added chain, and in different locations.

#### Applicability, strengths and weaknesses

The greatest advantage of this technique is that it is relatively easy to use, as it relies on observing actual market behaviour. Few assumptions, little detailed modelling, and only simple statistical analysis are required to apply it.

A major disadvantage is the fact that many ecosystem goods and services do not have markets or are subject to markets which are highly distorted or irregular. In such cases, it is inappropriate to use market price techniques:

- Ecosystem services such as catchment protection or nutrient retention are rarely available for purchase or sale. Because they have many of the characteristics of public goods<sup>3</sup>, it is in fact questionable whether the market can ever accurately allocate or price them.
- Many ecosystem goods and natural products are utilised at the subsistence level. They are not traded in formal markets, and are consumed only within the household.
- There exist a wide variety of subsidies and market interventions which distort the price of natural products or ecosystem-dependent goods. Examples include subsidies to water and electricity, centrally-set royalties and fees for products such as timber, and state controlled prices for basic food and consumer items.
- Because markets for most ecosystem goods and services are not well-developed, they tend not to be competitive, and prices are a poor indicator of true social and economic values. This may be the case where there is an additional social or environmental premium attached to natural goods and services, where there are only a small number of buyers and sellers, or where there is imperfect market information.
- In many cases, even where an ecosystem good has a market and a price, it is impossible to measure the quantities produced or consumed. Especially at the subsistence level, natural resource consumption and sale is often highly seasonal or irregular. For example, particular products are only available at particular times of the year, are used under special conditions, or are collected and used on an opportunistic basis. Ecosystem goods are also often collected and consumed as part of a bundle of items or have high levels of substitution<sup>4</sup> or complementarity<sup>5</sup> with other goods. For example, they are used only when other products are unavailable or unaffordable, or they form occasional inputs into the production of other goods.
- Even where an ecosystem good or service has a market, and quantities bought or sold can be measured, prices do not tell us how important this good or service is to society, nor how much some buyers would actually be willing to pay.

In such cases it is usually necessary to use alternative valuation techniques, such as those described below.

#### **Box 6: Using market price techniques to value freshwater wetlands in the Zambezi Basin, Southern Africa**

The Zambezi River runs through Angola, Zambia, Botswana, Namibia, Zimbabwe, Malawi and Mozambique in Southern Africa. It is associated with a large number of wetlands, which yield a wide range of economically valuable goods and services. Wetland-dependent products and services include flood recession agriculture, fish, wildlife, grazing, forest resources, natural products and medicines and ecotourism.

A study was carried out to estimate the value of the Zambezi's wetland goods using market price techniques. First, an inventory of the products and services was made for each wetland. Market prices were then used to calculate the value derived from each wetland. Crops and livestock were valued at their production value, and fish catches were valued according to their local sale price. Tourism earnings and utilisation charges were used to calculate the value of wildlife, and the market price of wetland products was applied to natural resource use. Donor contributions were assumed to reflect biodiversity conservation values.

Inputs and other production costs were deducted from these figures, so as to yield the marginal value of wetland resources. Total use values were extrapolated through making assumptions about the extent and intensity of wetland land and resource use. This yielded a marginal value of \$145 million a year for the 10 major wetlands in the Zambezi Basin, or an average of \$48 per hectare.

*From Seyam et al 2001*

#### *Effect on production techniques*

##### Overview of the method

Even when ecosystem goods and services do not themselves have a market price, other marketed products often rely on them as basic inputs. For example, downstream hydropower and irrigation depend on upper catchment protection services, fisheries depend on clean water supplies, and many sources of industrial production utilise natural products as raw materials. In these cases it is possible to assess the value of ecosystem goods and services by looking at their contribution to other sources of production, and to assess the effects of a change in the quality or quantity of ecosystem goods and services on these broader outputs and profits.

Effect on production techniques can thus be used to value ecosystem goods and services that clearly form a part of other, marketed, sources of production – for example watershed protection and water quality services, or natural resources that are used as raw materials. In the example below the value of flood attenuation benefits is estimated through its contribution to crop production.

#### Data collection and analysis requirements

There are three main steps to collect and analyse the data required for effect on production techniques to value ecosystem goods and services:

- Determine the contribution of ecosystem goods and services to the related source of production, and specify the relationship between changes in the quality or quantity of a particular ecosystem good or service and output;
- Relate a specified change in the provision of the ecosystem good or service to a physical change in the output or availability of the related product;
- Estimate the market value of the change in production.

Effect on production techniques rely on a simple logic, and it is relatively easy to collect and analyse the market information that is required to value changes in production of ecosystem-dependent products (see above, market price techniques).

The most difficult aspect of this method is determining and quantifying the biophysical or dose-response relationship that links changes in the supply or quality of ecosystem goods and services with other sources of production. For example, detailed data are required to relate catchment deforestation to a particular rate of soil erosion, consequent siltation of a hydropower dam and reduced power outputs, or to assess exactly the impacts of the loss of wetland habitat and water purification services on local fisheries production. To be able to specify these kinds of relationships with confidence usually involves wide consultation with other experts, and may require situation-specific laboratory or field research, controlled experiments, detailed modelling and statistical regression.

#### Applicability, strengths and weaknesses

Effect on production techniques are commonly used, and have applicability to a wide range of ecosystem goods and services. Their weakness relates to the difficulties that are often involved in collecting sufficient data to be able to accurately predict the biophysical or dose-response relationships upon which the technique is based. Such relationships are often unclear, unproven, or hard to demonstrate in quantified terms. Simplifying assumptions are often needed to apply the production function approach.

An additional concern is the large number of possible influences on product markets and prices. Some of these should be excluded when using effect on production techniques. In some cases changes in the provision of an ecosystem good or service may lead not just to a change in related production, but also to a change in the price of its outputs. That product may become scarcer, or more costly to produce. In other cases consumers and producers may switch to other products or technologies in response to ecosystem change or to a scarcity of ecosystem goods and services. Furthermore, general trends and exogenous factors unrelated to ecosystem goods and services may influence the market price of related production and consumption items. They must be isolated and eliminated from analysis.

#### **Box 7: Using effect on production techniques to value forest flood attenuation benefits in Eastern Madagascar**

This study looked at the value of Mantadia National Park in conserving the upland forests that form the watershed for the Vohitra River in Eastern Madagascar. It employed effect on production techniques to do so. The productivity analysis measured the forest's watershed benefits in terms of increased economic welfare for farmers. These benefits result from reduced flooding as a consequence of reduced deforestation, which is in turn associated with the establishment of the national park and buffer zone.

The study used a three stage model to examine the relationship between economic value and the biophysical dimensions of the protected area. First, a relationship between land use changes and the extent of downstream flooding was established. Remote sensing was used to construct a deforestation history of the study area, and to ascertain an annual deforestation rate. Records of monthly river discharge were analysed for flood frequency and time trend, and the effects of land conversion on flooding were quantified.

A second stage was to ascertain the impacts of increased flooding on crop production. Flood damage to crops was estimated taking into account a range of parameters such as area of inundation, flood depth, duration, seasonality and frequency. Analysis focused on paddy rice cultivation, a high value and locally important form of agricultural production which is tied closely to flooding.

The final stage in the valuation study was to adopt a productivity analysis approach to evaluate flood damage in terms of lost producer surplus. The economic impact of changes in ecosystem quality was established using the net market value of paddy damaged by flooding. This found that a net present value for forest watershed protection benefits of \$126,700 resulting from the establishment of Mantadia National Park.

*From Kramer et al 1997*

#### *Travel cost techniques*

##### Overview of the method

Ecosystems often hold a high value as recreational resources or leisure destinations. Even when there is no direct charge made to enjoy these benefits, people still spend time and money to visit ecosystems. These travel costs can be

taken as an expression of the recreational value of ecosystems. We can use this technique at the whole ecosystem level, taking into account all of its attributes and components in combination, or for specific goods or services such as rare wildlife, opportunities for extractive utilisation of products such as fishing or resource collection, or for activities such as hiking or boating that are related to its services. In the example given below, improved freshwater ecosystem quality was estimated through looking at visitor travel costs.

#### Data collection and analysis requirements

There are six main steps involved in collecting and analysing the data required to use travel cost techniques to value ecosystem goods and services:

- Ascertain the total area from which recreational visitors come to visit an ecosystem, and dividing this into zones within which travel costs are approximately equal;
- Within each zone, sample visitors to collect information about the costs incurred in visiting the ecosystem, motives for the trip, frequency of visits, site attributes and socio-economic variables such as the visitor's place of origin, income, age, education and so on;
- Obtain the visitation rates for each zone, and use this information to estimate the total number of visitor days per head of the local population;
- Estimate travel costs, including both direct expenses (such as fuel and fares, food, equipment, accommodation) and time spent on the trip;
- Carry out a statistical regression to test the relationship between visitation rates and other explanatory factors such as travel cost and socio-economic variables;
- Construct a demand curve relating number of visits to travel cost, model visitation rates at different prices, and calculate visitor consumer surplus<sup>6</sup>.

Travel cost techniques depend on a relatively large data set. Quite complex statistical analysis and modelling are required in order to construct visitor demand curves. Basic data are usually collected via visitor interviews and questionnaires, which make special efforts to cover different seasons or times of the year, and to ensure that various types of visitors from different locations are represented.

#### Applicability, strengths and weaknesses

The travel cost method is mainly limited to calculating recreational values, although it has in some cases been applied to the consumptive use of ecosystem goods.

Its main weakness is its dependence on large and detailed data sets, and relatively complex analytical techniques. Travel cost surveys are typically expensive and time consuming to carry out. An additional source of complication is that several factors make it difficult to isolate the value of a particular ecosystem in relation to travel costs, and these must be taken into account in order to avoid over-estimating ecosystem values. Visitors frequently have several motives or destinations on a single trip, some of which are unrelated to the ecosystem being studied. They also usually enjoy multiple aspects and attributes of a single ecosystem. In some cases travel, not the destination *per se*, may be an end in itself.

#### **Box 8: Using travel cost techniques to value the impacts of improved environmental quality on freshwater recreation in the US**

The Conservation Reserve Programme (CRP) in the United States aims to mitigate the environmental effects of agriculture. A study was carried out to see how non-market valuation models could help in targeting conservation programmes such as the CRP. One component of this study focused on the impacts of improved environmental quality on freshwater recreation.

This study was based on data generated by surveys that had been carried out to ascertain the value of water-based recreation, fishing, hunting and wildlife. These surveys sampled 1,500 respondents in four sub-State regions who were asked to recall the number of visits made over the last year to wetlands, lakes and rivers where water was an important reason for their trip. The cost of these trips was imputed using the travel cost method.

The influence of CRP programmes on improved environmental quality and on consumer welfare was then modelled. The study found that the combined benefit of all freshwater-based recreation in the US was worth slightly over \$37 billion a year. The contribution of CRP efforts to environmental quality, as reflected in recreational travel values, was estimated at just over \$35 million, or about \$2.57 per hectare.

*From Feather et al 1999*

#### Hedonic pricing techniques

##### Overview of the method

Even if they do not have a market price themselves, the presence, absence or quality of ecosystem goods and services influences the price that people pay for, or accept for providing, other goods and services. Hedonic pricing techniques look at the difference in prices that can be ascribed to the existence or level of ecosystem goods and services. Most commonly this method examines differences in property prices and wage rates between two locations, which have different environmental qualities or landscape values. In the example given below, the value of urban wetlands was estimated through looking at impacts on property prices.

### Data collection and analysis requirements

There are five main steps involved in collecting and analysing the data required to use hedonic pricing techniques to value ecosystem goods and services:

- Decide on the indicator to be used to measure the quality or quantity of an ecosystem good or service associated with a particular job or property;
- Specify the functional relationship between wages or property prices and all of the relevant attributes that are associated with them, including ecosystem goods and services;
- Collect data on wages or property prices in different situations and areas which have varying quality and quantity of ecosystem goods and services;
- Use multiple regression analysis to obtain a correlation between wages or property prices and the ecosystem good or service;
- Derive a demand curve for the ecosystem good or service.

Hedonic pricing techniques require the collection of a large amount of data, which must be subject to detailed and complex analysis. Data are usually gathered through market observation, questionnaires and interviews, which aim to represent a wide variety of situations and time periods.

### Applicability, strengths and weaknesses

Although hedonic pricing techniques can, in theory, be applied to any good or service they are most commonly used within the context of wage and property markets.

In practice, there remain very few examples of the application of hedonic pricing techniques to water-related ecosystem goods and services. One reason for this, and a weakness in this technique, is the very large data sets and detailed information that must be collected, covering all of the principal features affecting prices. It is often difficult to isolate specific ecosystem effects from other determinants of wages and property prices.

Another potential problem arises from the fact that this technique relies on the underlying assumption that wages and property prices are sensitive to the quality and supply of ecosystem goods and services. In many cases markets for property and employment are not perfectly competitive, and ecosystem quality is not a defining characteristic of where people buy property or engage in employment.

#### **Box 9: Using hedonic pricing techniques to value urban wetlands in the US**

This study aimed to value wetland environmental amenities in Portland, Oregon metropolitan region. It used hedonic pricing techniques to calculate urban residents' willingness to pay to live close to wetlands.

The study used a data set of almost 15,000 observations, with each observation representing a residential home sale. For each sale information was obtained about the property price and a variety of structural, neighbourhood and environmental characteristics associated with the property, as well as socio-economic characteristics associated with the buyer. Wetlands were classified into four types – open water, emergent vegetation, forested, and scrub-shrub – and their area and distance from the property were recorded.

The first stage analysis used ordinary least squares regression to estimate a hedonic price function relating property sales prices to the structural characteristics of the property, neighbourhood attributes, and amenity value of nearby wetlands and other environmental resources. The second stage analysis consisted of constructing a willingness-to-pay function for the size of the nearest wetland to a residence. Results showed that wetland proximity and size exerted a significant influence on property values, especially for open water and larger wetlands.

*From Mahan 1997*

### Replacement cost techniques

#### Overview of the method

It is sometimes possible to replace or replicate a particular ecosystem good or service with artificial or man-made products, infrastructure or technologies. For example, constructed reservoirs can replace natural lakes, sewage treatment plants can replace wetland wastewater treatment services, and many natural products have artificial alternatives. The cost of replacing an ecosystem good or service with such an alternative or substitute can be taken as an indicator of its value in terms of expenditures saved. In the example below, the value of wetland water quality services was estimated through looking at the costs of replacing these services by artificial means.

### Data collection and analysis requirements

There are three main steps involved in collecting and analysing the data required to use replacement cost techniques to value ecosystem goods and services:

- Ascertain the benefits that are associated with a given ecosystem good or service, how it is used and by whom, and the magnitude and extent of these benefits;
- Identify the most likely alternative source of product, infrastructure or technology that would provide an equivalent level of benefits to an equivalent population;

- Calculate the costs of introducing and distributing, or installing and running, the replacement to the ecosystem good or service.

Data collection is relatively straightforward, and usually relies on secondary information about the benefits associated with a particular ecosystem good or service and alternatives that are available to replace it. In most cases this can be ascertained through expert consultation and professional estimates, supplemented with direct observation.

### Applicability, strengths and weaknesses

Replacement cost techniques are particularly useful for valuing ecosystem services, and have the great advantage that they are simple to apply and analyse. They are particularly useful where only limited time or financial resources are available for a valuation study, or where it is not possible to carry out detailed surveys and fieldwork.

The main weakness of this technique is that it is often difficult to find perfect replacements or substitutes for ecosystem goods and services that would provide an equivalent level of benefits to the same population. In some cases this results in ecosystem under-valuation, as artificial alternatives generate a lower quantity or quality of goods and services. Yet this technique may also lead to the over-valuation of ecosystem benefits, as in some instances the replacement product, infrastructure or technology may be associated with secondary benefits or additional positive impacts. The reality of the replacement cost technique is also sometimes questionable: we may question whether, in the absence of a well-functioning ecosystem, such expenditures would actually be made or considered worthwhile.

#### **Box 10: Using replacement costs techniques to value wetland water quality services in Nakivubo Swamp, Uganda**

This study used replacement cost techniques to value the wastewater treatment services provided by Nakivubo Swamp, Uganda. Covering an area of some 5.5 km<sup>2</sup> and a catchment of over 40 km<sup>2</sup>, the wetland runs from the central industrial district of Kampala, Uganda's capital city, passing through dense residential settlements before entering Lake Victoria at Murchison Bay.

One of the most important values associated with Nakivubo wetland is the role that it plays in assuring urban water quality in Kampala. Both the outflow of the only sewage treatment plant in the city, and – far more importantly, because over 90% of Kampala's population have no access to a piped sewage supply – the main drainage channel for the city, enter the top end of the wetland. Nakivubo functions as a buffer through which most of the city's industrial and urban wastewater passes before entering nearby Lake Victoria, and physically, chemically and biologically removes nutrients and pollution from these wastewaters. These services are important – the purified water flowing out of the wetland enters Lake Victoria only about 3 kilometres from the intake to Ggaba Water Works, which supplies all of the city's piped water supplies.

The study looked at the cost of replacing wetland wastewater processing services with artificial technologies. Replacement costs included two components: connecting Nakivubo channel to an upgraded sewage treatment plant which could cope with additional wastewater loads, and constructing elevated pit latrines to process sewage from nearby slum settlements. Data were collected from the National Water and Sewerage Corporation, from civil engineering companies, and from a donor-funded water supply and sanitation project that had been operating in a nearby urban wetland area. It also took into account the fact that some level of intervention would be required to manage Nakivubo more efficiently for water treatment, mainly through extending and reticulating the wastewater channels that flow into the swamp. These costs were deducted when wetland benefits were valued. The study found that the infrastructure required to achieve a similar level of wastewater treatment to that provided by the wetland would incur costs of up to US\$2 million a year in terms of extending sewerage and treatment facilities.

*From Emerton et al 1999*

### *Mitigative or avertive expenditure techniques*

#### Overview of the method

When an economically valuable ecosystem good or service is lost, or there is a decline in its quantity or quality, this almost always has negative effects. It may become necessary to take steps to mitigate or avert these negative effects so as to avoid economic losses. For example, the loss of upstream catchment protection can make it necessary to desilt reservoirs and dams, the loss of wetland treatment services may require upgrading water purification facilities, and the loss of ecosystem flood control may require the construction of flood control barriers. These mitigative or avertive expenditures can be taken as indicators of the value of maintaining ecosystem goods and services in terms of costs avoided. In the example below, the value of wetland flood attenuation services was estimated through looking at the expenditures that would be required to mitigate or avert the effects of the loss of these services.

#### Data collection and analysis requirements

There are four main steps involved in collecting and analysing the data required to use mitigative or avertive expenditure techniques to value ecosystem goods and services:

- Identify the negative effects or hazards that would arise from the loss of a particular ecosystem good or service;
- Locate the area and population who would be affected by the loss of the ecosystem good and service, and determine a cut-off point beyond which the effect will not be analysed;
- Obtain information on people's responses, and measures taken to mitigate or avert the negative effects of the loss of the ecosystem good or service;
- Cost the mitigative or avertive expenditures.

Data collection and analysis is relatively straightforward, and usually relies on a combination of interviews, surveys, direct observation and expert consultation.

### Applicability, strengths and weaknesses

Mitigative or avertive expenditure techniques are particularly useful for valuing ecosystem services. In common with other cost-based valuation methods, a major strength is their ease of implementation and analysis, and their relatively small data requirements.

As is the case with the replacement cost technique, the mitigative or avertive measures that are employed in response to the loss of ecosystem goods and services do not always provide an equivalent level of benefits. In some cases it is also questionable whether in fact such expenditures would be made or would be seen as being worth making. An additional important factor to bear in mind when applying this technique is that people's perceptions of what would be the effects of ecosystem loss, and what would be required to mitigate or avert these effects, may not always match those of "expert" opinion.

#### **Box 11: Using mitigative or avertive expenditure techniques to value wetland flood attenuation in Sri Lanka**

This study used avertive expenditure techniques to value the flood attenuation services of Muthurajawela Marsh in Sri Lanka. Muthurajawela is a coastal peat bog which covers an area of some 3,100 hectares, running alongside the Indian Ocean between 10-30 km north of Colombo, Sri Lanka's capital city. One of its most important functions is its role in local flood control.

The study first involved investigating the biophysical characteristics of the marsh, and their relationship to local flooding patterns. Data were obtained from hydrological surveys, which estimated the maximum water storage capacity of the marsh at 11 million cubic metres, with a maximum discharge of 12.5 cubic metres per second and a retention period of more than 10 days. Analysis of historical rainfall and streamflow data found that during the rainy season large volumes of water enter the wetland system, from rainfall, through run-off from surrounding higher grounds and via floodwaters from the Dandugam Oya, Kala Oya and Kelani Ganga Rivers. Muthurajawela buffers these floodwaters and discharges them slowly into the sea.

The value of these services was calculated by looking at the flood control measures that would be necessary to mitigate or avert the effects of wetland loss. Consultation with civil engineers showed that this would involve constructing a drainage system and pumping station, deepening and widening the channels of water courses flowing between the marsh area and the sea, installing infrastructure to divert floodwaters into a retention area, and pumping water out to sea. Cost estimates for this type of flood control measure were available for Mudu Ela, a nearby wetland that has recently been converted to a housing scheme. Here infrastructure had been installed to ensure that a total of 443 acres of land remains drained, in order to reclaim an area of 360 acres. Extrapolating the capital and maintenance costs from Mudu Ela to Muthurajawela gave an annual value for flood attenuation of more than \$5 million, or \$1,750 per hectare of wetland area.

*From Emerton and Kekulandala 2002*

### *Damage cost avoided techniques*

#### Overview of the method

Ecosystem services frequently protect other economically valuable assets. For example, the loss of catchment protection services may result in increased downstream siltation and flooding, which leads to the destruction of infrastructure, settlements and agriculture. Such damage costs can be taken to represent the economic value of ecosystems in terms of expenditures avoided. In the example below, the value of wetland flood attenuation was estimated through looking at costs of damage avoided by conserving ecosystems.

#### Data collection and analysis requirements

There are four main steps involved in collecting and analysing the data required to use damage cost avoided techniques to value ecosystem goods and services:

- Identify the protective services of the ecosystem, in terms of the degree of protection afforded and the on and off-site damages that would occur as a result of loss of this protection;
- For the specific change in ecosystem service provision that is being considered, locate the infrastructure, output or human population that would be affected by this damage, and determine a cut-off point beyond which effects will not be analysed;
- Obtain information on the likelihood and frequency of damaging events occurring under different scenarios of ecosystem loss, the spread of their impacts and the magnitude of damage caused;
- Cost these damages, and ascribing the contribution of the ecosystem service towards minimising or avoiding them.

Data collection is for the most part straightforward, usually relying on a combination of analysis of historical records, direct observation, interviews and professional estimates. Predicting and quantifying the likelihood and impacts of damage events under different ecosystem scenarios is however usually a more complex exercise, and may require detailed data and modelling.

#### Strengths and weaknesses of the method

Damage cost avoided techniques are particularly useful for valuing ecosystem services. There is often confusion between the application of damage costs avoided and production function approaches to valuation. Here it is important

to underline that whereas this technique deals with damage avoided such as from pollution and natural hazards (which are typically external effects), change in production techniques usually relate to changes in some input such as water (typically internalised).

A potential weakness is that in most cases estimates of damages avoided remain hypothetical. They are based on predicting what might occur under a situation where ecosystem services decline or are lost. Even when valuation is based on real data from situations where such events and damages have occurred, it is often difficult to relate these damages to changes in ecosystem status, or to be sure that identical impacts would occur if particular ecosystem services declined.

### **Box 12: Using damage cost avoided techniques to value the role of flood attenuation in the Lower Shire Wetlands, Malawi and Mozambique and Barotse Floodplain, Zambia**

The Lower Shire Wetlands in Malawi and Mozambique and the Barotse Floodplain in Zambia cover a combined area of approximately 1.5 million hectares. They generate a number of economically important goods and services, one of which is flood attenuation. The wetlands play an appreciable role in minimising flood peaks and reducing flow velocity, because they store water and even out its release over time. At the onset of the rainy season, or in times of peak riverflow, their large surface area to depth and volume ratios mean that they are able to absorb and spread out water over a large area. The emptying of floodplains may take 4 times as long as the period between initial and peak season. The Barotse floodplain, for example, is capable of storing over  $17.2 \times 10^9 \text{ m}^3$  of water at peak floods, and may delay the downstream flooding peak by some three to five weeks.

The economic value of flood attenuation was valued by looking at the extent to which the wetlands minimise downstream flooding and thereby reduce damage to infrastructure, land and associated settlement and production opportunities. The valuation study involved assessing the frequency of floods, their severity of impact, and the economic damages they gave rise to. Affected areas were identified by land use and settlement maps which showed where human populations and production activities were concentrated, and district-level census and production statistics. Historical records provided estimates of flooding frequency and impacts, and the production and infrastructure damages that had arisen as a result of floods.

Taking account of the costs of temporary relocation of people, replacement of damaged roads and rail infrastructure, loss of farm fields and livestock and settlements destroyed, the study found a flood attenuation value for the two wetlands areas with a present value of over \$3 million.

*From Turpie et al 1999*

### *Contingent valuation techniques*

#### Overview of the method

Absence of prices or markets for ecosystem goods and services, of close replacements or substitutes, or of links to other production or consumption processes, does not mean that they have no value to people. Contingent valuation techniques infer the value that people place on ecosystem goods and services by asking them directly what is their willingness to pay (WTP) for them or their willingness to accept compensation (WTA) for their loss, under the hypothetical situation that they could be available for purchase

Contingent valuation methods might for example ask how much people would be willing to see their water bills increase in order to uphold quality standards, what they would pay as a voluntary fee to manage an upstream catchment in order to maintain water supplies, how much they would contribute to a fund for the conservation of a beautiful landscape or rare species, or the extent to which they would be willing to share in the costs of maintaining important ecosystem water services. In the example given below, household willingness to pay for conservation was taken as an estimate of the value of coastal wetlands.

#### Data collection and analysis requirements

There are five main steps involved in collecting and analysing the data required to use contingent valuation techniques to value ecosystem goods and services:

- Ask respondents their WTP or WTA for a particular ecosystem good or service;
- Draw up a frequency distribution relating the size of different WTP/WTA statements to the number of people making them;
- Cross-tabulate WTP/WTA responses with respondents' socio-economic characteristics and other relevant factors;
- Use multivariate statistical techniques to correlate responses with respondent's socio-economic attributes;
- Gross up sample results to obtain the value likely to be placed on the ecosystem good or service by the whole population, or the entire group of users.

This valuation technique requires complex data collection and sophisticated statistical analysis and modelling, which are described in detail elsewhere (see Carson and Mitchell 1989).

Most contingent valuation studies are conducted via interviews or postal surveys with individuals, but sometimes interviews are conducted with groups. A variety of methods are used in order to elicit people's statement or bids of their WTP/WTA for particular ecosystem goods or services in relation to specified changes in their quantity or quality. The two main variants of contingent valuation are: dichotomous choice surveys, which present an upper and lower



estimate between which respondents have to choose; and open-ended surveys, which let respondents determine their own bids. More sophisticated techniques are also sometimes used, such as engaging in trade-off games or using take-it-or-leave-it experiments. The Delphi technique uses expert opinion rather than approaching consumers directly.

### Applicability, strengths and weaknesses

A major strength of contingent valuation techniques is that, because they do not rely on actual markets or observed behaviour, they can in theory be applied to any situation, good or service. They remain one of the only methods that can be applied to option and existence values, and are widely used to determine the value of ecosystem services. Contingent valuation techniques are often used in combination with other valuation methods, in order to supplement or cross-check their results.

One of the biggest disadvantages of contingent valuation is the large and costly surveys, complex data sets, and sophisticated analysis techniques that it requires. Another constraint arises from the fact that they rely on a hypothetical scenario which may not reflect reality or be convincing to respondents.

Contingent valuation techniques require people to state their preferences for ecosystem goods and services. They are therefore susceptible to various sources of bias, which may influence their results. The most common forms of bias are strategic, design, instrument and starting point bias. Strategic bias occurs when respondents believe that they can influence a real course of events by how they answer WTP/WTA questions. Respondents may for instance think that a survey's hypothetical scenario of the imposition of a water charge or ecosystem fee is actually in preparation. Design bias relates to the way in which information is put across in the survey instrument. For example, a survey may provide inadequate information about the hypothetical scenario, or respondents are misled by its description. Instrument bias arises when respondents react strongly against the proposed payment methods. Respondents may for instance resent new taxes or increased bills. Starting point bias occurs when the starting point for eliciting bids skews the possible range of answers, because it is too high, too low, or varies significantly from respondents' WTP/WTA. With careful survey design, most of these sources of bias can however be reduced or eliminated.

#### **Box 13: Using contingent valuation techniques to value coastal wetlands in Korea**

This study used contingent valuation techniques to estimate the non-extractive benefits of conserving coastal wetlands around the Youngsan River in Korea. It focused primarily on the landscape, recreational, amenity and existence values.

The study involved a survey of more than 1,000 local residents. It elicited willingness to pay for a conservation programme designed to maintain coastal wetlands rather than develop them for alternative uses, measured through additional household taxes. Questionnaires ascertained respondents' attitudes and perceptions of coastal wetlands, their willingness to pay a minimum or maximum tax increase, and collected information about socio-economic variables such as age, education, income, marital status and expenditures on recreation.

Correlating these variables with respondent willingness to pay enabled the study to construct a demand curve for coastal wetlands. Overall, respondents stated that they would be willing to pay almost \$40 per household per month to ensure that coastal wetlands were conserved, suggesting an annual aggregate conservation value of more than \$176 million.

*From Pyo 2002*

### *Participatory valuation techniques*

#### Overview of the method

It is often difficult to use conventional environmental valuation techniques within largely subsistence-based economies, or to generate realistic estimates of local wetland use. Participatory valuation responds to some of the constraints and problems associated with using conventional valuation techniques, including:

- Many wetland goods have no substitute or market price, or it is unrealistic to use these as a proxy for their value in situations where the majority of the population do not have access to markets or substitutes.
- Cash measures and market prices may have little relevance in a subsistence economy where cash is not the main medium of exchange or indicator of local value.
- People frequently become suspicious when faced with a scenario where they must state a monetary willingness to pay/accept compensation for a natural product, if they suspect that they will be actually subjected to some kind of payment, tax or compensation. They will often under-quote the amount of money they would be willing to pay for wetlands goods if they fear that such charges may actually be made in the future, and over-quote the compensation they require if they think there may be a possibility of actually receiving payments.
- Most wetland uses are illegal in protected areas. People are reluctant to speak openly about their wetland use activities because they fear arrest. Some activities also have ritual or cultural significance, and knowledge is considered the preserve of specialist groups. Whereas households are reticent in the face of direct questioning, indirect techniques are a good means of stimulating discussion and gathering information.

Participatory valuation aims to find a bridge between local economic systems and cash values, and elicit information about wetland use and values at the subsistence, non-market level. It allows people to define wetland values within the context of their own perceptions, needs and priorities rather than according to externally-imposed categories or

market prices. It is particularly suitable for valuing occasional, subsistence-based or illegal wetland uses, and for relating wetland values to broader household livelihoods.

#### Data collection and analysis requirements

There are seven main steps to collect and analyse the data required for participatory valuation techniques to value ecosystem goods and services:

- Establishing the categories of wetland product, and types of activities, that are carried out in a particular locality;
- Defining a numeraire, or yardstick for valuation which is not cash. This is usually a commodity that forms an important part of the local socio-economy, has wide significance as an item of local value and exchange, and can easily be translated into a cash amount;
- Using picture cards to refer to each wetland product or activity that is used, and to the selected numeraire;
- Performing a ranking exercise on the picture cards, to ascertain the relative importance of different products;
- Establishing values by distributing a set number of counters between different picture cards, including the numeraire;
- Using the number of counters allocated to each card, translating wetland products into numeraire equivalents and converting this to cash amounts based on the price/market value of the numeraire;
- Discounting the resulting figures to give annual wetland use values.

#### Applicability, strengths and weaknesses

Participatory valuation techniques have most applicability to subsistence economies, particularly those which are relatively remote and where the majority of the population have a high livelihood dependence on wetland products. They are particularly useful in situations where wetland goods are used for subsistence purposes only, where wetland use is illegal, or otherwise a sensitive topic.

One factor to bear in mind is that even where markets for wetland products exist, participatory valuation rarely yields the same value estimates as market prices. This is because it is based on local perceptions of value, which may well not coincide with market-driven prices. Different people will value products differently, as values will reflect their relative importance to them in their daily lives, according to their personal preferences and responsibilities. Participatory valuation often yields far higher estimates of wetland value than other methods, because it incorporates a wide range of perceptions of value and is not confined to market prices alone.

Selection of the numeraire must be undertaken carefully, and a single measure used consistently across the community being studied. It is often challenging to identify a measure which has relevance and value for all concerned, and can be accurately reflected via a monetary value. It should be emphasised that the results of participatory valuation *must* be converted to an equivalent annual amount (or whatever time period that wetland values are being calculated for). This depends on the effective lifespan of the numeraire that has been selected.

#### **Box 14: Using participatory valuation to value wetland utilisation in Sacred Lake, Kenya**

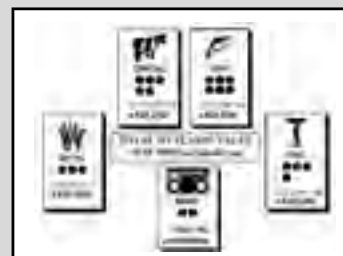
Wetland resource form an important part of domestic subsistence and local livelihoods around Sacred Lake in Mount Kenya Forest. The bulk of wetlands products are used within the household only, and are never bought or sold. Wetlands utilisation is also highly variable at different times of the year. Many wetlands uses are illegal. People are reluctant to speak openly about their activities because they fear arrest. Some wetlands activities also have ritual or cultural significance, and knowledge is considered the preserve of specialist groups.

For all these reasons it was necessary to use an indirect technique for valuation which would allow people to define wetland values within the context of their own perceptions, needs and priorities rather than according to cash amounts. Whereas households proved reticent in the face of direct questioning, drawing and manipulating pictures of different wetlands activities was found to be a good means of stimulating discussion. These pictures were used to value wetlands utilisation.

Because cash measures had little relevance in a subsistence economy such as that around Sacred Lake, it was necessary to find a numeraire for valuation which formed part of the local socio-economy, had wide significance as an item of value, and could be translated easily into a monetary amount.

Households chose a radio as the most appropriate measure of local value. Picture cards depicting wetlands activities were laid out together with a picture of a radio. Each household then distributed 20 beans as counters between these different activities and the numeraire card. It was thus possible to measure the perceived value of wetlands products in terms of radio equivalents, and translate each wetland product into a cash amount based on the market value of a radio, giving a total annual value for wetlands utilisation of approximately US\$200 perhousehold.

*From Emerton 1995*



#### *Other stated preference techniques: conjoint analysis and choice experiments*

Other stated preference valuation methods include conjoint analysis and choice experiments. Due to their complexity in terms of data needs and analysis, and because there exist very few examples of their application to ecosystem water services (see, for example, DGA & UAC 2000, Griner and Farber 1996, Kuriyama 2002, Morrison *et al* 1998), these methods are not described in detail here.

Conjoint analysis was originally developed in the fields of marketing and psychology, in order to measure individuals' preferences for different characteristics or attributes of a multi-choice attribute problem. In contrast to contingent valuation, conjoint analysis does not explicitly require individuals to state their willingness to pay for environmental quality. Rather, conjoint asks individuals to consider status quo and alternative states of the world. It describes a specific hypothetical scenario and various environmental goods and services between which they have to make a choice. The method elicits information from the respondent on preferences between various alternatives of environmental goods and services, at different price or cost to the individual.

Choice experiments techniques present a series of alternative resource or ecosystem use options, each of which are defined by various attributes including price. Choice of the preferred option from each set of options indicates the value placed on ecosystem attributes. As is the case for contingent valuation, data collection and analysis for choice experiments is relatively complex. Usually conducted by means of questionnaires and interviews, choice experiments ask respondents to evaluate a series of "sets", each containing different bundles of ecosystem goods and services. Usually, each alternative is defined by a number of attributes. For example, for a specific ecosystem this might include attributes such as species mix, ecosystem status, landscape, size of area, price or cost. These attributes are varied across the different alternatives, and respondents are asked to choose their most preferred alternative. Aggregate choice frequencies are modelled to infer the relative impact of each attribute on choice, and the marginal value of each attribute for a given option is calculated using statistical methods.

## E7. Analysing and presenting the data for decision-making (Stage 4)

Calculating the economic value of wetlands is not an end in itself. Rather, it is a means of providing information which can be used to make better and more informed choices about how resources are managed, used and allocated. In order for the results of the valuation study to influence real-world policy and practice, it is of critical importance that time and thought is given to analysing the data that has been gathered, and presenting it in a form that captures the attention of decision-makers, and is convincing to them.

### *Step 7: Analysing and expressing the valuation data*

In summary, this step involves relating values to the management issue or scenario under study and expressing changes in wetland status as indicators for decision-making support. It should result in quantified estimates of wetland benefits and costs, understanding of the economic implications of particular wetland management scenarios, and expression of changes in wetland status as indicators for decision-making support.

Decision-makers, whether in conservation or development sectors, are primarily concerned with choosing between different uses of land, funds and other resources – for example whether to manage a wetland under strict protection or to allow for some form of sustainable use, whether or not to build a dam, irrigation scheme or housing estate, which infrastructure design option to invest in, or whether to zone a wetland for conservation or to convert it to settlement or agriculture (assessing damage to a wetland). To analyse the results of a valuation study thus we need to be able to express ecosystem values as measures that make sense to decision-makers when they weigh up the different funding, land and resource management choices that wetland decisions involve.

Conducting a valuation study provides us with data about the economic value of particular wetland goods and services. However, what is important for decision-making is to be able to understand and express how making choices between alternative uses of land, water, resources or investment funds will influence these values. For example, how much additional flood-related costs would be incurred if a wetland were degraded, and what downstream production losses would arise from additional silt loads? Or what additional investments in water treatment and purification would be required if a particular wetland were reclaimed? Or what potential actually exists for raising revenues from urban dwellers to maintain water quality in a particular river or lake?

In order to answer these questions, and to integrate wetlands values into these decision-making processes, it is necessary to be able to analyse data so as to trace the economic implications of changes in the stock of wetland resources, flows of wetland services, or attributes of wetland systems that result from following a particular course of action, and factor them into measures of its economic desirability. In other words, we need to know what the economic impacts of particular decisions will be in terms of wetland costs and benefits.

### *Building up a bioeconomic model*

Various studies have demonstrated the utility of applying a simple bio-economic model in order to generate information for wetland decision-making (Colavito 2002, Creemers and van den Bergh 1998, Bennett and Whitten 2002). This type of model presents a useful tool for relating wetland values to decision-making, and involves a number of steps which translate baseline data on ecosystem values into information that can be used to assess the economic impacts of decisions on wetlands:

- **Establish ecological and socio-economic background and parameters:** This involves identifying, defining and understanding the status of the wetland and its links to hydrological goods and services, their benefits and beneficiaries, and the way in which various social, institutional and management aspects affect it.
- **Calculate baseline economic values from which to measure ecosystem changes:** This involves carrying out the partial or total valuation study.
- **Link physical changes in ecosystem status and integrity to changes in these economic values:** This involves tracing the effects of different decisions on the provision of wetland goods and services, and determining the impacts of these changes on economic values.
- **Express the results as indicators or measures that can be integrated into broader economic appraisal or analysis processes:** This involves expressing the results of value changes as quantitative indicators or measures that can be integrated into wider decision-support frameworks. The next two sections look at two of the most commonly used techniques for expressing wetland values in decision-making: cost-benefit analysis and multi-criteria analysis.

### *Cost benefit analysis*

Cost-benefit analysis (CBA) remains the most commonly used decision-making framework for using the results of a wetland valuation study in order to assess and compare economic and financial trade-offs. It is the standard tool for appraising and evaluating programmes, projects and policies and one that is a required part of many government and donor decision-making procedures. CBA is a decision tool that judges alternative courses of action by comparing their costs and benefits. It assesses profitability or desirability according to net present benefits – the total annual benefits minus total annual costs for each year of analysis or project lifetime, expressed as a single measure of value in today's terms.

In order to bring a project's benefits and costs over time to their present value, each is discounted. Discounting is essentially the inverse of applying a compound interest rate, and gives values relatively less weight the further into the future they accrue. It accounts for the fact that people generally prefer to enjoy benefits now and costs later, and that any funds tied up in a project could be used productively to generate returns or profits elsewhere. In most cases, the discount rate is therefore based on the opportunity cost of capital – the prevailing rate of return on investments elsewhere in the economy.

CBA presents three basic measures of worth, which allow different projects, programmes or policies to be assessed and compared with each other:

- **Net Present Value (NPV)** is the sum of discounted net benefits (i.e. benefits minus costs), and shows whether a project generates more benefits than it incurs costs.
- **Benefit Cost Ratio (BCR)** is the ratio between discounted total benefits and costs, and shows the extent to which project benefits exceed costs.
- **Internal Rate of Return (IRR)** is the discount rate at which a project's NPV becomes zero.

In general, a project can be considered to be worthwhile if its NPV is positive and its BCR is greater than one and if its IRR exceeds the discount rate. A positive NPV and a BCR greater than one means the project generates benefits that are greater than its costs. An IRR above the discount rate means that the project generates returns in excess of those which could be expected from alternative investments.

There are basically two types of Cost-Benefit Analyses: financial and economic. Financial CBAs look only at the private returns accruing to a particular individual or group. They calculate costs and benefits at market prices, reflecting the actual cash profits and expenditures that people face. A financial CBA might for example measure and compare the relative profitability of different dam design options for a hydropower company, the returns to improved water and sanitation facilities for urban consumers, or the highest earning mix of irrigated crops for a farmer. Here, wetland values will primarily be incorporated into CBA calculations as they influence private costs and benefits, affect investments and are expressed through market prices.

In contrast, economic CBAs examine the effects of projects, programmes and policies on society as a whole. They consider all costs and benefits, for all affected groups. Sometimes weights are assigned to prioritise particular groups, benefits or costs that are considered to be of particular importance in economic terms. As such, economic CBAs are mainly carried out by public sector and donor agencies, who are concerned with broad development impacts. For example, an economic CBA would consider the total costs and benefits of different hydropower design options, such as relocation costs and loss of production incurred by reservoir flooding, income from increased employment in the power sector and benefits associated with improved earning opportunities arising from electrification. An economic CBA of different irrigated crop mixes might include consideration of the premium attached to foreign exchange

earnings from export crops, improved food security benefits, and revenues in agro-processing and value-added industries.

Because economic CBAs assess the desirability of a given course of action from the perspective of society as a whole, they usually adjust financial costs and benefits to account for the various imperfections and distortions in the market. It recognises that market prices are not a good indicator of the true social and economic value of goods and services. This means that wetland values should form an integral component of economic CBAs.

#### *Other economic decision-support tools*

CBA remains the most widely used tool for the financial and economic appraisal of projects, programmes and policies. Other, less commonly-used, value-based measures of profitability or economic/financial desirability include:

- **Cost-effectiveness analysis:** This decision-support tool judges the minimum cost way of attaining a particular objective. Is useful where a project has no measurable benefits, or where a particular goal has already been set (for example maintaining a certain water quality level). It involves calculating all the costs of attaining the given objective, discounting them, and pointing to the option with the lowest NPV.
- **Risk-benefit analysis:** This decision-support tool focuses on the prevention of events carrying serious risks (for example investing in flood prevention). It assesses the costs of inaction as the likelihood of the specified risk occurring. The benefit of inaction is the saving in the cost of preventive measures. Is useful where risk is a major consideration in projects, and can be captured via monetary values.
- **Decision analysis:** This decision-support tool weights the expected values of a given course of action (in other words, the sum of possible values weighted by their probability of occurring) by attitudes to risk, to give expected utilities. It draws up and assesses decision makers' preferences, judgements and trade-offs in order to obtain weights that are attached to outcomes carrying different levels of risk.
- **Multi-criteria analysis:** Multi-criteria analysis provides one of the most useful and increasingly common tools for integrating different types of monetary and non-monetary decision criteria. It has been developed to deal with situations where decisions must be made taking into account multiple objectives, which cannot be reduced to a single dimension. Multi-criteria analysis is usually clustered into three dimensions: the ecological, the economic and the social. Within each of these dimensions certain criteria are set, so that decision-makers can weigh the importance of one element in association with the others. Here, monetary values and CBA measures can be incorporated as one of the criteria to be considered, and weighed against the others in decision-making.

#### *Step 8: Presenting management and decision-making conclusions*

In summary, this step involves relating the findings of the valuation study to on-going management issues, and targeting this to particular audiences and aims. It should result in a convincing report on the economic status and value of the wetland as it relates to management priorities and threats.

However good the results of a valuation study are, they will have little impact on decision-making if nobody sees, reads or is persuaded by them. There is an art to presenting information, and communicating it effectively. In many cases, the technical experts who carry out the valuation study itself may not be the best placed to do this – there is often a need for professional communicators and a properly-designed communications strategy.

Information about wetland values will be easiest to communicate when decision-makers find it useful, and it helps them to address or better understand a particular situation or problem. Many people are involved in shaping decision-making, and communication of the results of valuation studies must usually take place at many levels of scale. Making the results of valuation convincing to these different groups requires different types of communications strategies, different messages and different ways of presenting information.

In a perfect world where all decisions were made for the good of society, merely making valuation information available might be enough to ensure that water decisions took fair account of ecosystems. Unfortunately this is not usually the case. There exist multiple, and often competing, interests in wetlands. Fostering cooperation and balancing these competing interests is critical when the results and recommendations of wetland valuation studies are presented. Here, it is important to be tactical and work with the different constituencies who actually have the political will, and power, to influence wetlands. Just as wetland valuation aims to articulate particular costs and benefits that have traditionally been ignored in decision-making, it also represents the interests of many of the groups who have often been excluded from these decisions.

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E9. Field checklists for wetland valuation

**Table 7: Valuation checklist #1 - Identifying and listing wetland values**

Category of value	Values found in study wetland	Beneficiary or cost bearing group
Direct Values		
Indirect Values		
Option Values		
Existence Values		
Direct Costs		
Opportunity Costs		
Costs to other activities		

**Table 8: Valuation checklist #2 - Selecting wetland costs and benefits to be valued**

Benefit/Cost	Values found in study wetland	Beneficiary or cost bearing group

Values found in study wetland	Beneficiary or cost bearing group	Include <input checked="" type="checkbox"/>	Exclude <input checked="" type="checkbox"/>

Values found in study wetland	Beneficiary or cost bearing group	Include <input checked="" type="checkbox"/>	Exclude <input checked="" type="checkbox"/>

**Table 9: Valuation checklist #3 - Choosing wetland valuation techniques**

Values found in study wetland	Beneficiary or Cost bearing Group	Include <input checked="" type="checkbox"/>	Exclude <input checked="" type="checkbox"/>
Values included in study	List of possible valuation techniques	Technique to be used <input checked="" type="checkbox"/>	Technique not to be used <input checked="" type="checkbox"/>

Values included in study	List of possible valuation techniques	Technique to be used <input checked="" type="checkbox"/>	Technique not to be used <input checked="" type="checkbox"/>

**Table 10: Valuation checklist #4 - Identifying data needs and sources**

Values included in study	List of possible valuation techniques	Technique to be used <input checked="" type="checkbox"/>	Technique not to be used <input checked="" type="checkbox"/>
Values included in study	Selected valuation technique	Data required	Source of data

Values included in study	Selected valuation technique	Data required	Source of data



## Notes on this chapter

<sup>1</sup> A market can be said to be competitive when there are a large number of buyers and sellers, there are no restrictions on market entry, buyers and sellers have no advantage over each other, and everyone is fully informed about the price of goods.

<sup>2</sup> Marginal value is the change in value resulting from one more unit produced or consumed.

<sup>3</sup> A public good is characterised by the non-excludability of its benefits – each unit can be consumed by everyone, and does not reduce the amount left for others. Many ecosystem services are pure or partial public goods – for example scenic beauty (a pure public good), or water quality (which has many of the characteristics of a public good). In contrast a private good is one from which others can be excluded, where each unit is consumed by only one individual. Most natural resources are private goods.

<sup>4</sup> A substitute good or service is one which is used in place of another – for example kerosene instead of firewood, or bottled water instead of tapwater.

<sup>5</sup> A complementary good is one which is used in conjunction with another – for example between other products and fishing activities such as the collection of reeds for fishing baskets or firewood for fish smoking.

<sup>6</sup> Consumer surplus is the difference between the value of a good and its price, in other words the benefit over and above what is paid that is obtained by a consumer who is willing to pay more for a good or service than is actually charged. When a benefit is obtained free, all of its value is consumer surplus.



# Livelihood assessment tools

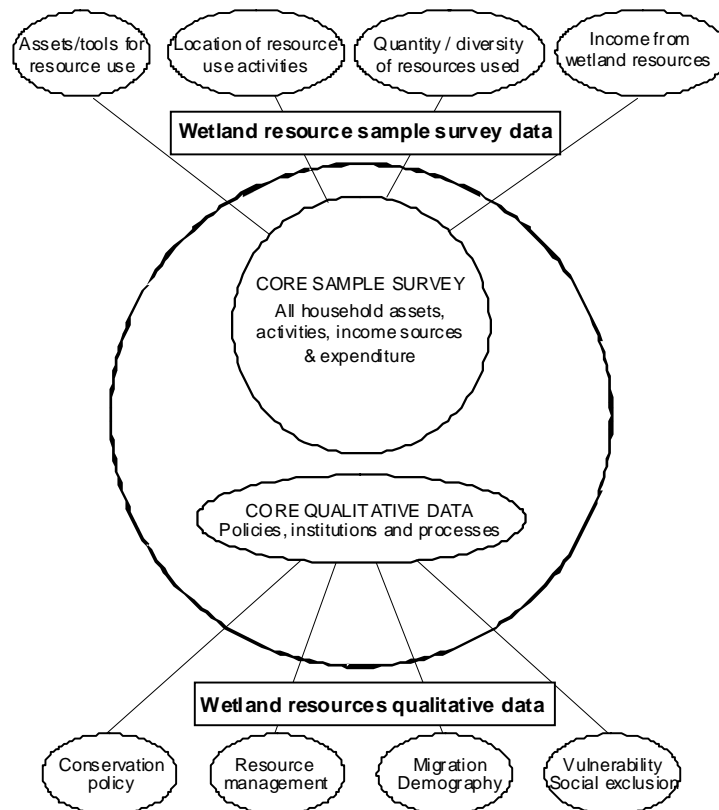
## L1. Organisation of livelihoods fieldwork - overview

The aim of livelihoods fieldwork in a wetlands management context is to achieve a good understanding of the following aspects of wetland-based rural livelihoods:

- the livelihood patterns and strategies of wetland-dependent individuals and households, and how these are changing over time
- the particular livelihood features and constraints of poor households, as distinct from the better-off or richer families in wetland communities
- the institutional context of wetland-based livelihoods at village level, with emphasis on the factors that inhibit rather than facilitate livelihood choices and options for the poor
- community natural resource management institutions and their interactions with the livelihood strategies and access to resources of the poor in these communities

In pursuit of these aims, a modular fieldwork research methodology is advocated (see diagram below). This consists of a generic livelihoods sample survey, and associated generic qualitative livelihoods data collection exercise, plus a set of components that are specific to wetland resource use as a livelihood activity. This ensures that wetland uses and use-values are nested within a livelihoods context, rather than the livelihoods research being seen as peripheral to detailed wetland biodiversity assessment studies. The overall framework for the livelihoods work is based on the Sustainable Livelihoods Approach, which is described in more detail on Sheet L2.

**Figure 23: Overview of fieldwork methods**



The following pages set out a proposed set of fieldwork methods for investigating the livelihoods of households dependent on wetland resources in low income countries. The methodologies are based on the following criteria:

- Relatively easy to implement with a small team comprising one or two social science researchers trained to postgraduate level, a wetland resource management specialist, and 2-3 field assistants or enumerators
- Can be achieved within a 7-10 day research period per village, with scope for return visits to validate information
- Achieves a balance between cost, feasibility and statistical representation or defensibility<sup>1</sup>.
- Aims to involve wetland resource users, local authorities and village residents in the research process, through use of participatory techniques, return visits to synthesise and check preliminary findings, and to provide channels of communication of local-level issues to decision-makers at district, national and international level.

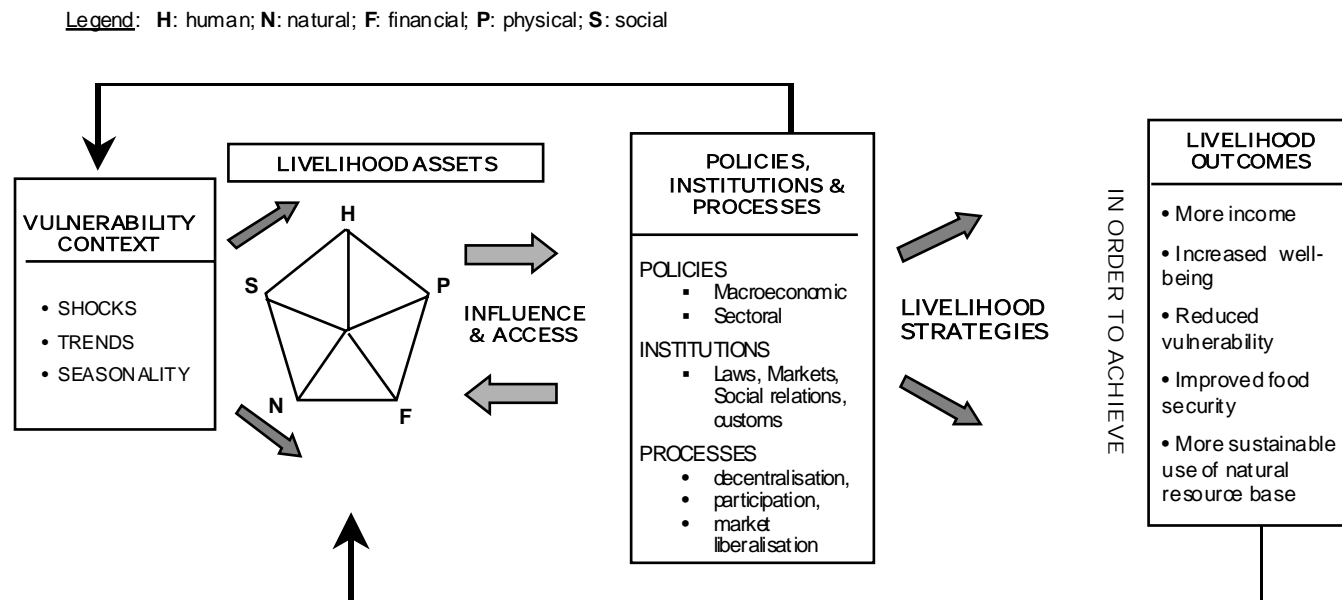
This is not the entire methodology that is needed for policy-relevant livelihoods research, which also requires work on micro-macro institutional links (for example, the impact of fisheries regulations on local level fisheries management) and engagement with relevant policy processes in the countries where research is being conducted. However, field research comprises a large and complex enough array of activities to merit treatment on its own.

The methodologies presented here are very similar to those used during the LADDER survey conducted by the Overseas Development Group, University of East Anglia. Their web-site contains detailed information about the methods and data obtained, including the database (downloadable) that they used to store the data. See their website: <http://www1.uea.ac.uk/cm/home/schools/ssf/dev/odg/research/currentprojects/LADDER> and the database link: <http://www1.uea.ac.uk/cm/home/schools/ssf/dev/odg/research/currentprojects/LADDER/Data>.

## L2. The sustainable livelihoods framework

The livelihoods framework brings together assets and activities of human populations and illustrates the interactions between them (Figure 24). The social and economic unit considered is typically the household, conceived as the social group which resides in the same place, shares the same meals and makes joint or coordinated decisions over resource allocation and income pooling.

**Figure 24: The sustainable livelihoods framework as a means to understand natural resource management systems**



(Source: modified from UK Dep't for International Development.)

The **capital assets** owned, controlled, claimed, or by some other means accessed by the household are grouped into five categories. These comprise physical capital (at household level – boats, house, bicycle etc, but also, at community or citizen level, access to infrastructure such as harbours, road networks, clinics, schools etc); financial capital (savings, credit, insurance); natural capital (fish stocks, areas of sea-bed leased or accessed by licence, land owned, crops cultivated etc.); human capital (people’s ‘capabilities’ in terms of their health, labour, education, knowledge, skills and health); and social capital (the kinship networks, associations, membership organisations and peer-group networks that people can use in difficulties or turn to in order to gain advantage)<sup>2</sup>.

Access to both assets and activities is enabled or hindered by **policies, institutions and processes (PIPs)**, including social relations, markets and organisations. PIPs include access and rights regimes and how they work – or don't. These are of course at the heart of fisheries management. The Sustainable Livelihoods Approach helps ensure that any fisheries or management intervention considers the range of resources that people may be able to draw on and the factors that may help some to do so, while hindering others.

Livelihood sustainability is also affected by external factors, referred to as the **vulnerability context**<sup>2</sup>, comprising cycles (e.g. seasonality), trends and shocks that are beyond the household's control. Trends might include decreasing catch rates, increasing prices for fish, and factors unrelated to fisheries that nevertheless impact on fishing households, such as rising costs of food staples or medicines. Shocks include storm damage to shore facilities, toxic algal blooms, fuel-price hikes and currency devaluations that affect the costs of fishing inputs and market prices for fishery products. At a household level, illness or death of a family member and the theft or loss of a fishing net are obvious shocks.

Understanding how people succeed or fail in sustaining their livelihoods in the face of shocks, trends and seasonality can help to design policies and interventions to assist peoples' existing coping and adaptive strategies. These may include improving access to education and health care facilities, strengthening rights to land for settlement and agriculture (i.e. not just rights of access to fish stocks), reforming local tax and licence systems, providing financial and enterprise development services (and not just credit for purchase of fishing gear) and promotion of diversification<sup>4</sup> – all issues seldom addressed in fisheries management and policy.

Capital assets permit **livelihood strategies** to be constructed by individuals or households.<sup>5</sup> Livelihoods incorporating small-scale fishing are typically either occupationally diverse, geographically dispersed, and sometimes both (Allison and Ellis, 2001; Allison, 2005). Mobility and migration is an important component of many fisherfolk's livelihood strategies (both men in the catching sector, and women in the post-harvest sector). Strategies can also relate to people's consumption choices (e.g. 'doing without' or the sale of assets). Short and long-term measures to ensure survival are often distinguished as 'coping' and 'adapting', respectively (Ellis, 1998).

Finally, this framework points to **outcomes**. A livelihood is sustainable if people are able to maintain or improve their standard of living related to well-being and income or other human development goals, reduce their vulnerability to external shocks and trends, and ensure their activities are compatible with maintaining the natural resource base - in this case the fish stocks.

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### L3. Research design, village and household selection

Ideally locations and households should be chosen as follows within the study area:

1. purposive selection of up to 3 locations in the designated area to explore a variety of different circumstances within the wetland (for example, varying across an environmental gradient from dryland to standing water, remoteness from markets etc)
2. purposive selection of 3 villages at each location to represent differing facets of the particular patterns of resource use being examined at that location
3. qualitative research in each village and location designed especially to examine the institutional context of wetland livelihoods
4. livelihoods sample survey comprising 30 households in each village, thus typically 90 households in a wetland/Ramsar site
5. stratification of sample by wealth groups in order to bring out clearly the critical constraints experienced by poor households in particular.

Clearly this will depend both on how large the area is (if the area is small, skip step 1) and on the time and budget available, which will limit the actual number of household surveys that can be done.

### *Location Selection*

This implies establishing a set of criteria for choosing areas within wetland sites to undertake the assessments. These criteria are as follows:

- representative livelihood patterns for that wetland (in a broad sense)
- relative extent of rural poverty in different places
- presence of particular livelihood features considered important to understand for conservation management and policy purposes, or relating to particularly to the management issue chosen as the focus of the study
- geographical spread and agro-ecological or habitat variation
- logistical feasibility (organisation, distances, budget etc)

The first of these criteria is a difficult one involving balancing a number of considerations. The critical factor is that the research should be seen to have captured a “typical” spread of wetland-based livelihood patterns, so that findings have policy and management relevance on a broad scale. An alternative way of looking at this is to avoid locations that are highly atypical in terms of the types of livelihoods and circumstances they represent (for example, the one location that has a fairly developed commercial fishery utilising large motorised vessels, or the one area where there is a luxury tourist resort providing employment)

### *Village Selection*

Having made a choice of locations or districts, and, usually, zones within those districts to conduct research, the next stage is village selection. Here again purposive choice of 3 villages should approximate a set of criteria, some of which are similar to those for selecting districts, while others are slightly different:

- village selection should bear in mind poverty-relative wealth considerations, given the typical poverty reduction focus of livelihoods assessments
- villages should differ from each other in some important respect, for comparative purposes
- this difference could be varying degrees of remoteness from infrastructure and services e.g. on a main road, on a dry season-only feeder road, lacking proper road access
- alternatively, villages might differ in the degree of their reliance on the wetland resource e.g. heavily reliant on direct use of wetlands, less reliant, and not very reliant

This last criterion has the important implication that just because livelihoods of people who live in or near wetlands are under investigation, this does not mean that all households interviewed need to rely heavily on that resource for their livelihoods. From a livelihoods perspective, as applied to wetland communities, what is interesting is the way families combine wetland resource use with other activities in a variety of different ways, and for various strategic reasons, and the extent to which a division of labour occurs so that some families specialise in natural resource use, while others do not (e.g. those providing services to others).

### *Household Selection*

It is envisaged that the selection of households for interviewing in a sample survey should take place at the same time that qualitative, PRA-type, work is being conducted in a village, and it should be integrated as far as possible with work to value environmental goods and services (cross ref to economic valuation) and relevant biodiversity assessment activities (for example to ensure that information of habitats and species utilised are collected alongside information on their use and value).

The first stage of household selection is for a community wealth-ranking exercise (Sheet L4) to be conducted, whereby village households are typically divided between poor, middle, and well-off categories. Then with a list of households in each income-wealth group, a random sample of 10 households is taken from each group. In summary:

- PRA wealth-ranking of village households, resulting eventually in 3 income-wealth groups
- random sampling from each income-wealth group
- 10 households from well-off group
- 10 households from middle group
- 10 households from the poor group
- this gives 30 households in total per village
- 90 households per research district or location

One or two “spare” households should be chosen for inclusion in the case that selected households are unavailable or unwilling to participate.

While this procedure will yield a statistically defensible sample of households in wetland villages it may not provide enough detail on wetland resource use as an activity if only a minority of households in the village actually engage in wetland biodiversity-related livelihood activities (as opposed to agriculture and non-natural resource activities). There

are several alternatives here. One is to follow the procedure as stated so that at the very least the typical patterns of livelihood in the wetland village are captured, but to add additional wetland-resource dependent households equally across the wealth categories until a sufficiently large sub-sample of such households is captured. The minimum sample size of specifically wetland-dependent households that would enable general things to be said about wetland resource use as an activity in that community is 30 households.

Alternatively, if the objective of the assessment is so definitely oriented to wetland resource use as to exclude those households not directly using wild wetland products from the zone of interest, then the sampling frame can be re-specified to exclude non-wetland resource-using households, and the entire process of undertaking wealth ranking and sample selection is then done only on those households identified as being involved with floodplain agriculture, hunting, fishing and gathering of wetland products.

## L4. Research methods

### *Conduct of secondary data, key informants and PRA-type research methods*

The qualitative research methods (Sheets L5-11) should precede the sample survey, so that members of the community have already got used to having the research or assessment team around, and have had a chance to voice their views on a variety of different issues, before selected households are interviewed.

PRA-type work in villages does not need to utilise very complex or lengthy participatory techniques. For better or worse, PRA methods are deployed in the context of the type of research envisaged here for information gathering purposes rather than in order to involve people in an active process of change i.e. they are more RRA than PRA. In many instances, the type of information being sought can best be obtained via group discussions, and these may involve a general cross-section of the village, or groups formed around particular activities or issues e.g. migrant fishermen, hunters, people engaged in the wildlife trade, women who gather wild foods etc. Sometimes these groups will suggest themselves due to the membership of people in a community management activity e.g. a village natural resource management committee, but researchers should be alert to how representative is the membership of such self-defined groups, and sometimes group formation drawing on a wider population and deliberately including poorer members of the community will be more appropriate.

In other instances, specific understanding of strategies and constraints may be more accurately obtained through discussions with individuals and households. This is a matter of judgement on the part of the researcher, and so-called "triangulation" whereby the same information is approached using several different methods should be considered, especially where there is a lack of clarity concerning the interpretation of issues or events.

The main areas of interest to be covered utilising qualitative research methods are set out in Sheets L5-L11. These typically provide a checklist of the points that need to be covered in group meetings. They may also suggest other PRA-type activities that should be conducted such as mapping of the seasonal migration patterns of wetland resource users. Sometimes they ask for specific quantitative data on which a consensus view is sought e.g. past and current prices of fishing gear or fish sales, or perceptions on habitat and vegetation change or resource abundance changes.

It is important that PRA field notes are written up soon after the conduct of group activities, while the direction of the discussion, and key points raised, are still fresh in the mind of the facilitator. In some cases (see Sheet L11) a format for summarising discussions on a single page is suggested.

### *Conduct of the sample survey*

Many of the questions in the sample survey (Section C below) are to do with people's work and incomes. Income is a sensitive matter, which is sometimes difficult to discuss with people, and enumerators should make very clear to respondents that this information is for research use only and no one else will know about it. Sample selection should include some "spare" households in case of non-cooperation by one or more chosen households. Enumerators should try to develop a good relationship with the family, and should be prepared to make repeat visits to clarify points that do not seem to make sense or to obtain more complete information.

Enumerators should also be sensitive to gender relations, and where it seems evident that clearer results would emerge by interviewing a particular woman or man separately, then this should be done in order to improve the accuracy of the data (both women and men may conceal details of particular activities and income flows from each other). Some further points about the conduct of the sample survey are:

- a) aside from gender-sensitive income data, interviews should be conducted with several members of the household present, so that individuals can remind each other of information that requires recall up to one year back
- b) where information is required of a household member who is absent (e.g. someone out earning wages), a return visit must be done to complete this information

- c) the attempt should be made to collect gender-sensitive income data from the individual concerned – this is likely to apply especially to specialist income-generating activities such as fish drying, beer brewing (Form E) or work outside the home (Form F); one way of achieving this may be to have both a female and male enumerator visit the household, which may make separate discussions with individuals easier to do (see also note below on Form J)
- d) after initial completion, the survey forms should be checked carefully for the consistency and accuracy of the information they contain. The proposed range of sample sizes is relatively small, so attention to detail is important. Answers which do not make sense, or which contradict each other in different parts of the questionnaire, should be checked by revisit to the household.
- e) enumerators should have a supervisor, who signs off on the front page of the questionnaire only when completely satisfied with the quality of the data on the form. If there are problems with the replies, return visit to the household should be made to try to sort them out
- f) in general most of the survey can be completed with a single visit to the household, provided this has been fixed in advance so that the relevant members of the household are there to be interviewed
- g) note, however, that Form F must be completed for each individual who has obtained non-farm or non-wetland-based income during the past year, including casual wage work, permanent wage or salary work, self-employment in a non-farm or non-wetland activity like driving a rickshaw, working in a government office, or pension income resulting from former full-time employment

The sample survey contains two forms that elicit qualitative rather than quantitative data. These are Forms I and J. Form I should be applied to all households. Form J is designed as a checklist of gender questions to discuss separately with a woman, or group of women, in the household. Form J should be implemented only to one out of every five households in the sample i.e. to 6 households per village (if the sample size of 30 is adhered to). These households can be selected by listing the sample households sequentially, then picking a random starting point (e.g. HH No.3) and selecting each fifth HH down the list (e.g. Nos 3, 8, 13, 18 etc.).

#### *The importance of informal institutions and of probing further...*

##### (1) Blocking or Inhibiting Factors in Peoples Livelihoods

A key purpose of livelihoods assessment in the context of poverty reduction and conservation is to discover what stops people from doing things, as well as what helps people to do things. The factors that stop people from conserving resources or taking up new economic opportunities may not be at all obvious, either because they are regarded as “normal” or because people feel they cannot do anything about them anyway. Cultural factors or social norms that prevent women or men from doing certain things is one example of the first type of reason. Licenses and taxes imposed by district authorities is an example of the second type of reason. It is very important that researchers probe further when someone says something like “this is not worth doing because. . . . .” In many ways, some of the most important new insights of this research are likely to emerge from an understanding of these factors.

##### (2) The Why? not just the What?

Field researchers sometimes have a tendency to stop further questions when they have discovered what is happening. For example: “do you keep goats?” is a what type of question, and if the respondent says “yes”, then the field researcher usually moves on. However, for good livelihoods research, this type of question needs to be followed by why the person does this thing. From why questions all kind of other things can usually be pursued, such as why one thing is better than another, or why someone does this rather than something else. For example, “why do you keep goats?” “I keep goats because they provide me with a means of obtaining income when fish catches decline” “are fish catches declining then, or do you mean seasonally?” . . . . . In this way a more complex view of the different reasons for pursuing a complex livelihood strategy can be revealed.

#### *Outputs from livelihoods fieldwork research*

The aim of the fieldwork research is for a set of outputs useful for further work and analysis to be produced downstream, resulting in ideas to be fed into ongoing policy processes such as poverty reduction strategy plans, decentralisation, Ramsar site management planning, and community-based or co-management of natural resources. The work is also intended to provide an empirical foundation to current discussion about the utility of the ‘livelihoods approach’ for poverty reduction in the context of integrated conservation and development approaches.

#### *Data Entry, Coding, Variable Names and Analysis*

After the fieldwork has been completed, the data on the survey forms should be transferred to computer, using a database entry system (Access). A database has been designed in which data can be entered in the same format as it appears on the survey forms. Since the survey forms were designed for codes to be entered at the time of completing the form, for the most part coding is already done and codes can be entered directly to the computer. Similarly variable names have already been devised, corresponding to the cells for data entry. Data entry formats incorporating checks for data consistency are provided.

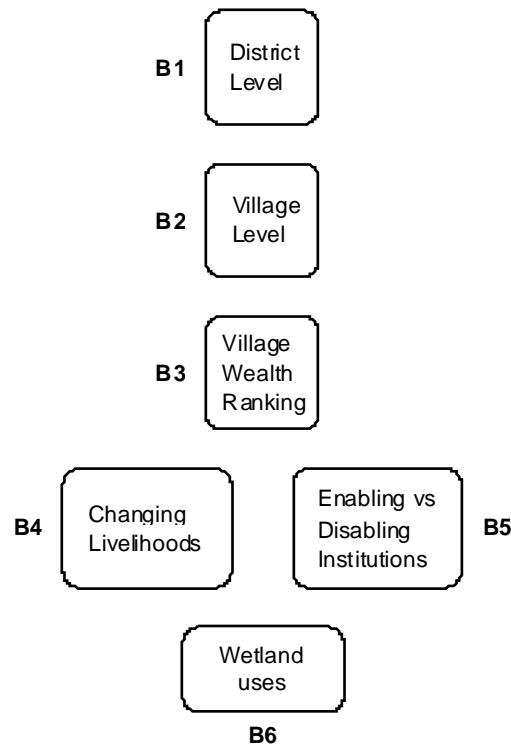


## L5. Secondary data, key informants and group methods

### Introduction

This section of the manual contains advice and guidelines for conducting the secondary data collection, key informant, and group or PRA-type research activities in sample villages. An overview of these data components is given in the diagram below.

**Figure 25: Map of qualitative data components**



The overall objective of using these research methods is the same whenever the objective is to discover the factors inhibiting the ability of people to find routes out of poverty. The interest is in people's livelihoods, whether they are improving or deteriorating, the factors that help them to construct stronger livelihoods, and those that weaken their ability to make a viable living. Also relevant are the factors that cause people to diversify their livelihoods i.e. that increase the range of different activities that they undertake in order to gain a living.

The setting out of particular methods here should not be regarded as the only way of collecting the different types of information that is asked. It will often prove useful to seek the same information utilising several different methods e.g. key informants, group meetings, spot interviews with individuals, in order to triangulate different sources and reach a multi-faceted view of the topic under investigation.

Many of the sub-sections below pose livelihood issues in the form of questions, but it is not intended that these are necessarily asked in their current form. Researchers will need to think through how they will address each of the issues implied by the question, and what will be the best way of gaining the required understanding. Researchers should seek and note different perspectives, not aim for a single answer. There may, of course, be occasions when everyone widely concurs about a particular issue, but many others when they do not, and silences may sometimes indicate when individuals are reserving their view about something.

The following principles apply especially to sub-sections B4 to B6

1. Focus on ranges of experience and difference, not on "averages"
2. The prime interest here is poverty, so we need to disaggregate understandings according to different households, strategies, relative poverty and wealth
3. Investigate gender differences for all of these issues, as appropriate
4. Seek understanding not just description: the 'why' not only the 'what' (see end of Section A above)
5. Probe on changes and trends whenever appropriate
6. Ask about problems, constraints, hindrances, faced for any of the issues, if appropriate.
7. Vary research methods according to what seems most appropriate – some of the issues that are listed here under group methods may be better approached through interviews with a range of different individuals

8. It is important to have a firm idea about how data gets recorded and written up - good records need to be kept during group meetings, perhaps by someone other than the facilitator, and notes should be written up straight afterwards; the same applies to semi-structured interviews with individuals and households

In summary, the purpose of the qualitative research can be summarised as identifying ways whereby it becomes easier for people to construct viable and improving livelihoods. This implies that:

- we need to know not just what people do, but why they do it. Understanding people's motivations and incentives is critical if they are to be engaged in conservation efforts
- we need to know what it is that enables people to do certain things relatively easily, but makes other things very difficult for them to start up or engage in
- what are the factors in the policy environment - which includes policy institutions of all kinds and levels – that help people versus those that hinder or block people's options and opportunities

## L6. Wealth ranking

PRA wealth ranking is best conducted by someone experienced in this method. Two main approaches seem to be followed: one depends on a consensus discussion in a focus group meeting, the other depends on household ranking by a number of individuals (key informants), or small groups, and the final division into categories is determined by adding together individual rankings (this second method is described in detail below). Note that if done properly, wealth ranking will often yield more than three wealth sub-groups, therefore the re-organisation of the sample frame into three groups must take place after the wealth-ranking by amalgamating adjacent sub-groups. Also, wealth ranking can be a valuable exercise in itself, independently of its function as a means of stratifying a household sample. The process of wealth ranking yields valuable information on the criteria utilised within the community to distinguish relative wealth and poverty. In addition, the wealth ranking exercise can be used to draw out information about the dynamics of poverty in the community i.e. who is moving between wealth categories and what causes these movements.

Initially, this exercise should be conducted with participants themselves choosing the number of income-wealth groupings, and defining the criteria separating one group from another. This information has value for the livelihoods analysis in itself, and field notes from the exercise should be written up. As well as the groupings, the criteria utilised by villagers for distinguishing households are of research interest; for example, the rich may be distinguished by having land holding above a certain size, or cattle above a certain number, or possession of particular types of physical asset, or some combination of these or other indicators. Also, the wealth ranking exercise may provide an opportunity to discover something about the direction of change i.e. who is moving into or out of poverty in the village, and the reasons for this.

### *Output*

The groups, criteria and other information about the dynamics of poverty discovered during the wealth ranking exercise should be written up for each village. The re-classifying into three groups results in the sample frame from which the stratified random sample of households is drawn (as described in Sheet L3).

### *A wealth ranking methodology*

The approach described below follows the wealth ranking methodology of Grandin (1988) closely. Before wealth ranking, simple data collection forms should be prepared in order to record:

- Location, date, researcher name, key informant name and details
- The households ranked in the different groups
- Room for a few extra notes alongside each household name (see step 8 below)
- Room for notes on characteristics of different groups and differences between them.

The principle steps in wealth ranking are:

1. Agree with local facilitator and two or more key informants on:
  - i) local concepts and language for describing wealth
  - ii) number of wealth categories that informants identify
  - iii) a working definition of a household
2. Identify several reliable key informants (3-4). These should be generally honest, longstanding community members. It is best not to use community leaders or extension officers, but they may suggest candidates. If any informant is reluctant to group people by wealth another should be selected.
3. Introduction. Explain to the informant the nature of the research and the value of knowing about the different problems of richer and poorer families. Ask the informant to give two examples of differences between richer and

poorer families to be sure the concepts of wealth are shared. Also check the informant and researcher are using the same definitions for a household.

4. Group activity: list households in the village. Best for the chairman and several others to do this (key informants can be included) - they call out the names as the researcher writes a list. Spend some time on this, as it is important to try to get as complete a list of the households as possible. All should be aware of the "boundaries" of the particular research location.

5. Each household name should then be written on a small card and the cards shuffled. If the informant cannot read the names on the cards, they are read to him and the informant is asked to place each card in one of a series of piles before him or her, corresponding to the previously agreed understanding of different wealth categories in the village. This may be more than three categories. This does not matter at this stage.

6. Verification. When finished pick up each card and read the names asking the informant again to be sure (s)he thinks they are in the right pile. (S)he is free to move them into a different pile.

7. Ideally no pile should have more than 50% of the households. If one does, the respondents may need to rethink the criteria they are using to define wealth.

8. Additional household information. The interviewer should then go through the cards in each pile and ask whether the respondent feels each household has become more wealthy or poorer over the last five years, or if they think the wealth of the household has not really changed. Responses can be recorded against the list of names on the data sheet. The informant can then be asked to give one or two reasons for the apparent change. This may be sensitive information.

9. After sorting has been verified discuss the nature of the differences between the different wealth ranks. Do not ask about specific households as this might be sensitive information. Usually it is easiest to begin with the richest group. Ask questions like "what do the people in this group have in common?"

10. After completing the wealth ranking, wealth groups should be re-distributed into three income-wealth categories, with advice from the key informants. The three categories should be: the poor, the middle or better off, and the rich or well-off. In most cases, this regrouping should be straightforward (the rich and the poor stay the same, and other groups end up in the middle). However, if the exercise produces a lot of groups, some thought may need to be given to how these match the poor, middle, rich distinction; and some help from informants may be needed in order to re-classify households in this way.

These three categories then form the basis from which the 10 households to be surveyed are randomly chosen. NB the number of households assigned by the wealth ranking to each category must be recorded before the sample is taken, for otherwise this information will be lost when the cards are mixed up or thrown away.

Grandin, B.E. (1988) *Wealth Ranking in Smallholder Communities: A Field Manual*. Intermediate Technology (London).

## L7. District or wetland site profile and village profile

### *District or wetland site profile*

The main method used here is secondary data collection, supplemented as required by key informant interviews. The purpose of this component is to be able to place the village and household level fieldwork in the context of the district and agro-ecological zone – and most specifically – the wetland site where the assessment is taking place. Key items required are:

- district and site-level map showing chief agro-ecological zones, forests, rivers, swamps, lakes etc.
- district and site-level maps showing location of survey villages, roads, towns etc.
- district and sub-district demographic data
- location, number, and level of schools in the sub-district where survey villages are located
- location, number, and level of health facilities in the sub-district where villages are located
- agro-ecological data for the district or sub-district where fieldwork is taking place: areas under forest reserves, cultivation, main crops or farming systems ([link with habitat mapping](#))
- **Overview of conservation and management plans, policies and regulations in force (e.g. Ramsar designation and planning)**
- any other features of special or notable interest with respect to that district or sub-district, e.g. recent road upgrades, major public works (dams etc.), new industries that have come into the district, major problems that are well-known for that district (stealing of nets, lack of transport to market etc)

- change in the district: what are the main things that have been changing in this district over the past five years or so – is it getting richer or poorer? are income or wealth differences widening or narrowing between different parts of the district? Are people migrating away from or into this district? Are there any events in the last five years for which this district is well-known e.g. environmental change, drought, civil unrest etc.

### *Village profile*

The main methods here are secondary data and key informants, supplemented where necessary by informal group or individual discussions. Key items required are:

- name of community and parish; its location; map showing key features of village and surrounding area
- number of households; village population
- ethnic affiliations, linguistic groups, main religions
- significant migrations into area over the past two or three decades
- main current sources of livelihood in the village
- change in the village: what are the main things that have been changing in this village over the past five years or so – is it getting richer or poorer? Are people migrating away from or into the village?
- institutions and organisations in the village; what institutions exist within the community? what outside organisations are represented or active within the community?
  - what traditional institutions exist (e.g. traditional chieftancy: is there a traditional chief? how is he (usually!) selected? what is his role? what other 'traditional' institutions exist?)
  - what political institutions exist (village chairman, elected councils, etc.)?
  - what formal organisations exist (e.g. community-level branches of development agencies, official cooperatives)?
  - what community-based organisations (CBOs) exist (fishermens associations, farmers groups, cooperatives, credit associations, social/religious organisations)?
  - what production services exist (e.g. agricultural extension, microcredit services, supply of nets, marketing)?
  - what social services exist (e.g. health clinics, schools)?
  - what non-government organisations (NGOs) exist and what do they do?
  - what significant private businesses operate in the locality?
- what development initiatives have taken place within this community in the last ten years? how were they implemented? what happened? (probe for history, attitudes, comments). Relevant areas in wetland might include irrigation schemes for rice or crop horticulture, ecotourism, sport fishing and wildlife hunting.
- common property: what key productive resources are held in common by the community? what criteria, rules and institutions govern access?
- land tenure: what is the main type of land holding in the village (e.g. private ownership, customary tenure);
  - if someone wants more land or to start-up farming here, how is access to land obtained?
  - how is ownership, access, control over land distributed between men and women

Note: when establishing a list of the existence and function of organisations and institutions, it is also important to probe about their effectiveness. Do they actually do anything? How responsive are they to the needs of their members or to the community as a whole? Some supplementary PRA work may be required in order to establish some of these aspects e.g. institutional mapping/Venn diagrams, ranking. Also change is important – which institutions are declining and which are rising in importance.

### *Output*

The output of this section should be a village-level report corresponding to the checklist given above. This report should also try to take a critical view of things that do not work, especially institutions that do not work well for the poor. Of special interest is to identify factors in the social and institutional environment that inhibit rather than encourage people from taking advantage of livelihood opportunities or creating new opportunities for themselves.

## L8. Village livelihoods, past and present

The principle method to be used here is that of the village group meeting, which in this case should be a group that represents a reasonable cross-section of the community. Facilitators should be sensitive to the tendency for a few people to dominate group discussions, and should try to elicit responses from the less forthcoming members of the group. The discussion should aim to discover activity patterns of the village and how they have been changing over the past ten years, including things that have got worse or better, and some general points on environmental change.

Questions asked here could also be asked of selected individuals across different social groups in the village, as a way of confirming understandings. Questions specific to wetland resource use and conservation are given later (B6). Points to cover in discussion include:

- what are the main sources of income in the village now? is this the same as five years ago? the same as ten years ago? are those sources of income as important now as they were five and ten years ago?
- what new activities are commonplace now, that were rare or did not exist before? activities that have started in the last ten years? the last five years? how important are these new activities now for the incomes of people in the village? what activities have stopped?
- what do villagers consider to have got worse in the last five years? last ten years? for those whose standard of living has deteriorated, what are the main things that have caused their lives or livelihoods to go down in the last five or ten years?
- what do villagers consider to have improved in the last five years? last ten years? for those whose standard of living has increased, what are the main things that have got better in the last five or ten years?
- what have been the main agricultural problems in the village over the past five or ten years? what has been happening with maize? other food crops? livestock? milk? etc both production and marketing problems can be discussed here.
- what has happened to people's access to natural resources over the past ten years? access to land for cultivation? fragmentation of holdings? distance of holdings from homestead? access to forests and forest products? timber? woodfuel? water for agricultural and household purposes? hay for cattle etc.?
- what has been the impact of health issues (e.g. Malaria, TB, water-borne diseases) on the village in the view of members of the group? are many households affected? what are the main effects on people's ability to gain a reasonable living? how has the village responded to children who are orphaned due to this illness? (Note – questions on illness, particularly around AIDS-related illness and death, need to be handled with sensitivity – trained health professionals should be consulted before making any assessment).
- how has the status of women changed in this village over the past five or ten years? are there more women that are heads of households than before? are there activities that women do now that they did not usually do before? what livelihood activities are women still not permitted to do in this community?

### Output

Information elicited should be written up in a summary report, and can also be summarised in a matrix format as illustrated in the table shown in Sheet L11.

## L9. Effect of institutions on livelihoods

The same methods can be used here as for the preceding Section, possibly even the same group of people can be used provided that this does not result in "respondent fatigue". Of special importance here are the factors that inhibit rather than encourage people from taking advantage of livelihood opportunities or creating new opportunities for themselves.

- are there particular activities in the village that require special permission or a license in order to be allowed to do that thing? [make list of such activities]
- for these activities, what person, or organisation or institution grants permission or issues licenses? [link this to the relevant activity]
- what is the cost of getting permission, or obtaining a license to start-up this activity? probe here both for official and 'unofficial' costs e.g. gift payments to traditional authorities or to local officials
- are there particular activities that individuals in the group would like to do, but are unable to do because of the costs that are imposed on starting up the activity?
- are there any restrictions on moving produce (non-timber forest products, fish, crops or livestock) from the village to the town for sale?
- if so, what are these restrictions? are payments required to any person or institution in order to move goods from one place to another?
- amongst the village organisations and institutions (sub-section B2 above) which ones are the most helpful for improving people's standard of living? [rank list in order of priority as given by people in the group]
- what is it that these organisations do that help people to gain a better living?
- are there people in the village who are excluded for some reason from the benefits that these organisations can provide? if so which group of people?

- amongst the village organisations and institutions (sub-section B2 above) which ones are least helpful, or even block, people from doing things to improve their standard of living [make ranked list of unhelpful organisations and institutions]
- what is it that these organisations do which hold people back from gaining a better living?
- are there people in the village who are particularly disadvantaged by the way these organisations or institutions work? if so, which group of people?

## L10. Special questions on wetland resource use

Most wetland resources are common property and as an activity, gathering, hunting and fishing poses special problems for investigation, due to the cyclical and seasonal nature of many resources, their varying location at different times and the difficulties of establishing rights of access and ownership. Fisherfolk, for example, tend to be more mobile than settled farmers and are sometimes a different ethnic group from the resident agriculturalists in wetland-area villages. Owners of boats and gears may be different from users of those same assets, and wage (or catch-share) labour arrangements may be prevalent. Qualitative data research can be divided into four main categories:

- general discussion about wetland resource use, in a broadly representative village group meeting
- discussion about regulations, access and management with members of fishing, hunting and gathering households (focus group meetings), and key informants, resident in the village
- if relevant, discussion with migrant fishermen or hunters who are temporarily sited at or nearby to the village
- mapping of migratory movements made by fishermen and other mobile hunter-gatherers

### Category A

Some main questions in a general village discussion about wetland resource use are:

- overall importance of direct uses of non-farm wetland products for survival in this community? is this just a minority occupation? do most households have members that fish, hunt or gather wetland products, or are there some families that specialise while others do not engage in these activities at all? obtain count of households that do and households that do not make substantive use of wetland products in this village
- how big an area is exploited by people based in the village? do village-based fishers and hunters move around and often fish or hunt elsewhere? (maps showing these with GPS coordinates)
- where are the main sites that village-based fishermen and hunters go for fishing? (a map may be helpful here – linked to habitat mapping) (maps showing these with GPS coordinates)
- how has the importance of fishing, hunting and gathering changed compared to five years ago? ten years ago?
- is it still possible in this village for people who were not fishing or hunting before to take up fishing and hunting now? Are fishing and hunting seen as a good way to strengthen livelihoods? what are the barriers for people who want to take up fishing and other common property resource-based activities?
- what are the seasonal characteristics of fishing, hunting and gathering as occupations? what are the peak months for catches and harvests, and the lowest months during the year? draw up a calendar showing seasonal changes in these activities; have there been any changes in the seasonal pattern of resource availability compared to five years ago? ten years ago? (reasons for these fluctuations? weather, drying constraints (e.g. rain), fish and wildlife movements/availability/depletion)
- aside from regular annual patterns of fishing and wetland product harvest, are there cyclical changes that occur across years e.g. very good years for fishing occurring every three years or every five years? what is the recollection of the community about years (over the past 10-15 years) that have been very good or very bad years for fishing (reasons/understanding of fluctuations – biological stocks, weather, markets, costs?)

### Category B

Some main questions for discussion with a focus group of wetland product-using households are as follows:

- what are the chief regulations about wetland resource access that the village understands to apply to their activities? do people comply with these regulations?
- how are the regulations policed? what is the penalty for non-compliance? is this an individual penalty or one imposed on the community?

- (j) does the village have its own (community management) system for regulating seasonal, spatial or personal access to natural resources and permitted harvesting equipment (e.g. guns, fishing gears), and how does this work?
- (k) have either formal or village regulations changed over the past five years? past ten years? and if so how have they changed?
- (l) are there conflicts between the way the village authorities would like to manage access to resources, and the rules that are imposed from outside by government departments?
- (m) do the rules (whether village-based or imposed from outside) mean that some individuals have permanent rights to use natural resources while others are always excluded?
- (n) have outsiders been coming in to use wetland resources over the past five years? if so, what effect have they had on the state of the resources (abundance, distribution, ease of harvest)? what effect do new resource users have on the way that resources are managed here?

After discussing these questions in a village group situation, they should be followed up by discussions with key informants to check on the understanding of different people about matters of regulation and access. For example, individuals who are in authority in the village, selected people who specialise in the various natural resource sectors (e.g. fishing, hunting, charcoal making), selected people who do not engage in these activities in order to find out why they do not if they are located in proximity to these resources.

### *Category C*

This category comprises migrant fishermen and other migrant resource users who are located at or nearby to the resident villages. Questions to be asked of this group are:

- (o) where are you from? (place of permanent residence)
- (p) which resources are you using? what is the main resource that you come here to use?
- (q) duration of stay in the wetland? other places you carry out these activities? always go to the same places? where are these places? do you come every year? or do you come only when you hear that there are good fish stocks (for example) here? [this set of questions should allow a map of places on the lake, river or coastline that are favoured by this group of resource users to be drawn, together with info on the time they spend at each location]
- (r) why do you come to this village in particular? what are the advantages of being located here? [list reasons given by the group, and follow up particularly on relationships between the migrants and the resident community e.g. exchanges, trading arrangements etc.]
- (s) do you need permission from the village authorities to be here? how do you get this permission?
- (t) is it easier or more difficult to get permission to fish/hunt/log/gather at this site compared to 10 years ago? 5 years ago?
- (u) what rules and regulations (e.g. rules about when you are allowed to fish, or about net size etc.) apply to your activities? are these good rules? what do you see as the good or bad points about these rules?
- (v) in your place of permanent residence what is the main activity of your family (e.g. farming etc.)? how important is fishing/hunting/gathering for you (i.e. for your livelihood) overall? (e.g. very minor, about a quarter, half etc.)
- (w) in general has access to natural resources in the wetland got more difficult? or less difficult? over the past 5 years? the past 10 years? what are the reasons for access getting worse or better?

### *Category D: Mapping Movements*

This is the mapping exercise alluded to in Section C above, and is about discovering the movements that wetland resource users make to different parts of the lake in order to sustain their catches and harvests. This does not require "formal" research methods, but will require visiting villages and temporary fishing or hunting camps, at intervals, along the banks of a river or lake, to find out where people are from, and to ask them about the main places that they use resources. Seasonal information about fishing, hunting and gathering locations should be included. Questions asked are where are you from? how long are you here? what other sites do you fish/hunt/gather/burn? in which seasons do you move between these places? For villages visited for PRA or sample survey purposes, this can obviously be done at the same time as the PRA. See Section on Mapping for further information on the types of spatial data that should be collected.

### L11. Example tabulation for summarising group discussions

**Figure 26: Example tabulation for summarising group discussions**

Village:  Checklist ID (Section of Manual):

This form is for summarising information obtained from group discussions in each village. The form will vary with respect to the topics listed down the left hand side according to the group or sub-group of topics under discussion (Sections B3, B4, B5 etc). A form like this provides a convenient way of summarising qualitative research findings but should be completed in rough first, making sure from field notes that all main points of general agreement are covered, before making a clean version later.

Group Question	Now	5 Years Ago	10 Years Ago
Main Incomes			
Comments:			
New Activities (started)			
Comments:			
Got Worse?			
Comments:			
Got Better?			
Comments:			
Agric and Marketing Problems			
Comments:			
Access to Natural Resources			
Comments:			

### L12. Household survey forms

The following diagram shows the survey forms available (below in this document, and in the LADDER database). These forms may need to be adapted for surveys in different areas and aimed to address different management questions. Some forms may not be necessary for some surveys.

The database itself (including all the forms) is available for download from the LADDER web-site: <http://www1.uea.ac.uk/cm/home/schools/ssf/dev/odg/research/currentprojects/LADDER/Data>.

**Figure 27: Example household survey forms**



*Core Quantitative Data - All Households*

- FORM A → BASIC
- FORM B → ASSETS 1
- FORM C → ASSETS 2
- FORM D → CROPS
- FORM E → LIVESTOCK/OTHER NR
- FORM F → NON-FARM
- FORM G → TRANSFERS/COPING
- FORM H → INCOME SUMMARY

*Qualitative Data - All Households*

- FORM I → CHANGE

*Qualitative Data - 1 in 5 Households*

- FORM J → GENDER

*Quantitative Data - Fishing Households*

- FORM K → FISHING

**LADDER Household Survey**

Cover page: HH ID

Household Code: <input type="text"/>	Country: <input type="text"/>	District: <input type="text"/>	Village: <input type="text"/>
Date of interview: <input type="text"/>	Study Location: <input type="text"/>	Name of Interviewer: <input type="text"/>	
Household Name: <input type="text"/>	Per capita income quartile - national sample: <input type="text"/>		
Ethnic Group: <input type="text"/>	Per capita income tercile - national sample: <input type="text"/>		
Residence in village: <input type="text"/>	Per capita income quartile - study location sample: <input type="text"/>		
Wealth Group: <input type="text"/>	Per capita income tercile - study location sample: <input type="text"/>		

**Form A1: Residents data**

Household Code:

Country:  District:  Village:  Study Location:

*Members of HH currently resident*

ID	Name	Age	Sex	Relationship to H/H head	Education Level Reached	Main Occupation
			CODE	CODE	CODE	CODE

Data not entered

Total no. of residents:

**Form A2: Non-residents data**

Household Code:

Country:  District:  Village:  Study Location:

*Members of HH permanently or mostly away*

ID	Name	Age	Sex	Relationship to H/H head	Education Level Reached	Main Occupation
			CODE	CODE	CODE	CODE
1M						
2M						
3M						
4M						
5M						
6M						
7M						
8M						
9M						
10M						
11M						
12M						
13M						
14M						
15M						

Data not entered

Total no. of non-residents:

**Form A3: Summary basic HH data**

Household Code:

Country:  District:  Village:  Study Location:

Total no. of residents	<input type="text"/>	Gender of HH head (incl. de facto)	<input type="text"/>
Total no. of non-residents	<input type="text"/>	Gender of HH head (M/F)	<input type="text"/>
HH Size: AEUs (Residents)	<input type="text"/>	Education of HH head (proxy years)	<input type="text"/>
HH Size: AEUs (Non-residents)	<input type="text"/>	Age of HH head	<input type="text"/>
HH Size: AEUs (Total)	<input type="text"/>	HH education (total proxy years for resident EAAs)	<input type="text"/>
HH Size: EAAs (Residents)	<input type="text"/>	HH education (per capita years for resident EAAs)	<input type="text"/>
HH Size: EAAs (Non-residents)	<input type="text"/>	Fishing HH?	<input type="text" value="No"/>
HH Size: EAAs (Total)	<input type="text"/>	Total annual remittances (US\$)	<input type="text" value="0.00"/>

**Form B: Assets 1 - Land, Livestock and Housing**

Household Code:

Country:

District:

Village:

Study Location:

**B1. Land Owned and Operated by the Household**

Current price of land in the area (US\$)

*Shambas and Gardens*

Field ID	Area (ha.)	Ownership		Rent In Land (US\$)	Rent Out Land (US\$)	Use of Field	Field Cultivated By	
		CODE					CODE	
A								
B								
C								
D								
E								
F								
G								
H								
I								
J								

No. of Plots:

Rent totals (US\$):

Total Area Owned:

Total Area Used for farming:

Check: Total Area Owned:

Check: Total Area Used for Farming:

**B2. Numbers of Livestock**

Livestock Type	Number Now	Number Year Ago	Number Born	Number Died	Number Bought	Number Sold	Number Gifts In	Number Gifts Out	Number Eaten	Current Price (US\$)	Check Number Now
Cattle											0
Goats											0
Sheep											0
Pigs											0
Chickens											0
Turkeys											0
Ducks											0
Donkeys											0

Total livestock holding in Cattle Equivalent Units:

**B3. House Construction**

Wall Construction:

Roof Construction:

Piped Water?

Water source:

Mains Electricity?



FORM D: CROP OUTPUTS AND INCOME (US\$)

Household Code															
Country			District				Village			Study Location					
Crop Name + Harvest Month		Unit	Quantity Consumed		Quantity Sold		Total Produced	Ave. Price	Gross Income	Check Gross Income	Variable Costs	Net Total Income	Check Net Total Income	Net Cash Income	Check Net Cash Income
Full	Standardised	Month	Qty	%	Qty	%									
Number of types of crop grown			Crop Totals:												
No. of (crop type X harvests)			Check Crop Totals				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FORM E1: LIVESTOCK AND OTHER NR OUTPUTS AND INCOME (US\$)

Household Code														
Country			District				Village			Study Location				
Milk cattle		No.	Breed		Total days milked (per cow)				Average daily milk yield					
Livestock product	Unit	Quantity Consumed		Quantity Sold		Total Produced	Ave. Price	Gross Income	Check Gross Income	Variable Costs	Net Total Income	Check Net Total Income	Net Cash Income	Check Net Cash Income
		Qty	%	Qty	%									
Number of livestock products		Livestock Totals												
		Check Livestock Totals				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other NFI activity	Unit	Quantity Consumed		Quantity Sold		Total Produced	Ave. Price	Gross Income	Check Gross Income	Variable Costs	Net Total Income	Check Net Total Income	Net Cash Income	Check Net Cash Income
Type	Details	Qty	%	Qty	%									
Number of Other NFI products		Other NFI Totals												
		Check Other NFI Totals				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Form F: Non-Farm Income Received by the Household (US\$)

Household Code							
Country		District		Village		Study Location	
No. of HH members with non-farm income			Annual total non-farm income for HH				

HH member with non-farm income	Type of work	Income last month	Income last year	Place of work
Name: _____ Gender: _____	_____	_____	_____	_____
				No. of employees (if self-employed) _____
				No. of employees (if self-employed) _____
				No. of employees (if self-employed) _____
				No. of employees (if self-employed) _____

**Form G: Transfers, Food Security and Coping**

Household Code:

Country:

District:

Village:

Study Location:

**G1 Physical Transfers and Payments In-Kind**

Description	Units	How Often times/year	Amount Each Time	Total Amount	Approx. Local Value per Unit	Approx. Total Local Value	Check Approx Total Value
<b>Approx. Value, All Items (past year)</b>					Local currency		0
					US\$		

**G2 Regular Food Consumption of Household (main staple foods eaten during past week)**

Main Staple Foods (Last Week)	Number of Days	Amount Eaten per Day		Current Price per Unit (local currency)	Cost of Main Foods (local currency)		Check Total Cost per Week
		Unit	Quantity		per Day	per Week	
<b>Total cost of main foods per week</b>					Local currency		0
					US\$		

**G3 Food Stocks and Losses**

Crop Name	Last Harvest (approx. date)	Total Stored Last Harvest	Amount in Store Now	When Store Ran Out (approx. date)	Loss in Store	Estimated Quantity Lost	% Loss	Main Reason for Loss

Has HH bought food during the past year?

Months when bought

No. of times each month

Amount bought each time

Total amount of food purchased (past year)

**G4 Response to Shocks (last 3 years)**

Event	When Happened	Effects of Event	Response to Event

### Form H: Household Income Summary

Household Code:

Country:

District:

Village:

Study Location:

ID	Description of Income	Source of Data	Amount
1	Crop Income	Form D	<input type="text"/>
2	Livestock Income	Form E	<input type="text"/>
3	Income from Renting Out Land	Form B	<input type="text"/>
4	Other Household/NR-Based Income	Form E	<input type="text"/>
5	Non-Farm Income (Year Totals)	Form(s) F	<input type="text"/>
6	Remittance Income	Form A	<input type="text"/>
7	Income from Fishing	Form K	<input type="text"/>
8	Estimated Income In-Kind	Form G	<input type="text"/>
<b>Total Income From All Sources:</b>			<input type="text"/>
<i>Check on Total Income From All Sources:</i>			<i>0.00</i>

Data Entry Form I (1): Changes in Gaining a Living

Household Code:

Country:  District:  Village:  Study Location:

11 At present members of this household gain a living by:

12 Has this pattern of activity changed over the past five years or so?  YES  NO

13 If yes, then what were the main activities for gaining a living five years ago?

14 Paying attention just to farming activities, does the household have  MORE  LESS  SAME different farm activities (i.e. different crops or animal types) than 5 years ago?  
 Why?

15 Has the HH started "new" farming activities in the past 5 years?  YES  NO  
 Why?

16 Would the household like to engage in any specific new farming activity, or expand any existing activity?  
 YES  NO  
 If yes, specify what is preventing this from happening

17 Moving now to non-farm activities, does the household rely  MORE  LESS  SAME on non-farm activities now than before?

18 If the household is relying more on non-farm activities than before, what are the main reasons for this?

19 If the household is relying on fewer non-farm activities than before, what are the main reasons for this?

110 Would members of the household prefer to have  MORE  LESS  SAME non-farm activities in the future?

111 If members of the household would prefer to engage in more non-farm activities, what are the main things that prevent them from doing this?

112 If members of the household would prefer to engage in less non-farm activities, what are the reasons stopping them from specialising in agriculture?

113 During the past five years, has the situation of this household been  
 IMPROVING  WORSENING  STAYING THE SAME

114 What are the main reasons given by household members for these changes or trends?

115 During the past ten years, has the amount of land available to the household for agriculture  
 REDUCED  STAYED THE SAME  INCREASED

116 If available land has reduced or increased, what have been the reasons for these changes?



### Form K: Fishing Asset and Income Data

<b>Household Code:</b>		<b>Fishing assets (index)</b>	
<b>Country:</b>	<b>District:</b>	<b>Village:</b>	<b>Study Location</b>

**K1 Fishing Assets (Owned or Rented by members of the household)**

Boat Type	No.	Ownership Own/Rent	Main Power Source	Current Boat Cost (local currency)	Gear Type	No.	Ownership Own/Rent	Current Gear Cost (local currency)
code		code	code		code		code	

How much does an outboard motor cost?      Size HP:       Current Cost (local currency)

**K2 Estimated Income from Fishing**

ID	Name	Fishing Work	Per week				Weeks Fishing per Year	Annual Fishing Income
			<i>// owner or renter</i>		<i>// labour</i>			
			Value of Catch	Operating Costs	Net Value	Cash or Equivalent		
	code							
							<i>Check Total</i>	
<b>Total Household Income from Fishing:</b>						Local currency		
						US\$		

## Notes on this chapter

<sup>1</sup> The use of relatively small sample-sizes for household surveys recognises that household survey data is time-consuming to collect and validate, and that such surveys can generate vast quantities of data which are then seldom properly validated and analysed. These drawbacks are well recognised in the major UNDP and World Bank household surveys conducted as part of national Poverty Reduction Strategy Programmes. This approach seeks to complement, rather than replicate these large-scale survey and monitoring exercises.

<sup>2</sup> Some argue that this framework would benefit from the addition of additional categories of capital – political and cultural (Sirrat, 2004).

<sup>3</sup> What is known as the vulnerability context in the livelihood framework is conceptually similar to what is termed 'risk exposure' in the literature on vulnerability.

<sup>4</sup> Diversification need not mean diversifying out of fishing entirely; it includes promoting alternative activities that may supplement fishing and reduce dependency on fish stocks.

<sup>5</sup> Some authors object to the term 'strategy' for what they see as the outcome of a bundle of reactive and unplanned actions (Dorwood *et al.*, 2003).

## Mapping tools

### M1. Mapping overview

Maps are an ideal way to present data; they are attractive, easy to understand, quick to take in and can be used to bring different types of information together. Therefore they are an ideal way of presenting integrated information to all stakeholders. In this toolkit, there is a strong emphasis on collecting georeferenced data in order to produce useful maps.

#### *Types of geographical data required*

Species data is traditionally mapped using point locations where species are found, which may be mapped to a grid or just used as point localities. However in order to be able to overlay species data with resource use data, we need to have complete coverage of an area with respect to species present. It is impossible to sample every point within an area, so we recommend an approach where the habitat types are mapped, species are sampled within the different habitat types, and then the species found within each habitat type are assumed to be distributed throughout that habitat type (this approach is described in more detail on Sheet ...). This requires that all species sightings are georeferenced, and that habitat types are mapped either using existing maps, aerial photos or satellite imagery, or by georeferencing the boundaries on foot or by boat (see Sheet ...).

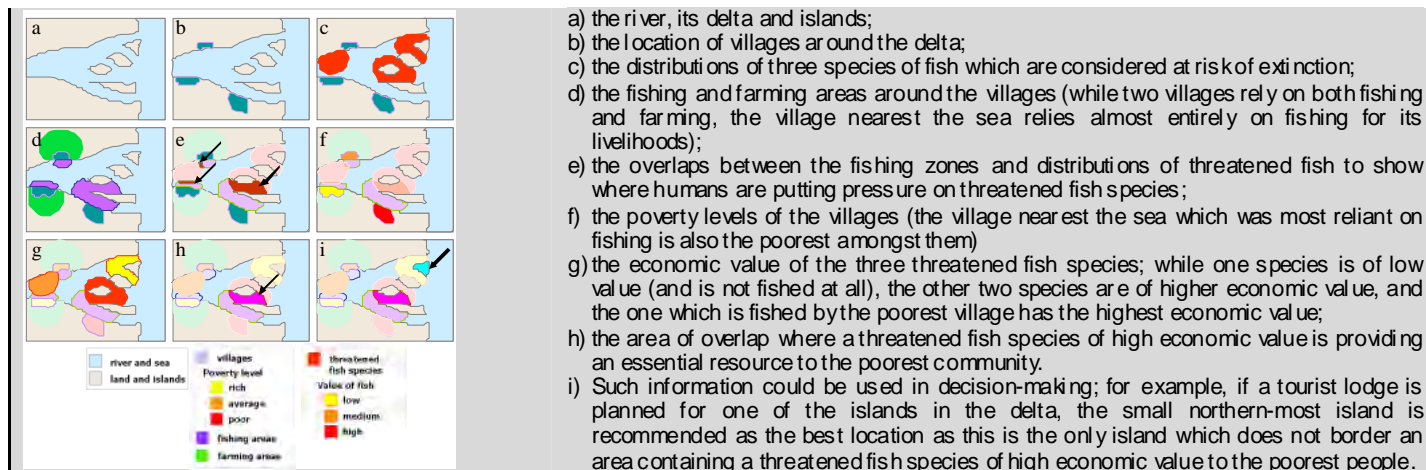
The spatial aspects of resource harvesting and the factors affecting people's access to resources can also be mapped. Areas to be mapped include resource harvest areas, institutional boundaries, natural boundaries, and other man-made boundaries, which may limit people's access to resources (these are described in more detail on Sheet...). Additionally travel times to different areas can be shown on maps, and these may be useful in understanding resource use patterns. Researchers need to enquire about where resources are harvested from and why in order to collect this types of information; participatory mapping exercises may be a useful tool for doing this, followed by georeferencing of areas or boundaries with the help of local people using a GPS.

Boundaries, not points It is important that the boundaries of areas, and not a point location in the middle of the area, are recorded for each habitat, resource harvest area or institutional boundary. Point locations are insufficient to map sites, unless notes are made about the size of the site; for example, if the middle point is georeferenced and notes are made that the area (e.g. a deep pool in a river) is approximately round, with a diameter of 20 metres, then that is sufficient to map the area. However it is still preferable to georeference the boundary of a site where possible, by going round it on foot, in a vehicle or by boat, taking GPS readings at the corners (if the site has straight edges) or every few metres (if the site is irregularly shaped).

#### *Examples maps*

The types of maps that we envisage creating, using the methods described in this toolkit, are shown schematically in **Box 15**. The maps should be clear, concise and easily accessible to decision-makers and other stakeholders. They may in themselves become useful tools to elicit further information on conservation and development issues within the area, as local people discuss the validity of the information shown.

Box 15: Schematic maps showing biodiversity, livelihoods and economic values in a wetland



## M2. Sources of maps

Increasingly many useful maps can be found on the internet, and time should be spent searching for these before starting to digitise your own maps. (See sheet on Finding Maps on the Internet). However maps may not be available at an appropriate resolution for a project if it is working in a relatively small area, and there may be issues of ownership (it is important to read carefully any contracts that you have to sign to use a map or map layers). If good digital maps are not available, the following will prove useful sources from which to digitise new maps.

### Topographic maps

Topographic maps are usually available from government mapping agencies for a small fee. They will show the larger rivers and lakes, and may indicate floodplains, marshes, seasonal pools and other wetland areas. They are particularly useful for making base maps, and then other features can be digitised from other sources. Care should be taken when digitising these maps to note the projection of the map, otherwise there will be problems later overlaying other map layers. Very old maps should be viewed with caution, although it is unlikely that the river and lake outlines will have changed significantly; however it may be worth checking if there have been any major changes in river course or lake water level in recent years. In areas where there are large annual fluctuations in water level, it is also a good idea to think about whether you want your map to show high water levels, low water levels or stages in between. Ideally it would be good to have a map of both high and low water; this is achievable if you digitise the map to a lower level of detail, which will still be adequate for the purpose of the study.

### Satellite maps

Satellite maps are becoming increasingly available, and many can be found free on the internet. However the resolution of maps which are freely available is usually inadequate for mapping wetland habitats. Most free satellite images have already been geocoded, but the extraction of information about the surface cover types requires specialist software, and so far wetland habitats have been poorly resolved. There are likely to be major advances in this area in the coming years, even to the point where some in-river habitats may be differentiated, such as riffles and deep pools (Ned Gardiner, pers. comm.). Satellite images may be useful to look for water bodies which are not currently included on the map; however digitising these habitats is probably best done using either aerial photos or by georeferencing their boundaries in the field.

### Aerial photos

For many areas, aerial photos may already exist, and these may be available for a fee from the government mapping agency, university geography departments or NGOs (such as those concerned with mapping old mine-fields or current gold-mining). 'Google Earth' now provides aerial images of the whole Earth; these are often quite low resolution in rural areas, but may nevertheless be adequate for making initial maps of an area (NB take care to find out which projection they are using).

In order to use aerial photos, they must first be geoprocessed: this process includes orthorectification and geocoding. Orthorectification is required to take account of distortion caused by the camera lens and the shape of the Earth. Geocoding puts the image in the right place on the Earth's surface, using Ground Control Points (GCPs), which are identifiable features in the photo whose exact latitude and longitude is known (the position of such features can be found using a GPS). Generally three GCPs are needed for each photo. Finally, aerial photos need to be mosaiced together, ensuring that the edges line up to make an image of the whole area. The provider of aerial photos may have already completed these steps, but they should not be skipped otherwise the quality of maps made from such photos will be seriously compromised (to the point of needing to start again).

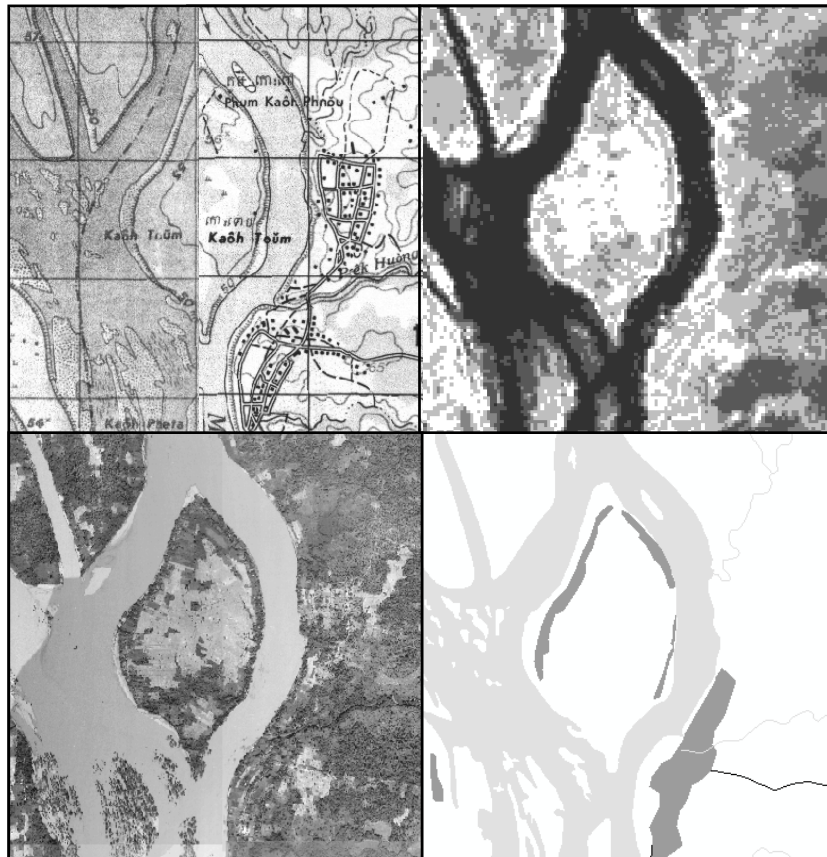
### Georeferencing in the field

This will be necessary for many wetland habitats of relevance to integrated assessments, as some of these may be small seasonal water bodies which are barely visible on satellite images and will only be seen in aerial photos if they were taken at the right time of year. To map such habitats requires a GPS (Geographic Positioning System) and the possibility for someone to walk, drive or travel by boat around the edge of the habitat to be mapped, taking GPS points at regular intervals along the way. Taking a point location from the middle of such habitats is not very useful for mapping, unless accurate measurements are also taken of the size and shape of the area.

### Example maps showing these techniques

The maps below show:

- a 1972 topographic map (low water)
- a LandSat satellite image
- a 2001 aerial photo, scale 1:40,000 (high water)
- a digitised image, using the topographic map as its base, but digitising villages (dark grey) from the aerial photo (land is white, river is light grey).



### M3. Finding maps on the internet

(to be written)

### M4. Digitising and manipulating maps

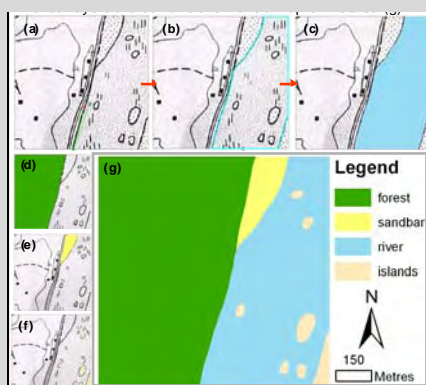
If only paper maps, satellite images or aerial photos are available, it will be necessary to digitise these using a Geographic Information System (GIS) software package such as ArcView or ArcInfo. Paper maps will first need to be scanned in to a computer, and satellite images or aerial photos need to be orthorectified. The various features, such as rivers, lakes, villages and roads, are then traced over to create a digitised layer for each feature. These can then be viewed separately or together, and in conjunction with other data such as habitat types or harvest areas as required.

#### What digitising means

When a map is digitised, it is converted from a picture (either on paper or in electronic format) into a format which can be viewed using mapping software. The different features of the map are represented by different layers which can be

viewed independently and recombined with layers generated from other maps. The digitising process is illustrated in Box 16.

### Box 16: Digitising a map



Starting with a scanned in topographic map, the river is traced over (a,b,c), followed by the forest, sandbar and islands (d,e,f). The four layers are combined to make a map of the area (g)

### Geographic Information Systems – software needed

A variety of software is available to digitise maps in this way, ranging from very expensive software, such as Arc Info, to very cheap or free software which usually have much more limited capacities, but may nevertheless be adequate depending on a project's needs.

### Using GIS to create maps and integrate information

The power of maps lies in their ability to present a lot of information visually, allowing people to take in that information quickly. They also allow different types of information to be displayed together, effectively integrating that information. For example, the following map brings together information on fish habitats as georeferenced from a boat guided by local fishermen (the habitat areas are named on the map), with the locations of villages (digitised from an aerial photo), the boundary of a Ramsar Site (defined as a certain distance from the river by government) and the river outline with its islands (digitised using a 1972 topographic map).



## M5. Mapping wetland habitats and species distributions

If available maps of the area do not show wetland habitats in sufficient detail, it may be necessary to map wetland habitats as part of the project. Maps will normally show streams, rivers and lakes, but may not show seasonal pools, marshes, floodplains, in-river and in-lake habitats (such as deep pools, rocky shores), water holes and various other habitats that may be important for local livelihoods or may contain unique freshwater species.

### Prioritising wetland habitats to map

Before spending too long mapping and digitising every wetland feature in an area, it is worth considering how much time is available for mapping habitats and conducting species surveys; if time only permits that three or four different habitat types be sampled for species, then habitat mapping should focus on those habitat categories; however these habitat categories should be broad enough to include the majority of wetland habitat that are present e.g. main river, tributaries, lakes and seasonal ponds (see Species Mapping Sheet).

The choice of habitats to focus on also needs to take into account their importance to livelihoods; for example, if seasonal pools are essential to livelihoods, then they should be mapped and sampled for species, even though they may have to be mapped on foot as they probably will not show up on satellite images or even on aerial photos if they are small. Deep pools in rivers may serve a similarly important livelihood function.

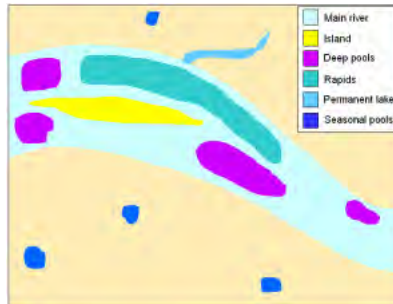
*Species mapping*

If the aim is to produce species maps for the study area, then a sampling strategy needs to be chosen that will efficiently sample the area to produce such a map. We recommend:

1. mapping the representative wetland habitats found in the area (as described above),
2. sampling for species in a subset of these habitats, and
3. mapping the species found in each habitat type to all similar habitats found in the area.

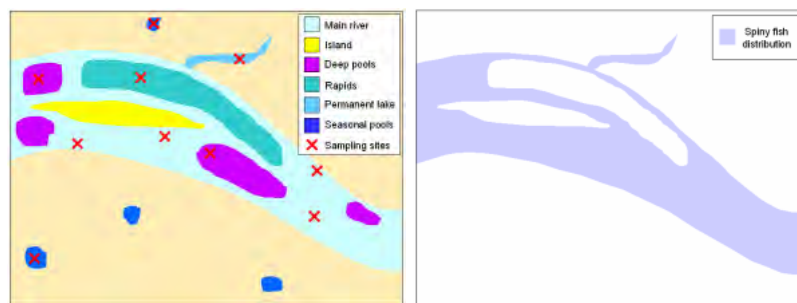
This will give species maps with complete coverage of the wetland area.

The following example demonstrates the approach.



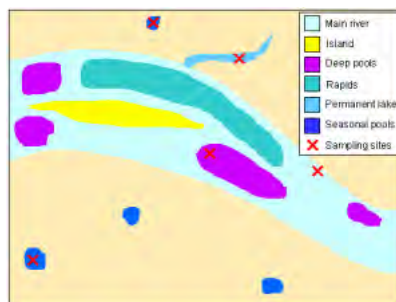
In this area, there are a variety of wetland habitats including: river margins, river mainstream, deep pools, rapids, permanent lakes and seasonal pools. If the time available allows the team to visit 10 sites for biodiversity surveys, which sites should be chosen?

All habitat types should be visited at least once (6 sites). Up to four habitat types can be sampled more than once; which habitats are chosen for additional sampling might depend on their importance to local livelihoods or other factors, such as the likelihood of variation in species assemblages between patches of similar habitats. For example, if the deep pools contribute significantly to the local fishery, then 2 more deep pools could be surveyed. If it is considered likely that the small seasonal pools will contain varied species assemblages, one seasonal pool from each side of the river could be sampled. Where more than one site of a particular habitat type can be sampled, the sites chosen should be of varying sizes, widely dispersed (i.e. not next to each other), and representative of other gradients present on the site (e.g. if some seasonal pools were on the floodplain while others were more than 20m above the river level, it would be useful to sample one from the floodplain and one from higher up). The accessibility to sampling sites should also be considered when choosing them. Therefore in this example the sampling sites chosen might be as shown here.



Following such sampling, each habitat will have a species list associated with it (species lists from different patches of the same habitat type can be combined). Species maps can then be generated by mapping species onto the habitats where they were found. For example, if the 'spiny fish' was found in the deep pools, main river, river margins and permanent lake, then its distribution map would look like this.

If only five sites could be surveyed, the main habitats could be reclassified as river habitats, lake habitats and seasonal pools. The survey points chosen might then be as shown below; which in-river habitats are sampled could be related to those habitats most frequently used as harvest areas by local people.



## M6. Mapping resource harvest areas and factors affecting access to resources

Resources harvested by local people will also need to be mapped. Whenever resource use is discussed, researchers need to enquire where those resources come from. This may elicit local names of sites, which can then be mapped later using a GPS and someone who knows the local names of sites; or people may be able to draw the locations on maps (e.g. using participatory mapping techniques, see Sheet...), but these will still need to be georeferenced; or, having established which resources are harvested locally, it may be best to spend a day going round the main areas within the study site with local people and a GPS, recording harvest areas and which species are harvested from which area. This last option may be an ideal opportunity to discuss when harvests are made, how they vary throughout the year in quantity and quality, why different areas are used at different times, who comes to each area to harvest and why. If local people are shown how to use the GPS, they may be able to georeference the harvest areas.

Other areas that need to be mapped include:

- institutional boundaries, such as the edge of a protected area or game reserve, beyond which it is illegal to harvest; and boundaries of ownership or right of use, such as village boundaries, family boundaries or the edge of a sacred site where harvesting is forbidden.
- natural boundaries, created by the geography (such as cliffs, chasms, rapids, waterfalls, mountain passes); many of these may be open at certain times of year, or passable but only with a lot of effort, meaning that harvests are less or only used in times of emergency. The presence of wild animals such as lions or crocodiles, or diseases, can also create natural boundaries or restrict access to resources at certain times; e.g. some lakes may be preferred for fishing over others because it is known there are no crocodiles in them.
- other man-made boundaries, such as areas where it is considered dangerous to go because of bandits, potential conflicts with other groups of people or old unexploded mines.

Such boundaries may be elicited by asking why certain resources are not harvested from locations which otherwise seem ideal, or by spending time discussing the geography of the area with local people, focusing on where the valuable resources are and what limits their harvest and use.

It may also be useful to note travel time to various important harvest locations; these can also be shown on maps, and are likely to have a strong influence on frequency of harvests; for example, harvest areas further away are likely to be important in times of need.

In summary, all spatial aspects of resource harvesting and the factors affecting people's access to resources should be documented and georeferenced where possible, in order that they can be shown on maps and integrated with data on species presence (i.e. resource availability).

## M7. Budget and timetable for mapping activities

Maps, aerial photos, satellite images, the software to handle them and people trained in doing so can be expensive to obtain or hire, and this needs to be looked into before the project starts so that an appropriate amount is set aside in the budget. This is particularly important if no maps are available, in which case aerial photos may need to be obtained. The time and expertise needed to work with maps also needs to be considered; staff trained in GIS technologies will be required, and sufficient staff time needs to be budgeted for (creating new maps by digitising aerial photos will take a lot of time).

**Table 11: Timetable of mapping activities**

Pre-project proposal	Look into existing maps. If none available, make sure project budget includes funds to buy satellite images/aerial photos and to hire/pay someone to compile and digitise these. Other items to include in the budget are one or more GPS's, which will be needed to georeference and groundtruth maps and delineate areas such as wetland habitats and resource use areas.
Pre-scoping mission	Make sure have a suitable map showing main features of sites - rivers, lakes, as many other wetland habitats as possible, towns, villages, roads etc. Use existing literature to find out what other wetland habitats are present in the area.
Scoping mission	Ground-truth maps. Check if there are more wetland habitats that should be included on maps. Use GPS to delineate



	unmapped wetland habitats. Choose biodiversity sampling points to be representative of wetland habitats present.
Field assessments	Georeference all species sightings and important places/areas for economics/livelihoods assessments, such as resource use zones, boundaries of use areas (e.g. by ownership) etc.

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