

WETLAND INVENTORY, ASSESSMENT AND MONITORING: AN INTRODUCTION

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ABSTRACT

Wetlands remain poorly known and undervalued ecosystems, yet they provide many benefits such as direct uses (e.g. fisheries, water supply), functions (e.g. flood control, groundwater recharge) and attributes such as biodiversity. Often, information is lacking on wetlands, yet it is essential for the wise management of these ecosystems. Wetland inventory and assessment is the process by which this information is gathered and evaluated.

The aim of this paper is to provide a broad introduction to the process of which wetland inventory, assessment and monitoring are parts. The terms “inventory” and “assessment” are often used interchangeably, yet they are two different activities in the same process. Wetland inventory is the activity through which information is gathered. Assessment is the activity which evaluates the information obtained. From the collection of the relevant information and its evaluation, management of the wetland can be implemented. During the management phase, monitoring is an important activity and may be defined as, “Regular collecting of information on the site using characteristics of the site or its catchment which, for which any change may produce a negative impact on the site”.

Information should be collected in a “top down” manner, starting off with the river basin/catchment, then focusing down on the sub-catchment, the wetland site or complex and finally the habitats contained within the wetland. Data should be collected in a standardised manner and should be directed primarily towards that which is relevant to subsequent management. This includes basic geographical, physical, chemical and biological information, with emphasis on data relating to the benefits that the wetland provides and the threats operating on the wetland.

The data collected should be easily accessible, in such a form as to be easily interpreted and to be easily up-dated. As such, the information should be held in a computerised database linked to a GIS.

The Med Wet project, a regional initiative in inventory of the countries surrounding the Mediterranean Sea, and the Asian Wetland Inventory project, are briefly discussed as examples of standardised wetland inventory projects.

1. INTRODUCTION

Sufficient, relevant, up-to-date data are a prerequisite for the effective management of all types of ecosystems including wetlands, yet there is still insufficient information on wetlands in the Asian region upon which to base sound management (Finlayson & Davidson 2001). Thus, there is a need for activities involving the collection and interpretation of information on wetlands for management purposes.

The first attempt at compiling information on wetlands in a systematic manner was with the Directory of Asian Wetlands (Scott 1989). The information collated was focused mainly on the biological importance of wetlands, especially for bird populations.

Many national wetland inventories in the Asian region have been published in the last decade or so which pioneered systematic and relevant data collection on wetlands, but the data collected were fairly limited, with an emphasis on identifying wetlands of importance for conservation purposes rather than for their importance for direct uses and for functions and services. The scope and the detail of data collected were also limited fundamentally by lack of funds and trained manpower.

Most of these inventories were published as printed documents, not in electronic format, which makes updating very difficult and time-consuming. This is understandable since electronic formats such as databases and GIS were not user friendly.

With the ever-increasing recognition that wetlands are important ecosystems and that they require sound management, a need has been recognised for a more systematic, comprehensive approach to wetland inventory (Finlayson & Davidson 2001). The development of more “user-friendly” databases and GIS means that this information can be easily held, interpreted and updated.

This paper gives a brief introduction to the activities involved in wetland inventory, assessment and monitoring, with an emphasis on inventory and assessment; and briefly describes two examples of wetland inventory projects: the Mediterranean Wetland Initiative (MedWet) and the Asian Wetland Inventory programme (AWI).

The generally accepted Ramsar definition of wetlands is used throughout this paper: “Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.”

2. WETLAND INVENTORY, ASSESSMENT AND MONITORING – THE PROCESS

The diagram below (Fig. One) shows the process of wetland inventory, assessment and monitoring and the activities involved.

These terms should be defined since the terminology is often confused - the terms inventory and assessment are often used interchangeably, but they refer to different stages in the process:

- ❑ **Inventory:** The activity of gathering information on wetlands and their catchments to produce a listing of sites. The information is collected in a standardised manner and includes location, size, physical, chemical and biological features, human activities, protection/management status, threats and benefits provided by the wetlands.
- ❑ **Assessment:** To assess something is to judge the worth or importance of it, in this case, the activity involves evaluating the information gathered on wetlands to judge their value. The end result may be a prioritised list of wetlands in terms of their importance. Wetlands

are normally assessed in terms of the benefits they provide and the threats which are operating on them.

- ❑ **Monitoring:** This is an activity which is carried out during the management phase. It is the regular collection of information on the wetland or its catchment which is targeted at variables which may negatively affect the wetland. Examples are monitoring human activities in the catchment, monitoring the level of resource exploitation within the wetland etc.

Thus, simply put, data are collected, these data are assessed/analysed and used in management. A monitoring programme is developed within the management regime to monitor any potential deleterious changes in the variables affecting the wetland and also to monitor the effectiveness of management. Monitoring is a tool whereby the management regime can be modified to take into account any change in variables operating within the wetland or its catchment.

STEP IN PROCESS	MAJOR ACTIVITIES
PREPARATION/ PLANNING	Rationale, objectives, scope, time and funds available. Data sheets, data collection methods, wetland classification scheme and wetland assessment methods should be finalised. Liaison with stakeholders, identification of inventory team. Development of database/GIS
INVENTORY	
DESK STUDY	Review of previous information on the wetlands, map and photo procurement
PREPARATION FOR FIELD WORK	Specific planning for fieldwork: Timing of survey. Contacting and liaising with government agencies, local communities, NGOs. Arrange logistics: places to stay, transport. Pilot testing and validation of methodology
FIELDWORK	Ensure all necessary data collected on wetland inventory forms
PRESENTATION OF DATA	Data held in database and linked GIS
ASSESSMENT	Interpretation of data: evaluation of wetlands mainly in terms of their values and the threats facing them.
OUTPUTS	Published of draft document with ranking of wetlands for their importance and urgency for management with justification. Workshop with stakeholders to fine-tune results. Development of action plan. Development of monitoring programme.
IMPLEMENTATION: MANAGEMENT & MONITORING	

Figure One: Overview of the wetland inventory, assessment and monitoring process

2.1 PREPARATION

It is essential to adequately prepare for a wetland inventory. The rationale and objectives for the project must be established first. Usually the rationale is that wetlands are valuable ecosystems, but are being destroyed and degraded rapidly and that there is a lack of relevant data on which to base sound management. A well-thought out rationale is essential to attract funding for the project.

Inventory objectives normally are to:

- ❑ Identify the type, location and size of wetlands,
- ❑ To collect data relevant to management in a standard systematic manner,
- ❑ To establish a baseline for the subsequent monitoring programme.

Preparation also involves developing a framework within which the project will be carried out—funds have to be secured; and standard data collection sheets, a wetland classification system and a standard wetland assessment methodology need to be finalised.

Most wetland classification systems in use at the moment are based on that of the Ramsar Bureau which in turn was derived from Cowardin's wetland and deepwater habitat classification for the United States (Cowardin et al. 1979). These classifications start off from the major wetland systems (lacustrine, palustrine, riverine, estuarine and marine) and then use hydroperiod, land form, substrate and vegetation to subdivide these major systems. However, a modified classification system is being developed which classifies wetlands initially by a combination of landform type and hydroperiod (Finlayson, pers.comm.) This type of classification is more logical in that landform and hydroperiod are the fundamental determinants of wetland character.

A computerised database, if possible linked to a GIS should also be developed, with the database fields being complementary to the fields in the field data collection sheets for ease of input.

It is also necessary to identify stakeholders in the project and collaborating partners.

Stakeholders include:

Relevant government agencies concerned with natural resource management, research institutions, universities, NGOs, funding agencies, local government units at wetland sites and local communities living in and around the wetlands.

2.2 COLLECTING THE INFORMATION: THE INVENTORY PHASE

As a guiding rule, collection of information should not be solely aimed at the wetland sites. It is also necessary to collect information on the river basin/catchment area in which the wetland lies, and the sub catchment. This is desirable for two major reasons:

1. Wetland sites are greatly influenced by the nature of the catchment and human activities within it.
2. Collection of data at the catchment and sub catchment level avoids needless repetition of data on wetlands within the same catchment/subcatchment. Wetlands can then be grouped together by catchment/river basin since they are hydrologically linked to each other and most likely share similar water quality characteristics.

The inventory team should be assembled at this stage – it should ideally be multi-disciplinary, with the members drawn from the disciplines of geography/geology/soils; hydrology; socio-

economics and ecology. All members should be familiar with rapid assessment techniques in their disciplines: e.g. rapid rural appraisal for the socio-economics member. A database/GIS expert should also be present.

It is also desirable, before embarking on the major part of the information gathering, to test the methodology and fine tune it.

2.2.1 *DESK STUDY*

This is an activity which is often not carried out comprehensively before collecting data in the field. Desk study; i.e., review of previously published information, can be a great help in identifying where there are large gaps in the information base and it will give an idea of the basic characteristics of the wetlands to be surveyed. There are four main sources of information:

1. Written publications and reports
2. Maps
3. Remote images: photographs, both aerial and ground shots and satellite images
4. Expert opinion: it is useful to consult people who have been to the sites to be surveyed since they can provide much useful information on features of the wetland on and logistical considerations such as accessibility of the area and the best season for surveys.

Collection of this data is also useful because there should be an indication of how the wetlands have changed since these sources became available. As part of the desk study, all relevant information should be held in one place for ease of access – thought should be given to setting up a resource centre for wetland information.

A start can be made on filling in the data collection form at this stage with information gathered from the desk study; e.g. geology, soils, climate, location, area, and socio-economic and management information.

2.2.2 *FIELD SURVEY*

Timing

An important consideration for field survey is the timing of the field survey. For example, what time of year would be best to get the most information from the visit? In many floodplains, most often habitats may be under water at certain times of the year making description of habitats well nigh impossible. How is access influenced by the seasons/ Is it easier during the wet or the dry season? Are there any migratory species that use the area? If so, it would be desirable that the survey coincide with the peak migratory period.

With wetlands that have a seasonally variable water regime, it may be best to make at least two visits in a year – one at minimum water level and one at high water.

The data collection sheet

As mentioned before, a standard wetland data collection sheet should be used in the field. This shows the core data that needs to be collected. The core data is the minimum data that need to be collected in order to characterise the wetland, to establish its benefits and to provide information for subsequent management.

Data are normally collected under the following headings:

GEOGRAPHICAL

Name
Location
Climate
Altitude
Area

PHYSICAL AND CHEMICAL

Landforms/geomorphology
Geology
Soils
Origin
Hydrology (inflows, outflows, hydroperiod)
Water Quality

WETLAND BENEFITS *

Direct Uses
Functions/Services
Attributes (e.g. biodiversity, cultural values)

LAND USE AND HUMAN ACTIVITY IN CATCHMENT

THREATS TO THE WETLAND AND CATCHMENT

MANAGEMENT INFORMATION

Land tenure/ownership
Agencies involved in management and resource use
Conservation and other management measures

REFERENCES/SOURCES OF DATA AND RESOURCE PERSONS

The above is a summary of the information to be collected during the inventory phase. It should be remembered that the information is collected at several levels from the catchment focusing down on the habitats within the wetland and data sheets are needed for each level since the exact type of information and the level of detail will vary at the different levels.

** The benefits of wetland have been divided into three types according to Claridge (1991).*

The term direct uses refers to aspects of a wetland which are harvested directly such as fishes, timber and water. These direct uses are easy to quantify in economic terms.

Functions (also called services) are those aspects of a wetland which are beneficial to humans such as flood control, shoreline stabilisation etc. Although these functions may have a great economic value; e.g. a marsh may prevent flood damage and associated economic costs downstream by reducing flood peaks, they are harder to quantify in economic terms than direct uses.

Attributes are those aspects of a wetland which do not necessarily have an economic value, but which are valued by society, or some sectors within society. Examples are cultural and spiritual values associated with sites; and biological attributes such as species richness, rarity, endemism etc..

2.2.3 POST-SURVEY PHASE: PRESENTATION OF THE DATA

A published document should be produced showing the results of the inventory as a bare minimum. However, it is desirable to enter the information into a computerised database, from which data can be easily used for interpretation purposes and which will be easy to up-date on a

regular basis. Moreover, for the accurate delineation and location of wetlands, it is essential that good, large-scale maps of the wetlands and the catchments be produced. Ideally a GIS should be linked to the database to show the data in spatial form and to facilitate the interpretation of the data.

2.3 ASSESSMENT

After the data have been collected and presented in an easily accessible form, the wetlands can be evaluated for their “importance”. Importance usually means evaluation in terms of the degree of benefits that wetlands provide; e.g. biological importance, socio-economic importance and provision of functions/services. The degree of threat is also important to evaluate.

The actual methodology used in assessment varies. Most of the techniques used are fairly subjective in their approach since there may be a lack of quantitative data, at least initially, on which to base objective decisions.

- ❑ Multi-criteria evaluation techniques have been used to assess the ecological importance of sites (e.g. Spellerberg 1992). Criteria to be used are first selected. These may include biological criteria such as species richness, species diversity, habitat diversity, habitat distribution, and presence of rare, endangered and endemic species. Other criteria normally include socio-economic importance (value for direct uses), importance for functions, the degree of threat, degree of disturbance and management viability. For each criterion, a range of scenarios is given; e.g. for degree of disturbance, these could range from undisturbed through slightly disturbed, moderately disturbed to heavily disturbed/degraded. Points are allocated to each scenario, with undisturbed sites having a higher points allocation. Similarly, for the criterion of species richness, those sites with higher species richness will score more points than those with poor species richness. Spellerberg (1992) gives several examples of these multi-criteria evaluation methods. The end result would be a comparative ranking of sites in terms of their importance for direct uses, functions and attributes, the degree of threat and management viability.
- ❑ Indicators may also be used to assess a wetland's importance. Biological indicators; e.g. bird species richness may be used as an rapid indicator of a site's biodiversity value and degree of disturbance. Degree of intactness is also a good indicator of ecological importance.
- ❑ Other indicators have been used to assess the importance of some functions and services provided by wetlands (e.g. Larson et al. 1989). For example simple indicators can be obtained from maps and/or field surveys to assess the potential importance of a wetland for flood control. The reader is referred to Larson et al. (1989) for more details.
- ❑ Expert opinion is another option for assessment, with a range of experts familiar with the sites giving their advice on the important wetlands.

However, there is no substitute for good quantitative data which can be tested statistically to produce an objective listing of important wetlands, but it should be realised that the amount of data available on most Asian wetlands precludes this for the time being.

A GIS helps enormously in interpreting the location, area and distribution of habitats and is therefore very important in identifying rare and endangered habitats.

2.4 OUTPUTS OF THE ASSESSMENT PHASE

At the end of this phase, it is useful to convene a workshop in order to discuss the results and fine-tune them. This workshop should include all stakeholders, including local community representatives.

The output of this phase should be a listing of wetland sites prioritised for their importance. This means that the most important wetlands in terms of the three categories of benefits should be ranked in relation to each other. Wetlands should also be ranked according to the type and degree of threat operating on them. This is very important since urgent management measures can then be directed towards important wetlands which are under the greatest threat of destruction or degradation.

2.5 MANAGEMENT AND MONITORING

The ultimate goal of the inventory and assessment process should be sound management of wetlands. What type of management regime is recommended for a particular wetland depends on the results of the assessment phase. For example, some wetlands may be found to have a very high value in terms of direct uses such as fisheries utilised by local people. In this case, the emphasis would be on development of a fisheries management plan to safeguard the fishery resource for local people, with the Fisheries Department being the lead agency. In other cases, a site may be found to have a very high biodiversity with several rare or endangered species. This site is more appropriate to be designated as a protected area with the conservation agency as the lead agency.

As mentioned before, monitoring is not just a regular collection of data which were gathered in the initial inventory exercise. Monitoring is a targeted activity and monitors those variables which may cause changes in the wetland and the benefits it provides. Any monitoring programme should provide feedback into a management plan so that management actions can be taken to minimise any negative impacts identified through monitoring. For example, hydroperiod (the water regime and how it varies seasonally) is one of the fundamental determinants of the character of a wetland. Any change in the hydroperiod will cause a dramatic change in the character of the wetland e.g. the vegetation. Therefore, any activities which may cause a change in the hydroperiod should be monitored closely. As a first step, base line data on the hydroperiod such as monitoring of water levels seasonally should be gathered. Monitoring of development plans and activities such as river flow modification in the catchment of the wetland would also be needed. It should be noted that monitoring in this case can be proactive; i.e. by monitoring plans and by seeking to be involved in the planning process, one can have a say in the decision-making process to minimise or remove any adverse effects before they occur.

Other examples of common monitoring programmes are those which look at levels of resource utilisation in the wetland such as exploitation of fishery resources. By monitoring the intensity of fishing (e.g. catch data, numbers of fishermen and numbers and types of gears), one can devise management strategies to ensure that resource utilisation is on a sustainable basis and that the fishery resources are available in undiminished quantity in future years.

3. EXAMPLES OF WETLAND INVENTORY PROJECTS

1. Mediterranean Wetland Initiative (MedWet)

This is a regional project launched in 1991, the first objectives of which were to assess the existing information on Mediterranean wetlands in order to identify gaps and assess the methodologies used; and to develop a standard methodology for wetland inventory in the Mediterranean region (Costa et al. 2001). The first stage was a three-year preparatory project to develop a standard set of tools to be used in the inventory process. These tools consisted of a reference manual, sets of inventory data sheets, a habitat description system and a computerised database to hold the information. Information in this project is collected at three levels: at the catchment level, the wetland site level and the habitat level.

There are three major phases to the MedWet project: review of existing information, simple inventory and then detailed inventory (Costa et al. 1996). The review of existing information was seen as a necessary prerequisite for the simple and /or detailed inventory phases. If resources are limited initially; a simple inventory may be undertaken first, with the production of simple maps for each wetland and filling in of information gaps identified from the review. As more resource become available, a detailed inventory can be undertaken with the production of detailed maps, ideally using a GIS and compilation of detailed information on each site. This phase is particularly important for developing a management regime for individual wetlands and providing a baseline for monitoring programmes. If sufficient resources are available from the start, a detailed inventory can be carried out straight away after the review phase.

After the three year preparatory phase, the methodology was tested in pilot studies in five countries and refined. Subsequently, the methodology had been used to develop wetland inventories in most of the Mediterranean countries. An important point here is that the methodologies are not “set in stone” but are continually being refined and improved as more and more experience is gained in their use.

2. Asian Wetland Inventory (AWI) programme

The “Global review of wetland resources and priorities for wetland inventory” (Finlayson & Davidson 1999), carried out by Wetlands International on behalf of the Ramsar Convention, concluded that the existing information base for Asian wetlands was inadequate. As a result of this, the AWI was launched in 1999 with the endorsement of the Ramsar Convention. The AWI aims to develop a standardised protocol for wetland inventory across the Asian region. Information is collected at four levels: 1. River basin, 2. Sub basin, 3. Wetland site or complex and 4. Habitat. Thus, attention is focused down progressively from the catchment level to the habitat level. Information can from the top two levels can be used in overall land use planning whilst information collected at levels 3 and 4 can be used for site specific management of wetland sites and complexes. The information gathered is to be held in a computerised database linked to a GIS. At present, the tools are being developed, including a manual, data sheets, a database and GIS. Pilot testing of the protocol will begin in the near future. More details on the project are given in Lopez (2002) (this volume).

CONCLUSION

There are several ingredients for a successful wetland inventory and assessment project – there must be adequate preparation of the methodology and pilot testing; there should be an extensive period of desk study prior to collection of new information from field surveys; a multi-disciplinary team should be used and there should be adequate time allocated to assessment of the

information collected. Any envisaged wetland inventory and assessment project should conduct a review of previous projects to benefit from their experiences and to build on them.

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