A Manual for an Inventory of Asian Wetlands

Version 1.0

CM Finlayson, G W Begg, J Howes, J Davies, K Tagi and J Lowry

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Asian Wetland Inventory

Ramsar

national centre for tropical wetland research

Ministry of the Environment, Japan

A MANUAL FOR AN

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Finlayson CM (Max.Finlayson@ea.gov.au), Begg GW (George.Begg@ea.gov.au) & Lowry J (John.Lowry@ea.gov.au), National Centre for Tropical Wetland Research, c/o Environmental Research Institute of the Supervising Scientist, GPO Box 461, Darwin, NT, 0801, Australia

Howes J (johnhowes@pd.jaring.my) & Davies J (jondavies@pd.jaring.my) , Wetlands International-Asia Regional Programme Office, 3A39, Block A, Kelana Centre Point, Jalan SS7/19, 47301 Petaling Jaya, Selangor, Malaysia

Tagi K (Ktagi@aol.com) , Wetlands International – Japan, 402 Axes Nishishinjuku, 8-5-3 Nishishinjuku Shinjuku-Ku, Tokyo 160-0023, Japan

Editorial assistants: Alvin Lopez, Lee Shin Shin & Flora George

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This publication is available from:
Wetlands International – Asia Regional Programme Office
3A39, Block A, Kelana Centre Point, Jalan SS7/19
47301, Petaling Jaya, Selangor, Malaysia
Tel: +603 7804 6770
Fax: +603 7804 6772
Email: wiap@wiap.nasionet.net
www.wetlands.org

FOREWORD

I am very pleased to see that the Asian Wetland Inventory (AWI) programme is progressing well and that, with the publication of this Manual, it has completed a major section of its first phase.

Wetland inventory is one of the key challenges for the Convention and its Contracting Parties. Until full, scientifically-prepared inventories are in place in all Parties, they will be handicapped in the implementation of the Convention in a systematic and effective manner, and the Convention will continue to suffer from a lack of a clear understanding of the extent and status of wetland resources on the planet.

AWI was born out of Resolution VII.20 on Priorities for Wetland Inventory adopted at the most recent Ramsar COP, in 1999, in particular paragraph 15 which "REQUESTS the Scientific and Technical Review Panel, in collaboration with Wetlands International, the Ramsar Bureau, and other interested organizations, to review and further develop existing models for wetland inventory and data management, including the use of remote sensing and low-cost and user-friendly geographic information systems, and to report their findings to the 8th Meeting of the Contracting Parties with a view to promoting international common standards."

In keeping with this request of the Ramsar COP, the AWI has been developed closely in line with the Convention's needs and its development, and it has in turn helped to shape the ongoing discussion and issues to be raised at the forthcoming COP in November 2002, when a resolution proposing a "Ramsar framework for wetland inventory" will be discussed and hopefully adopted.

I am confident that this AWI Manual, as a tool for developing a broadly-supported standardized inventory protocol that can provide information for the assessment, evaluation and monitoring of wetlands in Asia, will prove to be extremely useful for wetland policy-makers and practitioners in the region and elsewhere.

The AWI programme has been endorsed by the Ramsar Standing Committee and has received strong support and interest from Asian countries. I very much hope that the availability of the Manual will encourage countries to undertake national wetland inventories using a standardized protocol, so important for permitting comparisons and the study of trends.

I am also pleased to see that AWI provides direct support to concepts and guidance contained in the draft Ramsar framework to be considered by Ramsar COP8 in November 2002. In this sense, AWI should be able to provide leadership in the use of the Ramsar framework, which does not imply that other approaches should not also occur in parallel or concurrently.

A key feature of AWI is its clear potential to contribute to capacity building in countries wishing to undertake serious wetland work, by providing *inter alia* locally useable tools.

In addition, AWI is making a contribution to the Convention at the global level because it constitutes a tool that can be applied generically. In spite of the programme's title, there is nothing in it that is fully specific to Asia, and as such it could serve as the basis for other inventory approaches, adapted to national or regional requirements.

The AWI Manual is the forerunner of more specific manual(s) on techniques for collecting information on specific data fields, e.g., delineation, water chemistry, hydrology, waterbird populations, etc. I congratulate all those involved in the production of the Manual and look forward to the development of these additional components of this very important programme.

Delmar Blasco
Secretary General
Convention on Wetlands (Ramsar, Iran, 1971)
June 2002

Reliable information for management of natural resources is the basis on which all decisions with regards conservation and development are made. In 1999, Wetlands International undertook a global review of wetland inventories on behalf of the Convention on Wetlands (Ramsar, Iran, 1971). The review demonstrated that the existing inventory base was inadequate. Lack of a standardised, systematic approach to wetland inventory across the Asian region has made it impossible to accurately assess the extent, pressures and degree of degradation of Asian wetlands. Recognizing this urgent need, the Contracting Parties of the Ramsar Convention called on participating governments to collaborate with Wetlands International to review and further develop existing models for wetland inventory.

Responding to this call, the Asian Wetland Inventory (AWI) programme was initiated by Wetlands International in 1999 with initial support from the Ministry of Environment Japan and the endorsement of the Standing Committee of the Ramsar Convention. Over the last two years, resources have also been provided by the AEON Foundation, Japan Fund for Global Environment, and Dutch Ministry of Foreign Affairs.

The AWI provides an effective tool for collecting information for managing natural resources derived from or dependant on wetlands. It further provides a framework for considering individual habitats and sites within and outside of established jurisdictional boundaries. The AWI approach has recently provided the framework for the development of the Wetland Inventory Protocol for the Ramsar Convention.

Wetlands International, in collaboration with the Australian National Centre for Tropical Wetland Research (NCTWR), and the Wetland Inventory and Monitoring Specialist Group (WIMSG) has been responsible for the initial development of the project. A team of international and national experts in wetland inventory and conservation under the leadership of Dr. Max Finlayson, including Dr. George Begg, Dr. Jon Davies, Mr. John Howes, Mr. John Lowry and Mr. Koji Tagi have been

responsible for developing this manual over the past two years. We are grateful for all their efforts and hard work.

In April 2002 in cooperation with the Ministry of Environment of the Royal Government of Cambodia, a regional workshop brought together representatives of governments, international organisations and technical experts, to review the AWI programme. The meeting was most valuable in providing a basis for the finalisation of the methodology and the Manual.

The Manual is the first product and tool for the Asian Wetland Inventory. This will undoubtedly change as others want to develop inventory for different purposes or refine the detail at any level. Additional tools will be developed to assist with specific data collection needs. The cost for the production of the Manual has been supported by the Dutch Ministry of Foreign Affairs and we are very grateful for their kind support.

We are particularly appreciative of the strong interest and continued support by the Ramsar Bureau. Mr. Delmar Blasco, Secretary General has kindly provided a Foreword to this publication and Dr. Nick Davidson, Deputy Secretary General has provide technical advise and guidance.

Wetlands International strives to promote the conservation and sustainable use of wetlands worldwide. Over the next four years, Wetlands International will focus on four thematic programme areas, including wetland inventory, species conservation, wise use and capacity building (http://www.wetlands.org/aboutWI/Strategy.htm). Through the development of tools and provision of skill-based training, we wish to offer our advice and services to governments of the region, conventions and others to develop and maintain a comprehensive information base for wetland conservation.

Over the last year, the AWI programme has been supported and endorsed by a number of governments and other partners in the region. We look forward to building on this interest and support to encourage collection of high quality information on wetlands and make it widely available. This will enable improved management and wise use of wetlands for biodiversity conservation and lead to enhanced quality of life of local communities.

We trust you will find the Manual practical and useful. We look forward to receiving your comments and suggestions to update the information presented in the Manual and on ways to implement the AWI programme in the region.

Dr. Taej Mundkur
Regional Programme Director (Asia)
Wetlands International
June 2002

PREFACE

A mechanism for developing a comprehensive wetland inventory database for Asia has been developed under the auspices of the Wetland Inventory and Monitoring Specialist Group (WIMSG) of the international non-governmental organisation (NGO) Wetlands International. This provides a platform for comprehensive conservation planning, including assessment and monitoring of wetlands across Asia.

The aims of this mechanism are to determine the status of Asian wetlands for the 21st century and to develop a comprehensive Asian Wetland Inventory (AWI) database.

The Standing Committee of the Convention on Wetlands (Ramsar Convention) that supported a recent worldwide analysis of wetland inventory has endorsed the mechanism. The worldwide analysis of wetland inventory found that much of the existing inventory information, including that in Asia, was uneven and in need of updating. Guidance for conducting wetland inventory was provided at the 7th Meeting of the Conference of Parties to the Convention in Costa Rica, May 1999 (http://www.ramsar.org/key_criteria.htm) In line with this guidance the Asian Wetland Inventory uses a strategic and hierarchical approach for collecting and managing core data on wetlands.

This manual is considered to be a 'living' document and in effect is under constant review and when necessary it should be revised in accordance with further experience in conducting wetland inventory across Asia. (Given this situation this edition of the manual is coded as version 1.0.) Further, the manual does not purport to replace detailed texts that describe methods for collecting specific pieces of information required within an inventory. The reader is referred to specialist technical books and manuals for such detail. However, given the evolving interest in wetland inventory within many parts of Asia we welcome feedback and advice on further technical reports or documents that could complement the method outlined in this manual.

Dr CM Finlayson
Director, National Centre for Tropical Wetland Research
President, Wetlands International

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We wish to convey our gratitude to the Japanese Ministry of the Environment for providing the initial financial assistance required for the AWI. The project has since been carried out with financial support from the Dutch Ministry of Foreign Affairs (DGIS) under the Conservation and Wise Use of Wetlands – Global Programme managed by Wetlands International (2001–2002), the Japan Fund for Global Environment (JFGE) (2000–2001) and the AEON Foundation (2001–2002). We are also indebted to the Environmental Research Institute of the Supervising Scientist (Environment Australia) for its continued support with facilities.

We thank the AWI Management Team, Dr Douglas Taylor, Ms Kaori Matsui and Mr Matt Wheeler, for role they played in securing the funds required for the project, and are similarly indebted to Ms Robin Shaap, Dr Arthur Mitchell, Mr Scott Frazier and Dr Taej Mundkur (of Wetlands International) for project support and technical advice. In particular we also thank Mr Alvin Lopez for his hard work in co-ordination of the DGIS funded component of the AWI programme.

We also warmly thank the many other people who contributed their time and energy in preparing this manual. Mr Ben Bayliss (Environmental Research Institute of the Supervising Scientist), in particular, was instrumental in producing the figures that have been used to illustrate the report. We thank the many people who read and commented on earlier versions of the manual. In this respect we thank Mr Gordon Claridge, Dr John MacKinnon (EU Co-Director, ASEAN Regional Centre for Biodiversity Conservation), Mr Mam Kosal (Wetlands International – Lower Mekong Office), Mr Robson Ivan (WI – South Asia Office), Mr Reza Lubis (WI – Indonesia Office) and Mr Koji Shiguchi (Wildlife Protection Division, Nature Conservation Bureau, Ministry of Environment, Japan). The help and encouragement of everyone that has been involved, especially the wetland experts engaged to formally review the final draft of the manual (Dr Luis Costa, Dr Chris Gordon and Mr Sigid Hariyadi), is greatly appreciated.

We also thank the key supporters at the workshops held in Japan (Mr Kojiro Mori, Ministry of Environment, Japan) and Dr Yoshiki Yamagata (National Institute of Environmental Studies) and in Cambodia (representatives from the governments of Cambodia, China, Lao P.D.R., Malaysia, Philippines, Thailand and Vietnam), as well as the Japanese officials (Mr H Chiba, Mr H Eguchi, Mr K Kokubu, Dr M Komoda, Mr A Takamatsu and Mr T Torii) who, after a description of the programme by Ms Robin Schaap, offered to provide support for the Asian Wetland Inventory at the 24th Ramsar Standing Committee in December 1999.

In conclusion, we thank Wetlands International for supporting the Wetland Inventory & Monitoring Specialist Group and, along with the Bureau of the Ramsar Convention, for its long-term vision in promoting the development of improved approaches to wetland inventory. This entails special mention of Dr Michael Moser, Dr Nicholas Davidson and Dr Bill Phillips. Ms Khadijah Ahmad and Ms Flora George from Wetlands International need a special note of thanks for handling all administration and financial issues related to the development of the manual.

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EXECUTIVE SUMMARY

The Asian Wetland Inventory (AWI) outlined in this manual aims to develop a broadly supported standardised inventory protocol that can provide information for the assessment, evaluation and monitoring of wetlands in Asia.

The AWI protocol builds on past inventory protocols that have been successfully developed for use elsewhere in the world. It is also based on the recommendations made in the global review of wetland inventory conducted by Wetlands International on behalf of the Ramsar Convention Bureau and supports the provisions used in the Ramsar Convention framework for wetland inventory. Since its advent in 1999 (with financial assistance from the Ministry of Environment, Japan), the AWI has evolved into a regional conservation and development programme. Some of the main outcomes to be achieved through the AWI include:

- Increased awareness on the importance of wetlands and the need for a standardised inventory among relevant national government agencies across Asia.
- A dynamic and standardised Geographical Information System (GIS) integrated database providing core data/ information on Asian wetlands to guide and support planning and conservation efforts by national governments, international Conventions, NGOs and others.
- A strengthened network of trained personnel in techniques and skills required for implementation of the AWI at national and local level.
- Established national inventory programmes and databases in all participating nations.
- Established network of regional training programmes in wetland inventory
- A monitoring programme for regular revision and updating information on wetlands of national and international importance in Asia.

In terms of geographic coverage, the countries/territories that will be included within 'Asia' are countries covered in the *Directory of Asian Wetlands* as well as those in Central Asia, Russia eastwards of the Ural Mountains and any countries/territories that fall within a contiguous geographical region.

A principal purpose of the AWI is to delineate and map the wetland resources of Asia, taking into account wetland habitats from the intertidal zone to the uppermost reaches of all major river basins, and to store this information on a GIS. This exercise is to be undertaken at different scales with the amount of detail being dependent on the explicit purpose of the inventory and the size and importance of the wetland. The first two levels will provide the contextual basis for the inventory and provide the framework for further detailed wetland inventory and assessment. The third level will provide more information on core data attributes of wetland complexes and larger sites, while the fourth level will provide more information at the site/ habitat level.

Relevant government implementing agencies and other stakeholders will be able to obtain a copy of the manual on request from Wetlands International. It is also expected that the manual will be made available on the website for downloading. The information collected in the AWI will enable further assessment and monitoring of wetlands and improve access by a range of stakeholders to relevant data.

1 INTRODUCTION

The mechanism for wetland inventory outlined in this manual provides an effective tool for collecting information for managing natural resources derived from, or dependent on wetlands, and for meeting national obligations under international agreements. The mechanism uses a strategic and hierarchical approach to collect information and takes advantage of new technologies of data collection, storage and dissemination. It will build on past inventory effort, most notably that undertaken in the mid-1980s to collate *A Directory of Asian Wetlands* that provided summary information on the status, threats and biodiversity significance of 947 wetland sites in 24 Asian countries (Scott 1989; Scott & Poole 1989). However, as with similar inventories conducted elsewhere in the world this analysis was not complete and it is now outdated and in need of revision (Watkins & Parish 1999; Finlayson et al 1999).

Inadequacies in wetland inventory have been outlined in several international fora (Finlayson & Davidson 2001, Finlayson et al 1999, 2001) and resulted in a formal background paper being submitted and considered by the Ramsar Convention on Wetlands in Costa Rica, May 1999 (http://ramsar.org/cop7_doc_19.4_e.htm). This resulted in a resolution that encouraged the development of systematic and standardised approaches for wetland inventory and built on earlier calls for Contracting Parties to the Convention to develop national wetland inventories as a basis for national planning and wetland management. The importance of undertaking structured and rigorous wetland inventory was outlined in a Wetlands International workshop held in Dakar, Senegal, November 1998 (Finlayson et al 2001). This resulted in recommendations and the outline of an initial protocol for planning a wetland inventory (Finlayson 2001). Many of these recommendations were incorporated into the formal background paper developed for the Ramsar Convention's subsequent meeting in Costa Rica. This has resulted in the development on behalf of the Convention of a draft framework for planning a wetland inventory; the framework will be formally discussed at the forthcoming Meeting of the Conference of Contracting Parties to the Convention (Valencia, Spain, November 2002).

Finlayson (1996) differentiated between a wetland inventory and a wetland directory as follows:

> A directory and an inventory are used to compile the same type of information, but the former is limited to current information and may not be comprehensive. An inventory generally includes investigative steps to obtain more information and thereby presents a comprehensive coverage of sites. Thus, a directory may often be the precursor of an inventory.

However, Finlayson (1996) further notes

> In reality, however, the terms are often used interchangeably, and hence the point has become pedantic and need not be a hindrance to further discussion about the extent of wetland inventory.

Within this context we consider that wetland inventory provides a basis for collecting reliable knowledge and providing information for taking decisions concerning the conservation and wise use of wetlands (Dugan 1990, Finlayson 1996). Wetland inventory also assists Governments to identify wetlands of national and international

importance and prioritize their conservation and development initiatives in conjunction with the management of natural resources, in particular, water, fisheries and/or forestry. The Ramsar Convention has promoted wetland inventory as a means to:

- identify the function and values of wetlands, including ecological, social and cultural values;
- establish a baseline for measuring future change in wetlands, their functions and values;
- identify where wetlands are, and which are the priority sites for conservation;
- provide a tool for planning and management at both practical and/or political levels; and
- allow comparisons between wetlands and management procedures at different levels of government and management (local, national and international) .

Ramsar Contracting Parties have been encouraged to undertake better and more efficient wetland inventory and to establish and maintain national inventories and identify all sites that meet the criteria for selecting wetlands of international importance (http://www.ramsar.org/key_criteria.htm). Further, wetland inventory can provide information to support national programmes and reporting requirements for other international treaties, such as the conventions on biological diversity, migratory species, desertification, world heritage and climate change. At the same time, regional strategies, such as the Asia-Pacific migratory waterbird conservation strategy (http://www.wetlands.org/IWC/awc/waterbirdstrategy/default.htm) are dependent on inventory information for planning and prioritizing management and monitoring actions.

Further, there is a broad and growing consensus that wetlands are critically important ecosystems that provide local and globally significant social, economic and environmental benefits. Thus, an inventory can supply information for many purposes and involve many different stakeholders. It is essential that any inventory provides information that satisifies an agreed purpose and in a format readily usable by key stakeholders. For this to be successful it is recommended that stakeholders and users of the information are consulted before an inventory is developed and implemented. Thus it is stressed that the purpose of the inventory and the manner in which the information will be used should be agreed before data collection commences. The inter-relationship of many of the above reasons for conducting an inventory was well illustrated in discussions held in the Wetlands International workshop in Senegal (Finlayson 2001, Finlayson & Davidson 2001).

Building on past analyses, especially those discussed in the Senegal workshop, the basis of the mechanism to conduct an Inventory of Asian Wetlands is outlined in this manual. The key features are that it is hierarchical and map-based with outputs at four levels of detail. The level of detail is related to the scale of the maps that are contained within a standardised Geographic Information System (GIS) format with a minimum core data set. The mechanism abides by the recommendations made in the review of wetland resources conducted for the Ramsar Convention (http://www.ramsar.org/key_res_vii.20e.htm) and shown in Appendix A. The key feature of this approach is the adoption of a multi-scalar (hierarchical) approach to enable core data on wetlands to be collected at different scales for different purposes, but contained within an integrated data management system to encourage maximum usage of the information.

2 AIMS

Based on the rationale presented above for undertaking a wetland inventory the AWI aims to develop a standardised and compatible methodology that can be applied regionally and globally to:

- develop standardised field data collection sheets;
- provide core data / information on Asian wetlands to national governments and to support international conventions and treaties on wetlands, climate change, biodiversity, migratory species and desertification, and their implementation by Governments;
- analyse long term trends in Asian wetlands and their natural resources;
- enable regular revisions and updates of information on wetlands of national and international importance in Asia; and
- disseminate these analyses for wider consideration and use in sustainable development and conservation of wetland resources.

The purpose of this manual is to act as a step by step guide to compiling a wetland inventory that achieves these aims.

2.1 Geographic coverage

For the purposes of the AWI, the countries/territories that will be included within 'Asia' are countries covered in the *Directory of Asian Wetlands* as well as those in Central Asia, Russia eastwards of the Ural Mountains and any countries/territories that fall within a contiguous geographical region.

3 METHODS

The key features of the AWI approach are the production of maps and the collection and analysis of standardised categories of data within a hierarchical and scalar framework. The framework links the mapping scales and the level of detail required.

3.1 Definition of wetlands

Wetlands in Asia include many types of natural and constructed habitats (Scott 1989; Watkins & Parish 1999). Typical wetland types include:

- inter-tidal and estuarine areas, such as lagoons, exposed reefs, mud flats, sand flats and salt marshes (in temperate areas) and mangrove forests (in sub-tropical and tropical areas);
- rivers and their floodplain marshes, tributaries and lakes;
- permanent and temporary freshwater marshes and reed beds;
- tropical peat swamps and freshwater swamp forests; and,
- peat bogs and mires.

Less typical wetlands include seasonal features such as saline and/or alkaline lakes. Asia also has a large area of constructed wetlands, such as seasonally wet rice fields, salt pans, aquaculture ponds and reservoirs.

From these examples it can be seen that wetlands are difficult to define. Further, there has been a long history of difficulty with wetland definition (Finlayson & van der Valk 1995), partly related to problems in delineating habitats that are often considered as ecotones between aquatic and terrestrial habitats. One definition for wetlands that has gained worldwide recognition and acceptance is that used by the Ramsar Convention. However, as pointed out by Finlayson (1999), when developing protocols for an Australia-wide approach to wetland inventory, this definition is rather broad as it includes coastal and marine wetlands, those occurring inland as well as those with only seasonal or sporadic inundation by water. The inclusion of marine areas provokes much contention.

Noting this situation the Ramsar definition is adopted as the basis for this inventory. Thus:

> 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.

Article 2.1 of the Covention provides that wetlands ‘may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands’.

In this respect the definition adopted provides support for formal national and international purposes associated with the Ramsar Convention, but is sufficiently broad to support other wetland analyses that may use a narrower definition.

3.2 Classification of wetlands

Whilst the Ramsar typology of wetland habitats and ecosystems (Appendix B) is useful and has been widely used, it should be stressed that it is based on a mixture of vegetation, soil, inundation and landform features that are often inconsistent and have led to much confusion (Semeniuk & Semeniuk 1995, 1997). More recent analyses and reviews of wetland classification have underlined the need to overcome major inconsistencies in such classifications. Finlayson & Davidson (1999) have concluded that a far more robust and consistent classification is one that is based on landform and water regime — the two fundamental features that determine the existence of all wetlands, regardless of their climatic setting, soil type, vegetation cover, or origin.

Such classifications have been developed in the USA (Brinson 1993) and Australia (Semeniuk & Semeniuk 1995, Semeniuk 1987) with the latter being proposed as the standard for a national inventory in Australia (Finlayson 1999). The AWI aims to utilise these more consistent and modern approaches, as outlined below, in addition to the classification provided by the Convention.

Thus the AWI also supports a classification based on five landform attributes and four hydrological characteristics that result in some 13 categories of wetlands (Table 29). These are mutually exclusive categories and provide a consistent basis for identifying wetlands. It facilitates a scalar approach to classification and hence to wetland inventory without being entrapped initially by, for example, vegetation features that are not independent of climatic or soil characteristics. This approach brings out the underlying similarity of wetlands across a wide range of climatic, geomorphic, soil, and vegetation settings based on the rationale that landform and water characteristics are the dominant and/or common feature for all wetlands, regardless of their setting. The classification can be extended by the addition of descriptors for salinity, vegetation cover, shape and size, as described below.

In this sense the classification for any particular wetland is derived from the information contained within the data collected during the inventory and, in particular, the landform and hydrological information upon which hydrogeomorphic classification relies. It is noted that the categories of wetlands used in the Ramsar wetland typology cannot be as easily derived from the core information obtained in the data sheets thereby reflecting the inconsistencies within the classification. It is also noted that the core information collected in the data sheets can be used to support or derive other classifications that may suit specific purposes.

3.3 Wetland delineation

A principal purpose of the AWI is to delineate and map the wetland resource in Asia, taking in wetland habitats across the intertidal zone to the inland, and to display this information on GIS-based maps. It is intended that this would occur at different scales with the amount of detail being dependent on the explicit purpose of the inventory and the size and importance of the wetland.

Thus, a hierarchy of four scales of mapping is proposed, none of which are fixed and any of which can be used (Figure 1). Typical mapping scales, for example, could be:

1 1: 500 000 to 1:1 000 000 scale maps for major river basins, coastal regions or islands,

2 1:250 000 to 1: 500 000 scale maps for sub-basins and coastal sub-regions,

3 1:100 000 to 1:250 000 scale maps for wetland complexes,

4 1:10 000 to 1:50 000 scale maps for wetland habitats.

It is suggested that river basins, coastal regions and major islands are used as the basis for the initial geographical regionalisation of Asia because they not only cut across political boundaries but also are topographically and hydrologically distinct. Coastal regions would comprise of numerous small rivers that drain the landmass between major river basins such as when there is a mountain range running parallel a short distance from the coast. A coastal sub-region would consist of one of these small river basins with its associated coastal wetlands.

The four scales adopted in the hierarchy will provide different information for wetland management. As the data fields for each scale are inter-linked it will be possible to compile the inventory in either a top-down or bottom-up approach, depending on the purpose of the inventory. The information at each scale can also serve different reporting purposes.

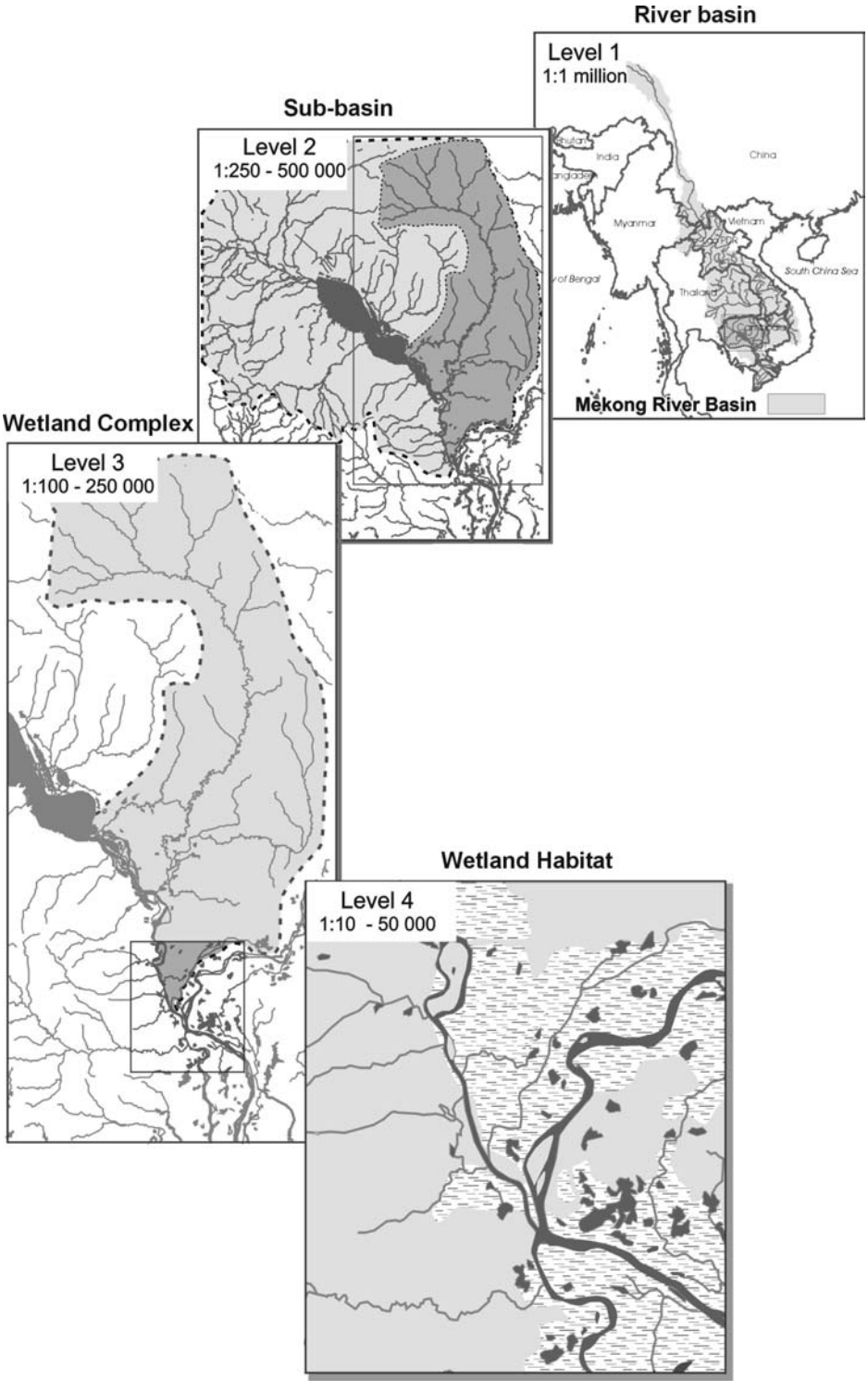


FIGURE 1: The four tiered landscape (multi-scale) approach of the AWI. The level of detail varies with spatial scale in a hierarchy from an entire river basin / catchment level (1) to a habitat level (4). Note the figures shown are not to scale. Source: Level 1 adapted from WRI (2001a) and WRI (2001 b), Level 2 & 3 from ESRI (1993), Level 4 from USGS, 2001.

The major river basins, coastal regions and major islands of Asia (shown partially in Figure 2), are produced from existing map-based products and will be accompanied by a text description and map of the major geologic, climatic and vegetation features of each basin. As the maps will be contained within a GIS the information on these features can be displayed at either a continental or river basin scale.

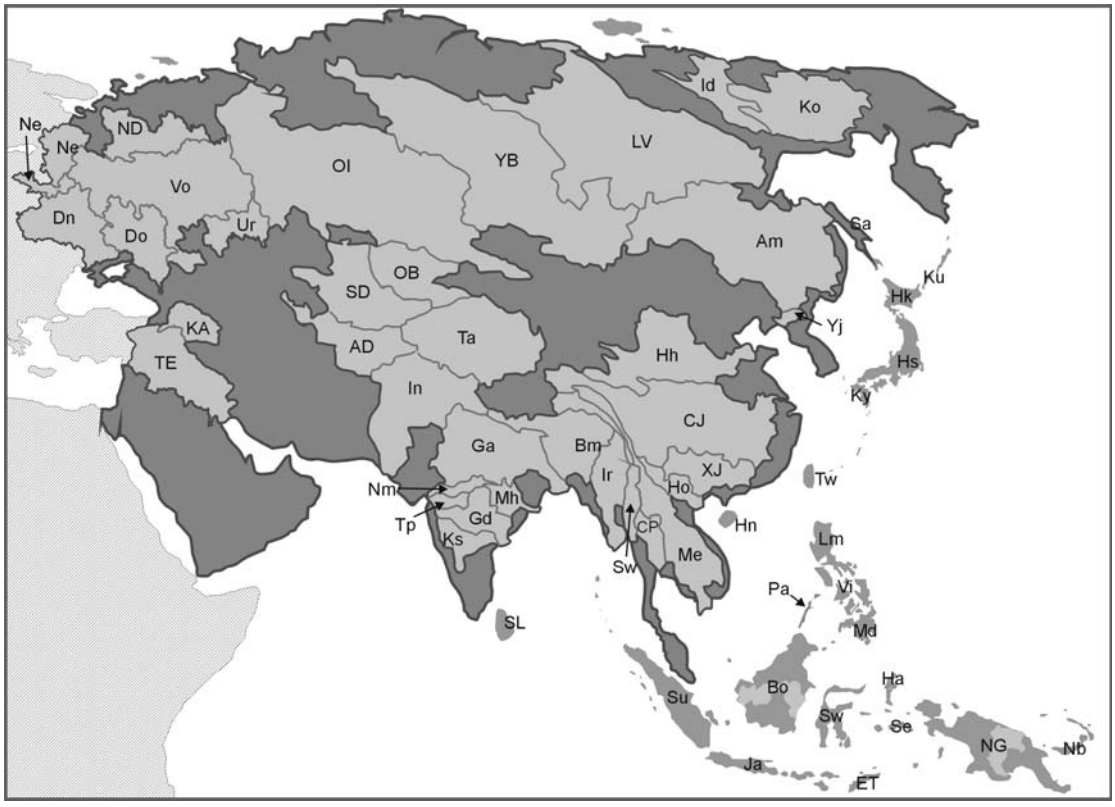


FIGURE 2: A schematic map of the major river basins and islands of Asia showing proposed codes and areas in which major river basins and coastal regions have yet to be defined (heavily shaded). Full names of the codes proposed appear in Appendix C. (Source: adapted from WRI 2001 a).

The river basins provide a geographical context for delineating and mapping wetland regions within each basin. That is, regions within each river basin that share common landforms and water regimes as determined by topographic, hydrologic and climatic features, such as rainfall, will be further delineated and presented on maps (1: 250 000 to 1:1 000 000) scale). The regional maps will provide the basis for delineating and mapping (1:100 000 to 1:250 000 scale) complexes (or aggregations) of wetlands confined within the same sub-catchment. The sites concerned can be further separated into individual habitats based on detailed delineation of topographical features (1:10 000 to 1:50 000 scale).

Whilst the hierarchical (scalar) approach will provide a logical progression in scale it is expected that delineation and mapping at the habitat scale will occur in tandem with the less detailed analyses as national agencies address both specific site-based and regional management and conservation priorities. The latter could include, for example, analysis of water or forest resources at a provincial or national level, or assessment of global change impacts at a national or regional level. Thus, the hierarchical approach allows for a strategic assessment of information needs in

relation to spatial scales. It further provides a framework for considering individual wetland habitats and sites within and outside of established jurisdictional boundaries.

3.4 Wetland description

A further purpose of the AWI is to describe the wetland resource of Asia using a core data set. Whilst a huge amount of information on Asian wetlands was collected during the 1980s through the Asian wetland directory (Scott 1989; Scott & Poole 1989) and national wetland inventories, there has been no consolidated update on much of this in the last decade (Watkins & Parish 1999). The information contained within these inventories and other sources identified by Spiers (1999) and Watkins & Parish (1999) will be assessed as needed in each of the information collection steps of the AWI.

The initial analysis (Level 1) encompasses a description, using existing global and Asian regional maps, of the broad-based geographic regionalisation based on river basins, coastal regions and major islands. It further encompasses a description of geologic, climatic and ecological features of each area, based on existing information. The regionalisation is map-based and presented on a GIS, making it possible to overlay national borders and geographic and demographic information as required. The distribution and occurrence of sub-basins within each river basin, sub-regions within coastal regions and occasionally aggregations of small offshore islands (Level 2) is then described on the basis of similar characteristics, such as climatic, geologic, hydrologic and vegetation features. Each of the sub-basins and coastal sub-regions can be further sub-divided into complexes (Level 3) containing wetlands with broadly similar ecological characteristics and values. Aggregations of small offshore islands can be similarly subdivided according to geographic features of the islands or into smaller grouping of islands. Data collection then focuses on describing the ecological character of the wetland habitats (Level 4) defined at Level 3.

The above descriptions should be undertaken by people with appropriate skills and access to corresponding resources, and in conjunction with relevant institutes and agencies to identify information sources. The usefulness of all information will need to be assessed and used as a basis for determining the extent of further analysis and data collection, including fieldwork. Generally the descriptions that are undertaken at each level are as follows:

- Level 1— desk study using existing information to describe each major river basin, coastal region and major island,
- Level 2 — desk study using available information to identify and describe the sub basins, coastal sub-regions and aggregations of small offshore islands;
- Level 3 — fieldwork and analysis to identify and describe wetland complexes within each sub basin, coastal sub-region and aggregation of small offshore islands; and
- Level 4 — detailed field work and analysis to delineate and describe habitats within each wetland complex.

Data collection sheets, together with a computerised database (see Section 4 below), for each level of the hierarchy have been developed. The data sheets indicate the core data that is considered necessary for each level of delineation and description of

wetlands, and provide a standardised format for recording and presenting this information. Whilst core data fields have been identified and a standardised data format proposed this manual does not outline specific methods for collecting such data. It is recognised that a further technical manual that specifically provides recommended methods, for example, for delineating wetland boundaries or assessing the goods and services provided by a wetland may be warranted. This has not been sufficiently addressed in the initial development of the AWI method and will require further consultation and analysis of existing sampling and data collecting methods before being produced. It is acknowledged that a further detailed techniques manual would complement the current manual which is designed to outline a standardised approach for undertaking inventory without recommending specific individual data collection techniques.

4 INFORMATION MANAGEMENT

The emphasis placed on the use of spatial datasets, databases and GIS technologies (http://ramsar.org/cop7_doc_19.4_e.htm) means that information management is a critical component of the AWI process. Within the context of the AWI process, information management will provide guidelines for data entry using standardised data sheets.

To enable the extraction, analysis and management of information which has been collated or created for each level of inventory an information management system comprised of three related, but distinct elements has been developed:

1. An interactive, user-friendly relational database which stores the actual inventory information for each of the levels proposed in the AWI methodology;
2. GIS software and datasets, which store the spatial datasets for the AWI, and which are able to be integrated and updated with, and from the relational database;
3. A metadatabase, comprising records describing individual inventory datasets. The metadata items recorded will correspond to those identified in the framework developed for the Ramsar wetland inventory metadatabase.

At the core of the information management system for the AWI is a computerised database engine with data/metadata entry and querying interfaces, and GIS display and querying capabilities. This will serve as the primary data management / storage / retrieval component of the project. The design of the system is modeled after the MedWet database (Tomàs-Vives et al. 1996, Costa et al. 2000) with several significant differences:

- Addition of a powerful querying capacity to allow customised query.
- The ability to import data from other formats and sources.
- The ability to export data to other formats for further data analysis.
- Incorporation of a metadata component for each inventory dataset.
- In line with the AWI methodology, data is structured and stored in a hierarchical manner, defined by spatial scale and extent.

The initial version of the AWI database has been developed in *MS Access97®*. Users will be guided through the data entry process through interactive help menus. The current and future versions of the database simplify the process of populating the database through the extensive use of look-up tables, which provide the user with a selection of options to populate the database fields. At the same time, the option of placing 'free-text' descriptions for particular fields will be retained. Later versions of the database will be released as 'stand-alone' systems which do not require *Access* or other database packages to be installed on the computer. The current version of the database does not support seamless integration of GIS software and database components that enable the results of queries, interrogation and integration of datasets to be spatially represented. Later versions of the database will support GIS software such as *ArcView®*.

During the initial stage of development of the information management system the database will be developed and maintained in English with limited bilingual support in data collection components. It is intended to develop support for multi-language functions —for example, using the Microsoft MultiLanguage Pack (for *Access*). This flexibility will allow for future conversion of the database to other languages. Similarly, although the database will initally be developed in *Access97®* format, it will be possible to convert it to later *Access* versions, depending on the need and rate of adoption of these programs.

The database will contain all of the fields that are recommended for the AWI process. The fields and protocols used in the development of the information management system are compatible with international database standards. The AWI database framework will enable the development of sub-regional / national databases, which can be developed bi-lingually, and still be compatible with databases used by others using the AWI approach.

Successive additions to the database will add the capacities to record, extract and query metadata, and enhance the capacity to relationally link datasets to GIS software, and to store and record GIS information.

While the entry and management of inventory data will be the responsibility of the individual national participating agencies and organisations, maintenance and support for the information system can be provided by Wetlands International. Future development of the information system will be managed by Wetlands International in consultation with partner agencies and organisations.

The AWI data sheets described in Appendices D – G identify the type and format of information which should be obtained and recorded for each level of the AWI. These sheets are available in a database format (*Microsoft Access97®*). Information from these data sheets will be used to both populate the AWI database, and add further information to the GIS datasets, enhancing the range of spatial products that may be produced. In the current version of the database, map-based outputs will be stored on the GIS. Subsequent versions of the database will enable the outputs to be stored in the database itself.

At present, the website http://www.wetlands.org/awi/ serves as the main communication node for announcements and discussions and is maintained by Wetlands International. It is envisaged that the complete AWI information management system will be able to be served through the internet, allowing web browsers to view existing information and be directed towards data sources from individual inventory projects. It is also intended that the AWI website will eventually be able to serve GIS datasets for Levels 1 and 2, to assist users to undertake wetland inventories at these levels. Inventories undertaken at Levels 3 and 4 are expected to be undertaken by individual national agencies and/or organisations and will only be accessible through the AWI web site with permission from these agencies and/or organisations.

5 CORE DATA COLLATION

5.1 Level 1 data — major river basins, coastal regions and islands

The data fields recommended for an inventory at Level 1 (fig 1) are described below and a datasheet format shown in Appendix D**.** The datasheet should be accompanied by a GIS-based map (scale approx. 1: 500 000 to 1:1 000 000) of each basin, coastal region or island in which the wetland inventory is to be compiled. In some cases, depending on the bathymetry of the surrounding coastal shelf, aggregations of smaller islands may be grouped.

Information on the major river basins, coastal regions and islands of Asia (fig 2) can be derived from a number of sources. These include the Land Oceans Interactions in the Coastal Zone (LOICZ) database (http://www.nioz.nl/loicz) and the World Resources Institute (WRI) web site (http://www.wri.org/wri/watersheds/watersheds.html). Maps from the WRI can be downloaded from the web site and are accompanied by profiles of each river basin, including information on: basin area; population density; numbers of total fish species, endemic fish species, threatened fish species, and endemic bird species; number of Ramsar sites, protected areas, 'wetlands' and other habitat / vegetation types; loss of original forest; numbers of large dams; and numbers of proposed dams.

5.1.1 Name and code of major river basin, coastal region or island

For identification purposes each river basin, coastal region or island should be given a name and a unique code. This can either be taken from the Table of proposed names and codes (see Appendix C), the LOICZ database (http://www.nioz.nl/loicz) or self-selected. However, other than in the case of major islands and coastal regions, the names of the basins and codes used should reflect the name of the major river draining the area.

5.1.2 Geology

General descriptions of the main geological zones of the river basins, coastal regions and islands of Asia are available from the Cornell University interactive website (http://atlas.geo.cornell.edu/ima.html) which allows the on-line creation of geological maps for a user-defined area, and enables the user to download maps as image files. The website also has comprehensive metadata records for the geological datasets available for the Asia-Pacific region.

5.1.3 Climate

The major river basins, coastal regions and islands of Asia can be divided into one or more climate classes using the Koeppen climate classification. A description of each climate zone (based on monthly rainfall and temperature data) of the major river

basins and islands is available from datasets on the United Nations Food and Agricultural Organisation (FAO) web site:

http://www.fao.org/waicent/faoinfo/sustdev/EIdirect/climate/EIsp0002.htm.

5.1.4 Ecoregions

The global biogeographical regionalisation developed by the World Wildlife Fund for Nature (WWF) can also be used to describe major river basins, coastal regions and islands. Each biogeographic unit or ecoregion in the WWF system is a relatively large unit of land or water that contains a distinct assemblage of natural communities sharing a large majority of species, dynamics and environmental conditions. The WWF ecoregion maps for Asia (more specifically the Palearctic and Indo-Malay regions) can be downloaded from the WWF web site (http://www.wwfus.org/ecoregions/index.htm). Reports for each ecoregion containing detailed information on the location, climate, geography, common vegetation, distinctive biodiversity features (including endemic species), status and threats are also available online.

5.1.5 Vegetation

Datasets suitable for describing the vegetation of the geographical regions can be obtained from the United Nations Environment Program – Global Resource Information Database (UNEP-GRID). This includes two datasets: the Global Vegetation Map produced by Murai et al. (1990) and that produced by Matthews (1983). Details on both datasets, can be accessed through the UNEP-GRID web site (http://www.grid.unep.ch/data/).

5.1.6 Wetland area and type

For each major river basin, coastal region or island record the amount of wetland in the region (in km^2) and the proportion of the river basin, coastal region or island that is known to occupied by wetlands (in %). This can be done using a variety of remote sensing techniques that have been developed to map the distribution of wetlands at global and regional scales. The data provided by Matthews and Fung (1987) which are freely accessible through the UNEP-GRID web site (http://www.grid.unep.ch/data/) is a fairly reliable global source of information on wetland abundance, but it should be noted that due to the lack of unanimity on the definition of wetlands and matters such as regional diversity, global estimates of wetland extent and type in a region such as Asia will vary widely. Better sources of information are available, such as the Digital Chart of the World produced by the US Defence Mapping Agency (Danko 1992), and can be purchased from the nearest office of the Environmental Systems Research Institute Ltd (ESRI) or local software providers.

Other sources of information about wetland extent are found in the WWF ecoregion maps for Asia (http://www.wwfus.org/ecoregions/index.htm.) and the WRI maps of primary river basins (http://www.wri.org/wri/watersheds/watersheds.html). The Water Resources and Wetlands e-Atlas project which is presently being developed by UNEP–GRID (http://www.grid.unep.ch/activities/sustainable/wateratlas/index.html) could serve as an additional source of such information.

5.1.7 Wetland goods and services

Describe the goods and services that are provided by wetlands in the region by using the information developed by the Millenium Ecosystem Assessment (MA) (www.millenniumassessment.org) as a guide (Table 1). Where possible indicate which of the goods and services listed are the most important to the region as these are likely to differ, depending on whether the region is developed, undeveloped or developing. This information could be used in later analyses to describe the extent of wetland degradation and the loss of wetland goods and services at local, regional and global scales (Mitsch and Gosselink 1986).

TABLE 1: Categorisation of region-wide goods and services provided by wetlands (Source: Millenium Ecosystem Assessment Working Group, http://www.millenniumassessment.org/en/workgroups/index.htm).

Goods and services
Freshwater
Food, fibre and fuel
Other biological products
Biological regulation
Nutrient cycling and soil fertility
Atmospheric and climate regulation
Human health control
Waste processing and detoxification
Flood, storm and erosion protection
Cultural and amenity services

5.1.8 Management issues and threats

Using information drawn from the WWF ecoregion maps for Asia (http://www.wwfus.org/ecoregions/index.htm.) and the conceptual framework of the Millenium Ecosystem Assessment (MA) (www.millenniumassessment.org), identify the primary reasons for the loss and degradation of wetlands in the region. The threats or pressures concerned (Table 2) are referred to as 'primary drivers' in the MA framework and are regarded as the major forces which influence one or more of the 'proximate drivers' that are described in Level 2 (Table 5) .

TABLE 2: Primary drivers of major management issues and threats
(Source: MA Conceptual Framework ,www.millenniumassessment.org)

Primary driver	Examples
Demographic	Population growth and demographic structure; spatial distribution of population
Economic	Globalisation and trade policy; econmic growth and structures; consumption patterns; income and wealth distribution; agriculture, forestry and fishery policies
Socio-political	Governance / collective action; democracy; institutional settings; attitude towards gender; involvement in conflict / war
Technology	Agricultural innovation; information technology, rate of technical change; access to information / intellectual property rights
Biophysical	Climate, sea levels

Note that the difference between issues and threats have been defined by Ntiamo-Baidu et al (2001):

- A wetland **issue** is an underlying socio-economic and/or political factor (e.g. urbanisation, population pressure, sectoral structures) that could lead to adverse change in the ecological character of a wetland.
- A **threat** to a wetland is a specific natural or human-induced factor (e.g. landslides, volcanic eruptions, water pollution, siltation, agricultural expansion, over-exploitation) that could have a detrimental effect on the ecological character of the wetland or even cause its disappearance.

5.1.9 Data sheet completion

- **Name and address of compiler :** The name and address of the compiler should be stated as shown in the datasheet (Appendix D).
- **Date sheet completed / updated:** The date the data sheet was completed should be stated (e.g. 02 October 2001).

5.2 Level 2 data — sub-basins and coastal sub-regions

Data collection at Level 2 focuses on sub-basins and coastal sub-regions (fig 1) within each of the major river basins, coastal regions and islands determined earlier at Level 1. In some cases aggregations of small offshore islands are also included at Level 2. Depending on the size of the areas concerned one or more sub-basins of a major river basin or island can be regarded as a single unit.

The Level 2 data sheet (Appendix E) should be accompanied by a GIS-based map (scale approx. 1:250 000 to 1:500 000) of the sub-basin or coastal sub-region for which the inventory is being compiled.

Data on some wetland regions can be derived from the World Resources Institute (WRI) web site (www.igc.org/wri/watersheds/index). This provides information about large sub-basins within a river basin (e.g. in the case of the Amur, Lena or Ob) or of a major island (e.g. in the case of Borneo (Kalimantan) or New Guinea). In most cases the watersheds of each sub-basin will need to be defined manually and a decision made about whether or not the area shown comprises a distinct wetland region as is, whether it needs further subdivision, or whether it warrants being grouped with adjoining sub-basins. In making the decisions required, access to a topographic map or a digital elevation model (DEM) of the primary river basin is of considerable assistance.

5.2.1 Name and code of sub-basin or coastal sub-region

Each sub-basin or coastal region should be identified by a discrete name (using the name of the largest river draining the area) and a code (e.g. numeric). However, the unique code initially used for the major river basins or islands (Level 1, section 5.1.1) in which the sub-basins or coastal regions are located, always remains the same.

5.2.2 Geographic location

The location of a sub-basin or coastal sub-region is defined using standard geographical coordinates. Using an appropriate map the coordinates are determined by taking the latitude of the most northern and southern extremes and the longitude of the most eastern and western extremes of the area.

It is also recommended that a centroid identifying the geometric centre of the sub-basin or coastal sub-region is also included. The centroid can be obtained from GIS-based maps and can be useful for quickly identifying the location of the area and possible sources of information from maps and remotely sensed imagery.

5.2.3 Climatic characteristics

Using the sub-classes of the Koeppen classification as a basis describe the distribution of rainfall and temperature in the sub-basin or coastal sub-region, noting the name of the official recording station(s). This information (e.g. the range and mean annual precipitation and air temperatures) should be obtained from an official recording service. If this is not the case this should be noted in the data sheet. Information on mean air temperatures and precipitation are also available on the LOICZ coastal typology database (http://www.nioz.nl/loicz).

5.2.4 Physical features

i) Type of region

State whether the area of interest is one of the following:

- Sub-basin (or group of sub-basins) of a primary river basin / island,
- Coastal sub-region, or
- Aggregation of small offshore islands.

ii) Altitudinal range

The altitudinal range of the area is defined by providing the minimum and maximum heights above (or below) the local height datum (available from the national land survey service) for sea level. These data are recorded in metres (m) and are normally available from topographical maps, orthophotographs and/or national and regional land information services.

iii) Wetland area and type

Using Table 3 as a guide, record the spatial extent of wetland (in km^2) and calculate the proportion of the area that is occupied by wetlands (in %) by using existing maps on the WWF (http://www.wwfus.org/ecoregions/index.htm.) and the World Resources Institute (http://www.wri.org/wri/watersheds/watersheds.html) web sites, or by locating surrogate data in the form of topographic maps, soil maps or maps of land capability units that are commonly housed by government organisations and aid agencies. The area calculations required can be obtained either with the aid of a planimeter, from a grid placed over a map of appropriate scale, or electronically using GIS applications.

TABLE 3. Surface area of wetland in region.

Category	Extent (%)
Very large	> 75
Large	50 – 75
Medium	25 –50
Small	<25

In the case of wetlands which assume a linear form (i.e. channel features such as rivers and streams) record the cumulative length of the channel (in km) and, if possible, differentiate between the extent of the stream orders concerned (i.e. compare the sizes of the different rivers in the region). The smallest streams, which have no tributaries, are called first order streams; when two of these coalesce they form second order streams; and when two second order streams join they form third order streams; and so on).

iv) Geological characteristics

Describe the specific geological zones/features of the area, noting that these should be a more detailed sub-set of the information presented in the Level 1 data sheet.

v) Water regime

With reference to published data or sources such as the LOICZ coastal typology database (http://www.nioz.nl/loicz), provide data on mean annual runoff (MAR) and seasonality of inflows. For coastal sub-regions and islands the LOICZ data base can be used for information on both tidal range and river discharge.

5.2.5 Vegetation

Describe the major vegetation zones/features of the area, noting that in the very least, this should be more detailed than the information presented at Level 1. Sources of such data include the internet (UNEP-GRID), in-country / in-region vegetation maps, and descriptions from well established organisations such as the Space Application Centre (in India) and others (e.g. LOICZ coastal typology data base).

5.2.6 Wetland goods and services

Expanding on the wetland values identified at Level 1 (Table 1) describe the goods and services that are provided by wetlands in the area of interest by using the information presented in Table 4 as a guide. Where possible indicate which of the goods and services are the most important in the region (using hearsay if necessary) and try to establish whether they differ from one area to another depending on whether it is developed, undeveloped or developing.

TABLE 4: Categorisation of region-wide goods and services of wetlands.

Goods and services	Example
Freshwater	Water storage, streamflow regulation, groundwater recharge, drought relief
Food, fibre and fuel	Rice, reeds, peat
Other biological products	$CaCO_3$ from reefs, wildlife trade, harvestable resources (fish /shrimp ponds, livestock grazing, timber)
Biological regulation	Food chain support, pollination, control of invasives
Nutrient cycling and soil fertility	Agricultural production
Atmospheric and climate regulation	Regulation of global carbon cycles
Human health control	Water quality improvement
Waste processing and detoxification	Denitrification, pathogen removal and waste assimilation
Flood, storm and erosion protection	Flood peak reduction and erosion control (shoreline and bank stabilisation)
Cultural and amenity services	Heritage, recreation, ecotourism and education,water transport

5.2.7 Management issues and threats

Expanding on the management issues and threats identified at Level 1 (Table 2) identify the specific reasons for the loss and degradation of wetlands in the nominated region. The threats concerned are referred to as ‘proximate drivers’ in the MA

framework (Table 5) and are regarded as the forces which have direct influence on the ecosystem services described earlier (section 5.2.6 above).

TABLE 5: Proximate drivers of management issues and threats (adapted from: MA Conceptual Framework).

Primary driver	Proximate driver	Examples
Biophysical	Climate change	Shoreline erosion, rise in sea surface temperature, saline intrusion
	Desertification	Drying up of inland wetlands that formerly acted as water storage areas
	Species introduction and biotic invasion	Invasive plants and animals that subsequently become declared weeds, pests or vermin
Economic	Natural resource extraction	Mining, fishing, logging, salt recovery, sand, gravel and shell extraction
Technology	Industrialisation and urbanisation	Mangrove removal, swamp reclamation, waterfront residential development, dredging
	Pollution	Water and air pollution, acid rain, leachates, toxicity, pesticide usage
	Waste disposal systems	Sewage treatment plants, retention ponds, solid waste landfill sites
Demographic	Land and water use	Landscape fragmentation, cover change, dewatering
	Agricultural production systems	Irrigation, fertilisers, soil degradation, rice cultivation
Socio-political	Disease emergence and drug resistance	Spread of malaria, schistosomiasis, liver fluke, onchocersiasis, pesticide usage

5.2.8 Jurisdiction

Each sub-basin or coastal sub-region should be described in terms of its national and local jurisdiction. Country codes of the International Organisation of Standardisation (ISO) (www.iso.org) should be used to show national jurisdiction and the names of Provinces, Counties and City administration units stated under each relevant ISO Country code. In addition, jurisdiction in terms of public or private land ownership could be stated here.

5.2.9 Data sheet completion

- **Name and address of compiler :** The name and address of the compiler should be stated as shown in the datasheet (Appendix D).
- **Date sheet completed / updated:** The date the data sheet was completed should be stated (e.g. 02 October 2001).

5.3 Level 3 data — wetland complexes

Level 3 data collection focuses on defining and describing 'wetland complexes' within the sub-basin or coastal sub-regions identified at Level 2.

The larger the river basin the larger the number of sub-basins (or sub-catchments) within it. Wetland complexes can be either entire sub-catchments (fig 1), large, individual wetlands (of various types), or a number of smaller discrete wetlands (sometimes only a few hectares in size) that are hydrologically linked because they lie within the same sub-catchment. The watersheds between wetland complexes serve to distinguish the sub-catchments involved. The Level 3 data sheet (Appendix F) should be accompanied by a GIS-based map (scale 1:100 000 to 1:250 000) of the wetland complex.

Depending on the regional topography, both river basins and coastal regions can contain wetland complexes. Understandably they exhibit some fundamentally different features and require different data fields. These differences are recognised and the AWI database contains separate data fields, where necessary, for wetlands in river basins and those in coastal zones.

As considerably more data are required at this level it is recommended that data collection is conducted on a priority basis and in conjunction with other parties and wetland programmes. As a wetland region can contain a number of wetland complexes it is also noted that data collection should be done efficiently as similar data is required for all wetlands within each complex.

5.3.1 Name and code of wetland complex

Using the procedure followed for Levels 1 and 2, each wetland complex must be identified by a name and code. A subsidiary code (using decimal places) can be used to further define the primary code ascribed at Level 3. Alternatively, the name and code can be derived from local maps by adopting the name of the largest river draining the complex. Where no river name for the wetland complex exists, the name of the Province, County or other administrative unit in which the complex is located should be used.

5.3.2 Geographic location

The size and location of a wetland complex will play a significant role in determining how the geographic location of the complex is recorded. It is important to define the extent of the wetland complex, through recording the location of its extremities. At a minimum, the upper left and the lower right extremities of the complex must be recorded. Alternatively, a series of coordinates defining the shape / outline of the complex may be recorded.

In most cases, it is recommended that a projected coordinate system, such as the Universal Transverse Mercator (UTM) system, be used to record the coordinates of the extremities. In such a system, the coordinates would be expressed as metres of Eastings and Northings eg 211396E 8489624N. Recording the coordinates as metres increases the relative accuracy with which the boundary of the complex is defined. It also assists with area and distance calculations.

It is important to recognise that projected coordinate systems may not be suitable for recording the geographic locations of all wetland complexes. In some situations, such as the boundary of two projected system zones running through the complex, it is recommended that a geographic coordinate system be used. In such a situation, the coordinates should be recorded as degrees of latitude and longitude.

Those responsible for entering data must therefore specify whether they are using a geographic or projected coordinate system; and if the latter, the type of projection that is applied (for example, the WGS 1984 UTM projection), and where appropriate, the map grid zone in which the complex occurs.

5.3.3 Climatic characteristics

Record the following general information, noting the location of the recording station (name, latitude and longitude, altitude): average rainfall, temperature range (including average temperatures), relative humidity (9 am and 3 pm), prevailing winds and evaporation (Class A pan).

5.3.4 Ecological character

Ramsar's 7th Conference in San Jóse, Costa Rica in 1999 revised and adopted definitions of '*ecological character'* based on expert advice from the Convention's Scientific and Technical Review Panel (STRP). These definitions, as adopted by Resolution VII.10, are as follows:

> Ecological character is the sum of the biological, physical, and chemical components of the wetland ecosystem, and their interactions, which maintain the wetland and its products, functions, and attributes.

On this basis, the core data required to describe the 'ecological character' of a wetland complex should be grouped under three headings describing the physical, physico-chemical and biological features of the complex.

i) Physical features

Altitudinal range
Record the altitudinal range of the wetland complex by defining its minimum and maximum heights above (or below) sea level (in metres). This information is normally available from topographical maps, orthophotographs and/or national and regional land survey or mapping services. For wetland complexes in coastal regions the LOICZ coastal typology database (http://www.nioz.nl/loicz) can also be used.

Spatial
Establish / describe the spatial extent of the wetland complex (in km^2).

Currents, waves and sediment movement in a coastal area

In the case of a wetland complex in a coastal sub-region there are four extremely important forces (currents, tides, wind and waves) that exert an important influence on sediment movement in the area (e.g. longshore drift of marine sediments). Therefore, it is advisable to record any information that exists about distributive forces of this nature. Information on the dominant wave direction and the prevailing wind direction relative to the coastline is generally available from the local Port Authority, Department of Transportation, or the LOICZ coastal typology database (http://www.nioz.nl/loicz). The position and shape of inlets, shoals and sandspits, as seen from aerial photographs, also provides a good indication of the environmental factors influencing coastal sand transport in the region.

Erosional status

Describe the susceptibility of complexes in coastal regions to erosion (wave-, wind-, storm-, or current-induced) using the categories suggested by Heydorn and Tinley (1980) and shown in Table 6.

TABLE 6 : Erosional status of coastal landforms and wetland complexes.

Erosional status	**Definition / example**
Eroding	Areas where the action of the sea is eroding the land substrate, e.g. cliffs, dunes, or beaches
Accreting	Areas where the predominant landform is depositional, e.g. beach, intertidal mudflat and where further sedimentation is active
Stable	Areas where the predominant landform is balanced by erosion and accretion

Soil types

Search for existing soil maps of the complex and describe the dominant soil type(s) within the area using standardised soil classifications for the area. Depending on the size of the wetland complex the FAO digital soil map of the world (http://www.fao.org/ag/guides/subject/p.htm) and the LOICZ coastal typology database (http://www.nioz.nl/loicz) can serve as additional sources of such information.

Water regime

For wetland complexes in the coastal zone the tidal range should be recorded using locally available tidal chart data to give both the maximum (Spring) and minimum (Neap) tidal variation. Using such data the coastal region can then be classified into sectors experiencing either small, moderate or large tidal ranges (Table 7).

TABLE 7: Classification of coastal regions according to tidal range experienced (after Hayes 1977).

Category	Tidal range
Micro-tidal	< 2 m
Meso-tidal	2–4 m
Macro-tidal	> 4 m

For inland wetland complexes describe the mean annual run-off generated by the catchment. If measuring weir data are unavailable, predictive models can be used for runoff estimation but such techniques will obviously involve considerably more time and expertise. Record the cumulative length of the main rivers and streams draining the complex (in km) and, as done at Level 2 (section 5.2.4 iii), differentiate between the extent of the stream orders concerned.

Groundwater
With the role of groundwater in wetland hydrology being a very important relationship and many wetland complexes being located in groundwater discharge areas, it is advisable to search for and record any information about the hydrogeology of the area in which the complex is situated. Such data are generally found in reports on the underlying geology (lithology and stratigraphy) of the area and include information on the aquifer systems that may be present in these formations, subterranean flow paths, the base flows of rivers that drain the region, springs and seepage zones.

ii) Physico-chemical features

Water quality
Where water quality data are available provide an overview of river health with specific reference to stressors such as the level of nutrients / toxicants (during low flow periods), sediment inputs (during high flow periods), acidification and salinisation. Such data can be drawn from existing reports and liaison with the local water authority or ministries (e.g. industry, agriculture, mining). Wherever possible indicate the sources of contributing nutrients (e.g. fertilised crop or pasture land, sewage outfalls), toxicants (e.g. mining, industrial effluents) and sediments (e.g. cropland, irrigation return waters).

Categorise the sediment input as negligible, intermediate or high and, where wastewater discharges are known to contaminate streamflows, try to estimate the proportion of wastewater to streamflow using the guidelines provided in Table 8. However, it is acknowledged that as compliance to discharge standards is rarely met in developing countries, the relevance may well be questionable. If insufficient data are available this should be stated.

TABLE 8. Likely level of impact of wastewater discharges on water quality (after Kotze et al 1994)

Wastewater input (%)	Probable impact assuming compliance with discharge standards
< 5	low
5 - 20	intermediate
> 20	high

iii) Biological features

The biological features of the wetland complex should be described using general indices that give an overview of the importance of the region for biodiversity. The indices include vegetation cover, dominant vegetation types, the biological importance of the wetland and noteworthy species (endemic or threatened species of flora and fauna).

Biological condition of complex

Using existing reports or maps, describe the vegetation cover in the wetland complex by estimating the relative proportions of the dominant vegetation types in the landscape. Describe known trends in the status/condition of vegetation (with specific reference to the occurrence introduced and environmental weeds) and similar trends (if any) in fauna populations. If insufficient data are available this should be stated.

Species and associations of biological significance

Use information on the WWF (http://www.wwfus.org/ecoregions/index.htm) and IUCN (http://iucn.org/redlist/2000/index.html) web sites for assessing the species of biological importance in the complex. List all the wetland-dependent threatened plant and animal species in the complex, indicate their status and the habitats in which they occur. Additionally, if the wetland complex regularly supports 1% of the individuals in a population of a threatened species, it should be stated.

Other biodiversity databases containing information on the status of species poorly represented in the 2000 IUCN Red List of Threatened Species include those for fish (http://www.fishbase.org/search) and plants (UNEP-WCMC Threatened Plant Database http://www.wcmc.org.uk/species/plants/plants.by.taxon.htm). For the purpose of determining species of National significance supported by the area other local data sources include National Red Data Books (if available) and local experts.

Habitat(s)

In preparation for, or in anticipation of, launching Level 4 of the AWI procedure (section 5.4) name / list the habitats which are found in the complex using the Ramsar classification for guidance (Appendix B) and provide the area of each habitat in hectares (ha).

In the event of a habitat classification system being used other than the Ramsar classification, provide the bibliographic details and date of the classification adopted.

Where no existing classification is available, group similar vegetation assemblages where these are know to support the same fauna species.

5.3.5 Population demographics

With the aid of government statistics (census data), describe the characteristics of the human population in the wetland complex noting that as official population and demography data are generally related to administrative regions, population density data can be recorded either as the number of villages / towns / cities in the area with populations greater than a certain number (the categories developed by Hecker et al 1996 for the MedWet inventory were towns with population <1 000; 1000 – 10 000; 10 000 – 100 000; > 100 000) or as the number of inhabitants per km^2 (Table 9). For wetland complexes in coastal regions use the LOICZ coastal typology database (http://www.nioz.nl/loicz) for information on population density.

Where possible describe the number of people occupying the complex (population, age structure, seasonal variation in numbers, long term trends) and the principle activities of people living in the complex (agricultural, grazing, aquaculture, forestry etc.).

TABLE 9: Population density categories (using inhabitants per km^2).

Population density	Inhabitants per km^2
Very dense	> 500
Dense	200–500
Moderate	100–200
Low	20–100
Sparse	1–20
Uninhabited	< 1

5.3.6 Land and water use

Describe and, where possible, map the manner in which the complex is used by local people. The categories presented in Table 10 can be used as a guide, noting where appropriate, whether or not these are undertaken for subsistence or for commercial purposes, and by using mainly traditional or modern techniques.

5.3.7 Jurisdiction

Describe the management jurisdiction over the wetland complex and where necessary, the proportion of the area managed by one or other jurisdiction. This includes the following categories: national, provincial and local authorities, private ownership, and any legal instruments that may be in force (e.g. legislation and/or policies).

TABLE 10: Classification of major land and water uses of wetland complexes.

Land / water uses	Examples
Cropland	Sugarcane, cereals
Grazing	Cattle, sheep, goats, horses, camels
Improved grazing	Pastures for dairy cattle
Horticulture	Vegetables, bananas, flowers
Urban	Infrastructure (roads, railways, etc.)
Settlement	Residential areas
Construction	Reed harvesting, mangrove poles
Fishing	Nursery stock, shellfish, finfish
Aquaculture	Shellfish, prawns/shrimps, finfish
Forestry	Timber / woodchip / pulp
Fuel	Peat, timber / charcoal
Hunting	Invertebrates, frogs, reptiles, birds, mammals
Water supply	Surface storage, groundwater recharge/discharge
Transport	Barge, ferry, houseboat, harbours
Extractive industry	Minerals, peat, oil/gas, sand/gravel or salt extraction
Energy	Hydro-electric power, peat farming
Conservation	Natural or cultural heritage
Recreation	Active (golf courses) or passive (birdwatching)

5.3.8 Management issues and threats

Using Table 5 (Level 2) as a guide, for each wetland complex describe the management issues that specifically confront local communities as users of the system (Table 11) (e.g. overfishing, illegal hunting, declines in agricultural or fisheries production), and human threats to sustainable use of the area that may well be beyond their control (e.g. herbicide / pesticide use of surrounding croplands, eutrophication, upstream use of the river system that supplies water to the complex). Describe the management practices / plans (if any) being employed / developed by agencies working in the area. Record the number of people interviewed, the names and status of the informants.

Where the utilisation of a wetland complex presents risks to human health, the type of disease carrying organisms living in the wetland (e.g. mosquitoes, liver fluke, snails) and the incidence of disease within the human population (in %) should also be described.

Where wetland complexes are subject to natural threats (e.g. from climate change, subsidence, storm surges, erosion) describe the underlying reasons for and extent of the habitat loss or degradation that is evident.

TABLE 11: Management issues and threats to wetland complexes.

Proximate driver	Examples of management issues and threats
Climate change	Flooding of residential areas, roads and infrastructure, erosion / siltation, salinisation of water supplies.
Desertification	Irrigation, reclamation, water diversion and wetland drainage.
Species introduction and biotic invasion	Alien invasive species and environmental weeds, vermin and pest animals.
Natural resource extraction	Agriculture, tree planting, grazing, fishing, fuel, forage, thatch, hunting, aquaculture, forestry, mining.
Industrialisation and urbanisation	Erosion / erosion control, flooding / flood control, vegetation clearance and fire, sedimentation, infrastructure / housing, quarrying / sand winning, hunting disturbance, recreational activities, agricultural expansion.
Pollution	Expansion of existing and development of new industries without adequate regulation and planning controls.
Waste disposal systems	Solid waste, siltation, faecal contamination, mining wastes, pesticides, fertilisers, salinisation.
Land and water use	Poor awareness by the general community and policy makers of wetland values; low level of community participation in conservation.
Agricultural production systems	Ownership and access to land and resources; questions of stewardship, traditional rights and attitudes of new settlers.
Disease emergence and drug resistance	increasing population and pressure due to poverty; urban or rural expansion; poorly resourced government agencies, shortage of trained personnel; conflicts with other agencies; weak legislation or without political support .

5.3.9 Data sheet completion

- **Name and address of compiler :** The name and address of the compiler should be stated as shown in the datasheet (Appendix D).
- **Date sheet completed / updated:** The date the data sheet was completed should be stated (e.g. 02 October 2001).

5.4 Level 4 data — wetland habitats

Level 4 data collection focuses on defining and describing the 'wetland habitats' (fig 1) which occur within the wetland complexes identified at Level 3. Even if lying within the same complex, wetland habitats do not necessarily have the same characteristics. For example, they would not necessarily experience the same water regime or have the same ecological characteristics. Nor would they provide the same goods and services or require the same form of management.

The Level 4 datasheet (Appendix G) should be accompanied by a GIS-based map at a suitable scale (e.g. 1:10 000 to 1:50 000 depending on the extent of the habitats concerned). Data collection for wetland habitats must be done efficiently because similar information is needed for all habitats within a given wetland complex or region. Therefore, it is inevitable that substantially more groundtruthing, analysis of existing maps, and use of existing references is required. As such, Level 4 data becomes **the core data set** relating to the primary interests of the managers of a particular wetland habitat or individual site.

5.4.1 Name and code of wetland habitat

A name and code for each habitat must be devised. The name can be derived from local communities or existing references. Where multiple names exist (e.g. in the case of transboundary wetlands where names in different languages / dialects are used for the same site) use them all. Where no name for the wetland habitat exists, the descriptive qualifiers / typology used by the Ramsar Convention (Appendix B) can be used in conjunction with the wetland classification proposed in Table 29.

5.4.2 Geographic location

It is important to define the extent of the wetland habitat as accurately as possible. At a minimum, the coordinates representing the upper-left and lower-right extremities must be recorded. Alternatively, a series of coordinates defining the boundary of the habitat may be entered.

It is recommended that the coordinates be recorded using a projected coordinate system, such as the Universal Transverse Mercator (UTM) system. In such a system, the coordinates would typically be recorded as metres of Eastings and Northings. The use of such a system enhances the ability to extract additional information, particularly those items relating to area calculations.

Those responsible for entering data must specify the type of projected coordinate system used eg WGS 1984 UTM projection, including the coordinate map grid in which the habitat is situated.

5.4.3 Climatic characteristics

Noting the location of the nearest meteorological recording station (name, latitude and longitude, altitude, period of record) describe the average and range of rainfall, noting the wettest and driest months; monthly temperature range, noting the hottest and coolest months; the range of relative humidity (9 am & 3 pm), and the most and least humid months; the range of annual (Class A pan) evaporation; the prevailing winds

and time of the year when the wind regime changes. In each case provide the source and date of the information utilised.

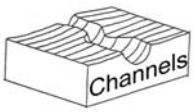
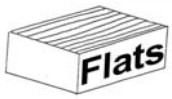
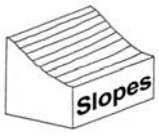
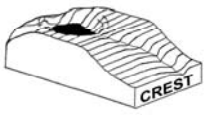
5.4.4 Ecological character

i) Physical features

Geomorphic setting

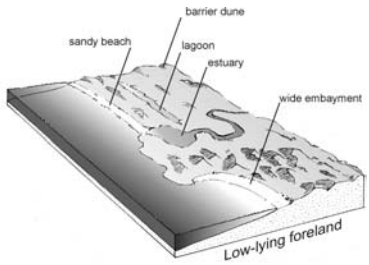
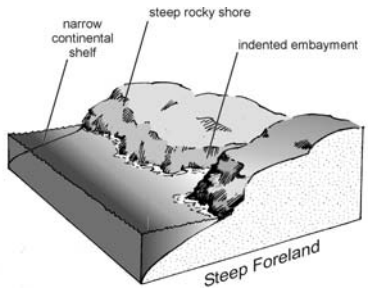
Describe the landform (or cross-sectional geometry) of the habitat using the terms supplied in Table 12. Generally there are at least 5 basic landform types that determine the occurrence of wetlands and, whilst each are intergradational, it is important to describe the entire landform in which the habitat is situated and not just parts of it (Semeniuk & Semeniuk 1995).

TABLE 12: Categories of landforms that are host to wetlands (adapted from Semeniuk & Semeniuk 1995 and from Kotze et al 1994).

Landform	Definition	
Basins	Basins are depressed basin shaped areas in the landscape with no external drainage. They may be shallow or deep and may have flat or concave bottoms. They usually have clearly defined margins.	
Channels	Channels refer to any incised water course. They may be shallow or deep but always have clearly defined margins.	
Flats	Flats have a slope of less than 1%. Little or no relief and diffuse margins. Flats can be incised by a channel thereby giving rise to the term 'channeled flats'.	
Slopes	Slopes are areas with a gradient of greater than 1% which may be concave or convex.	
Hills / highlands	Hills / highlands are generally convex areas on the top of mountains, hills or similarly raised areas.	

In the case of a wetland habitat in a coastal region the landforms that are host to wetlands are more complex and do not lend themselves as easily as inland wetlands to categorisation. Nevertheless, the terms supplied in Table 13 (after Heydorn and Tinley 1980) provide a provisional means of doing so.

TABLE 13: Categories of landforms that are host to wetlands in coastal regions (adapted from Heydorn & Tinley 1980).

Landform	Definition
Low lying	Wide coastal embayments, sandy beachfronts, salt marshes, mangrove swamps, deltas, lagoons and estuaries, often associated with regions where the continental shelf is wide. 
Steep/mountainous	Steep rocky shores, deep heavily indented embayments, and seacliffs, pebble shores often associated with regions where the continental shelf is narrow. 

Altitudinal range

Record the altitude of the habitat (in metre Above Height Datum (AHD)) by ascertaining its minimum and maximum height above (or below) sea level. This information is normally available from topographical maps, orthophotographs and/or national and regional land survey or mapping services.

Spatial

Define the areal extent of the habitat using the scale shown in Table 14. In addition, obtain the following spatial data:

- *surface area* ——measure the surface area using either a planimeter; a grid placed over a map of appropriate scale; or GIS applications and record the area in hectares. Provide an indication of the extent to which a wetland may vary in size from one season to another. After flood events, inundation maps (drawn from remotely sensed data) can act as a source of information about the variation in

wetland extent, but aerial photographs (where available) are otherwise the most useful source of reference.

- *length* — measure the maximum length of the wetland habitat in kilometres.
- *width* — measure the maximum and average width of the wetland habitat, in metres or kilometres. The average width can be recorded as the average of five equal segments drawn perpendicular to the flow.

TABLE 14: Terms for defining the areal extent of a wetland complex (adapted from Semeniuk 1995).

Classification	Frame of reference for all categories except channels	Frame of reference for channels (width to length relationship)
Very large	> 10 x 10km	> several km wide; hundreds of km long
Large	1000 x 1000m to 10 x 10km	Several hundred m wide; several to tens of km long
Medium	500 x 500m to 1000 x 1000m	Hundreds of m wide; thousands of m long
Small	100 x 100m to 500 x 500m	Tens of m wide; hundreds of m long
Very small	< 100 x 100m	Several m wide; tens of m long

Basin morphology

Bathymetry

Record any existing information about the depth of the basin (i.e. maximum depth and, where known, the average depth). If such data are not available they should be obtained by taking the measurements needed using either a depth sounder or a hand held plumb line graduated in metres (at 10 cm intervals).

Inlet stability

In the case of an estuary mouth or the entrance to a land-locked bay, record any information about the width and position of the entrance, noting in particular whether it is permanently or periodically open. If so, with the aid of vertical aerial photographs, establish whether there is any evidence of flood- or ebb- tide deltas (i.e. inner and outer bars) in the mouth region because such features greatly influence tidal exchange in the system concerned. If the mouth is normally closed (as it would be in the case of a lagoon) provide information on the height and width of the bar and, through consultation with local communities, establish whether or not artificial breaching of the bar occurs.

Currents, waves and sediment movement in a coastal area

Record any site specific information about the dominant wave direction and the prevailing wind direction relative to the coastline. Using aerial photographs describe the position and shape of inlets, shoals and sandspits (coastal sand transport) in the region.

Erosional status
Describe the susceptibility of the habitat to erosion (wave-, wind-, storm-, or current-induced) using the categories shown in Table 1 (Level 3).

Soil types
Using existing soil maps and/or reports describe the dominant soil type(s) within the habitat of interest. State what soil classification system is used and the date of data collection (if known). The FAO soil classification scheme (Purnell et al. 1994) is one of the most commonly used systems for naming soils in a consistent way and is recommended on the grounds that it provides an adequate description of the general nature of the soil mantle and has been well tested in the field.

Where remotely sensed data are available these can also serve as a useful source of information about soil saturation within the habitat.

Bottom sediments / substrata
Search for and document any information about the nature of the sediments / substrata on the floor of the wetland. Sediments include organic and mineral particles of all sizes and composition. However, in the event of such data not being available a simple visual / textural method of classifying the substrata in situ may need to be used, noting that core samplers may be necessary where the water depth is in excess of approx. 1.5 m (Table 15).

Water regime
For wetland habitats in the coastal zone the tidal range should be recorded using locally available tidal chart data to give both the maximum (spring) and minimum (neap) tidal variation AHD. For inland (non-tidal) wetland habitats describe the water regime (or hydroperiod) using one or more of the four terms shown in Table 16.

The water regime can be further described by supplying information on the seasonal and inter-annual depth (maximum, minimum and average), the pattern of flows into and out of the wetland; the period(s) of inundation and the area flooded. The source of inflow should be recorded (e.g. sea, river, groundwater, spring, rainfall only, artificial) and both the inflow and outflow recorded as permanent, seasonal, intermittent, episodic, or none.

Groundwater
If available, record information on the depth of the water table and on seasonal variation in the water table depth in the near vicinity of the wetland habitat.

TABLE 15. Texture based substrate classification (adapted from Begg 1984).

Textural class	Texture / general appearance	Percentage composition	
		% clay	% sand
Stoney	Rough or gritty texture, evidence of small stones and pebbles.	n/a	n/a
Coarse Sand	Disintegrates readily, individual sand grains can be readily seen and felt. Shell fragments are common	n/a	80
Fine sand	Well packed, clean, disintegrates readily and individual sand grains hard to distinguish.	10	90
Muddy sand	Sandy material noticeably discoloured by mud.	20	80
Sandy mud	Muddy material with equal quantities of sand and mud.	50	50
Silt or mud	Silty or muddy material, loose when moist, with traces of sand.	70	30
Silty clay	Sand hardly evident. Usually grey, sometimes containing iron concretions.	90	10
Clay	Sand not evident. Stiff and tenacious material, greasy when moist. Solid grey to blue grey in colour.	100	n/a
Peat	Organically laden substrata containing partly decomposed plant remains. Spongy when wet.	n/a	n/a
Ooze	Fine black, organically laden sludge, generally smelling of hydrogen sulphide.	n/a	n/a

Footnote: n/a = not applicable

TABLE 16: Categories of non-tidal water regimes for wetland habitats (adapted from Semeniuk & Semeniuk 1995)*.

Water regime	Definition
Permanently inundated	Areas where land surface is permanently covered with free-standing water (except in years of extreme drought).
Seasonally inundated	Areas where land surface is semi-permanently flooded. When surface water is absent, water table is at or near surface.
Intermittently inundated	Areas where the land surface is temporarily flooded. Surface water is present for a brief period during the year but water table is otherwise well below the soil surface.
Seasonally waterlogged	Areas where land surface is saturated for extended periods but surface water is seldom present.

* Noting:

- *Inundated* means soils that are covered with free-standing water; the soil below the surface in these situations is also saturated (waterlogged).
- *Waterlogged* means soils that are saturated with water, but where the water does not inundate the soil surface.

ii) Physico-chemical features

The following features describe the water quality of the wetland habitat and, unless known, are measured using standard techniques as given in 'Standard methods for the examination of water and wastewater' (Clesceri et al 1998) and general limnological texts such as those of Moss (1980), Wetzel and Likens (1991) and Wetzel (2001) .

Surface water

Temperature

Describe the annual range of water temperature of the major part of the flooded area and the annual average temperature. Note details of the recording station(s) and depth and time of measurements. If data are available this can be recorded for each season or each month of the year and a mean annual value given. If insufficient data are available this should be stated. Where possible classify the water body according to the thermal characteristics shown in Table 17.

TABLE 17: Categories of thermal characteristics based on different types of mixing (adapted from Bayly and Williams 1981).

Category	Definitions
Amictic	Never mixes (remains permanently ice-covered)
Oligomictic	Rarely mixes (remains warm at all depths)
Monomictic	Mixes once a year
Dimictic	Mixes twice a year
Polymictic	Mixes many times in a year

Salinity

Where known, provide the annual range of the salinity of the major part of the flooded area, noting details of the recording station(s) and depth and time of measurements. If data are available these can be recorded for each season or each month of the year and a mean annual value given. If insufficient data are available this should be stated. Where possible classify the water body according to the salinity characteristics shown in Table 18.

TABLE 18: Salinity classification.

Classification	Salinity (g L^{-1})
Fresh	< 0.5
Brackish	0.5–18.0
Semi -saline	18.0–30.0
Saline	30.0–40.0
Hypersaline	40–100
Ultrasaline	> 100

Wetland habitats with seasonal variability in salinity are categorised by the salinity status which exists for most of the year. For example, a wetland that ranges from freshwater for most of the year, to brackish during the short dry season would be classified as 'freshwater'. The salinity can further be described as constant (salinity remains within a single salinity range) or fluctuating (salinity that markedly fluctuates throughout the year).

In the event of salinity data being unavailable, conductivity measurements can be used to calculate the salinity using a conversion factor.

pH (hydrogen ion concentration)

Provide the annual range of the pH of the major part of the flooded area, noting details of the recording station(s) and depth and time of measurements. If data are available these can be recorded for each season or each month of the year and a mean annual value given. If insufficient data are available this should be stated.

Where possible classify the water body using the scale shown in Table 19, with pH 6.6–7.5 being 'neutral', lower numbers being more acidic and higher numbers alkaline.

Transparency

Provide the annual range of water transparency, as recorded with a 20-30 cm diameter Secchi disc, of the major part of the flooded area, noting details of the recording station(s) and depth and time of measurements. If data are available these can be recorded for each season or each month of the year and a mean annual value given. If insufficient data are available this should be stated. Where possible classify the water body according to the transparency categories shown in Table 20.

TABLE 19: Acidity / alkalinity classification based on pH units.

Classification	Range (pH)
Very strongly acidic	1.0–2.9
Strongly acidic	3.0–3.9
Acidic	4.0–4.9
Weakly acidic	5.0–6.5
Neutral	6.6–7.5
Weakly alkaline	7.6–8.5
Alkaline	8.6–9.9
Strongly alkaline	10.0–11.5
Very strongly alkaline	11.5 +

TABLE 20: Classification of transparency as measured with a Secchi disc (adapted from information provided in Moss 1980).

Category	Secchi disc depth (m)
Opaque	< 0.05
Very turbid	0.05–0.25
Turbid	0.25–2.50
Clear	2.5–25.0
Very clear	> 25

Whilst the term ‘colour’ should not be confused with ‘transparency’, it should be noted that the ‘opaque’ category can be subdivided into :

- ‘Black’ / tea-coloured water — indicates staining by peat in the catchment .
- Greenish water — indicates relatively high productivity.
- Brown / cloudy water — indicates high concentrations of suspended solids.

Nutrients

Provide the known annual range of nitrogen (nitrate and total nitrogen) and phosphorus (ortho-phosphate and total phosphorus) concentrations of the major part of the flooded area, noting details of the recording station(s) and depth and time of measurements. If data are available these can be recorded for each season or each month of the year according to the categories shown in Table 21. If insufficient data are available this should be stated.

TABLE 21: General relationship of wetland productivity to average concentrations of total phosphorus (from Wetzel 2001).

Category	Total P (µgm/l)
Ultra-oligotrophic	< 5
Oligo-trophic	5–10
Meso-eutrophic	10–30
Eutrophic	30–100
Hyper-eutrophic	> 100

A test kit can also be used for rapid determination of the trophic status of a wetland. In the case of phosphorus the test is based on the classic molybdenum blue colorimetric test for 'weakly coordinated' phosphate, otherwise known as orthophosphate, or filterable reactive phosphorus (FRP). Instead of using a spectrophotometer, a simple colour comparison is made using a disc.

Groundwater

If available, provide information on the chemical composition of the groundwater in unconfined shallow aquifers in the general area.

iii) Biological features

a) Vegetation

Dominant assemblages

Using Table 22 as a guide, list all the vegetation assemblages present, using the classifications used during the vegetation studies of the site and, if available, the most widely accepted vegetation classifications at the regional / state level. For open water areas indicate the stable state, i.e. whether the water body is macrophyte or phytoplankton dominated.

TABLE 22: Example format for categorisation of vegetation assemblages (example from Tasek Bera, Malaysia).

VEGETATION ASSEMBLAGE	TOTAL AREA IN WETLAND (ha)	% OF TOTAL AREA COVERED	PHYSICAL / HYDROGRAPHIC SETTING
Freshwater swamp forest	4100	67	seasonally inundated mineral soils with some peat areas
Pandanus/Lepironia marsh	2050	32	fringing open water areas, rarely drying out
(open water)	100	1	
	Total: 6250		

Dominant species

Provide a list of species (as shown in Table 23) which indicates growth strategy (annual, perennial, geophytic perennial), growth form (terrestrial or aquatic species), and the structural type (grasses, herbs, sedges, shrubs, ferns, palms, trees). For aquatic species (i.e. plants that have vegetative parts that are permanently or seasonally inundated) indicate if they are emergent, floating-leaved, free-floating, submerged rooted or free floating submerged.

It should be noted that Specht (1981) and Walker & Hopkins (1984) define a tree as a 'woody plant with a single stem within 2m of the ground'; a shrub as a 'woody perennial plant with multiple stems arising within 2m of the base'; grass as 'herbaceous plants in the family Poaceae'; sedges as 'herbaceous plants, normally with tufted habit and from the family Cyperaceae or Restionaceae'; forbs as 'herbaceous plants that are not grasses or sedges'; and the term aquatic to mean 'herbaceous plants that live only live in water'.

TABLE 23: Example format for categorisation of plant species (showing details of growth strategy, growth form and structural type after Finlayson et al 1989). Note: species listed do not necessarily occur in Asia.

Species & common name	Growth Strategy	Growth Form
Eleocharis sphacelata *Cyperus platystylis* *Fimbristylis denudata*	Perennial	Aquatic emergent sedge
Eleocharis dulcis	Geophytic perennial	Aquatic emergent sedge
Nymphoides indica	Perennial	Aquatic floating-leaved herb
Myriophyllum dicoccum *Dysophylla stellata* *Limnophila gratioloides*	Annual	Aquatic emergent herb
Oryza meridionalis	Annual	Aquatic emergent grass
Sesbania cannabina	Annual	Aquatic emergent shrub
Melaleuca cajuputi	Perennial	Aquatic / terrestrial tree

Alien invasive species and environmental weeds

List alien invasive species and environmental weed species, indicating which species are introduced and providing estimates of cover for each as area (ha) or percentage cover (%) of the site.

Species and assemblages of conservation significance

Using Table 24 as a guide list the plant species and/or assemblages present by status (endangered, vulnerable, rare, threatened), level (global, national state, regional) and, where appropriate, indicate the legislation applicable to each level of significance. For plant assemblages it is advisable to record the source of the information used as the same assemblage may be recorded differently in subsequent surveys.

TABLE 24. Example format for recording plant species and assemblages of conservation significance (example from Tasek Bera, Malaysia).

TAXON	TAXONOMIC GROUP	DISTRIBUTION	STATUS	LEVEL
Cryptocoryne purpurea	Araceae	endemic to Tasek Bera	Not determined	

The UNEP-WCMC Threatened Plants Database:

http://www.wcmc.org.uk/species/plants/plants.by.taxon.htm.)

is a useful reference in that it contains information on the status of plant species of conservation significance throughout the world.

Vegetation cover

Using aerial photographs or cover maps of the habitat, normally obtainable from the offices of local planning authorities and / or governmental agricultural or forestry services, describe the 'vegetation cover' by estimating the relative proportions of vegetation cover and open water by using the categories proposed by Semeniuk & Semeniuk (1995). These are illustrated in fig 3 below. Note that due to the gradational nature of vegetation cover the temptation to attribute more precise categories of 'percentage cover' should be avoided. However, where the areal extent of the vegetation cover is greater than 90%, the cover can be considered as 'complete'.

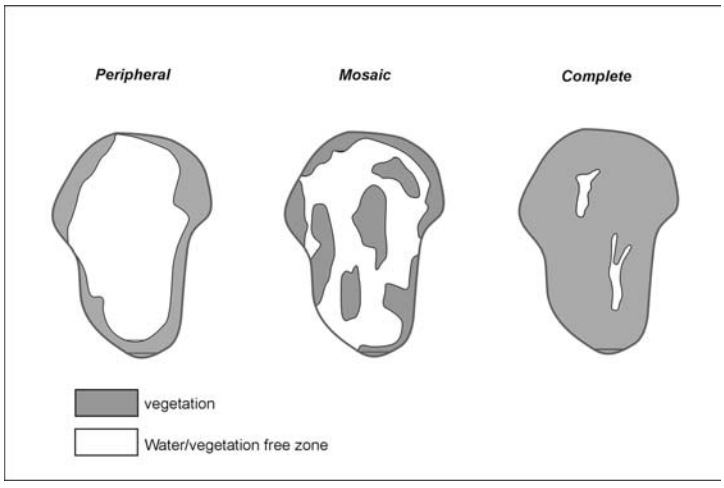


FIGURE 3: Categories of vegetation cover (after Semeniuk et al 1990).

b) Fauna

Dominant assemblages and species

With view to providing a record of species richness and diversity for each of the main taxonomic groups present (i.e. invertebrates, vertebrates — mammals, birds, fish, etc) provide a list of animal species associated with the site (vermin and pest species

included). Make specific reference to any species that may have declined or increased over time.

Species of conservation significance

Using Table 25 as a guide, list species of conservation significance (endangered species first, followed by vulnerable and rare species) including those listed in national or state legislation as threatened or as listed migratory species etc.

As done in the case for species of conservation significance at Level 3, use the '2000 IUCN Red List of Threatened Species' (http://iucn.org/redlist/2000/index.html) to determine internationally important and endangered species supported by the habitat. For fish species the following can also be used (http://www.fishbase.org/search). For the purpose of determining species of National significance supported by the habitats of interest other local data sources include National Red Data Books (if available) and local experts.

TABLE 25: Example format for recording animal species and assemblages of conservation significance (example from Tasek Bera, Malaysia).

TAXON	TAXONOMIC GROUP	DISTRIB.	STATUS	LEVEL
Scleropages formosus	Pisces; Osteoglossidae	SE Asia	Endangered	Global (IUCN 2000)
Balantiocheilos melanopterus	Pisces; Cyprinidae	SE Asia	Endangered	Global (IUCN 2000)

Populations

In situations where abundance data are available, tabulate the average and maximum estimated population numbers present as shown in Table 26a. Describe the abundance of the fauna (key species, largest concentrations, etc.) paying particular attention to breeding populations (where data available tabulate as in Table 26b), migratory populations (e.g. birds, fish) and key migration periods in wetland. Where known, draw attention to populations of wetland species that may have declined / increased over time.

In the event of abundance data being unavailable provide an indication of the abundance (e.g. A = abundant ; C = common ; U = uncommon; R = rare.) and status (e.g. B = breeding; W = wintering ; R = resident; V = vagrant) of the species concerned.

TABLE 26: Example format for the tabulation of population abundance data (a) and information on breeding populations (b).

(a)

Species	Status	Average number	Maximum number	Date of census (month / year)

(b)

Species	Number of breeding records

Alien invasive and vermin/pest species

List and describe the alien invasive and vermin/pest species present in each habitat, indicating which species are introduced.

c) Habitats

Using the most widely accepted existing habitat classification scheme (Appendix B) tabulate the habitats of the wetland and, as shown in Table 27, list the key taxa of the fauna that occur in each habitat. Where known draw attention to what are considered to be key habitats for breeding fauna or for species of conservation significance and indicate whether any such habitats may have declined or increased in area and/or quality over time. Where possible describe the faunal characteristics of each habitat using species richness data to give an indication of the importance of the habitat for the maintenance of biodiversity.

TABLE 27: Example format for listing of key faunal taxa associated with each major habitat together with an indication of the available information for each.

Habitat type	Key fauna taxa	Available information
Open water	Invertebrates	September 1992; December 1996
	Amphibia	Very limited
	Waterbirds	Numerous surveys (50+) have been conducted over the period 1965–present
Fringing rushes and reeds	Waterbirds	Numerous surveys (50+) have been conducted over the period 1965–present
River channel	Fish	August 1994

d) Biological significance of the habitat

Use the criteria for identifying wetlands of international importance defined by the Ramsar Convention (http://www.ramsar.org/key_criteria.htm) to describe the biological importance of the habitat. The Ramsar Convention presents eight criteria to assess the importance of a wetland habitat with a specific emphasis on birds and fish (Table 28).

TABLE 28: Summary of the criteria for listing a wetland as internationally important under the Ramsar Convention.

Criterion	Description
1	a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
2	supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
3	supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
4	supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
5	regularly supports 20 000 or more waterbirds.
6	regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
7	supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
8	important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Use the 'Waterfowl Population Estimates':

(http://www.wetlands.org/IWC/WPE2toc.htm)

to determine population estimates of waterbirds that meet criteria of internationally important sites.

5.4.5 Habitat classification

The AWI manual is focussed on collecting the core data that may be required, amongst other things, to classify a wetland habitat. Users of the manual are entitled to use whatever classification system they prefer. However, it is strongly recommended that, in the first instance, each site is classified using the terminology provided in Table 29 by combining the landform type (Table 12) with the water regime (Table 16). If required, water chemistry (e.g. salinity), nature of the bottom materials (e.g. sand, mud, clay), and vegetation (e.g. organisation, structure and floristics) can be used at a later stage to augment the primary units defined.

TABLE 29: Classification of the 13 basic wetland categories formed by combining landform and hydroperiod attributes (after Semeniuk & Semeniuk 1995).

Hydroperiod / landform
Permanently inundated basin
Seasonally inundated basin
Intermittently inundated basin
Seasonally waterlogged basin
Permanently inundated channel
Seasonally inundated channel
Intermittently inundated channel
Seasonally waterlogged channel
Permanently inundated flat
Seasonally inundated flat
Seasonally waterlogged flat
Seasonally waterlogged slope
Seasonally waterlogged highlands

The technical basis for the abovementioned classification system proposed is widely accepted. In addition, it provides useful mapping units and highlights an important natural resource management principle, namely that of conserving each of the recognised wetland types for the sake of preserving the ecosystem diversity of a particular landscape (Semeniuk & Semeniuk 1995). The classification proposed provides a non-genetic framework on which to base further detailed work and is sufficiently robust to account for the variability of determinants such as climatic differences across the geographic regions of Asia.

Self-emergent wetlands (e.g. mound springs, some raised bogs and geothermal wetlands) are not catered for in the classification proposed above. However, such wetlands are rarely encountered.

5.4.6 Wetland goods and services

Describe the major goods and services of the wetland habitat using the information presented in Table 4 as a guide, but adding site specific details that may not have been apparent at previous levels. The goods and services derived from the habitat include products that are obtained directly from the wetland as well as some less tangible services based on social or cultural values.

5.4.7 Land and water use

Describe and, where possible, map the manner in which the habitat is used by local people noting matters such as the yield obtained from crops or fisheries; whether

wetland use is seasonal or year round; the extent of cultivated areas; the type of gear used for fishing; whether there are any social, economic or political conflicts (e.g. conversion to farmland, dam construction etc.).

Describe the land and/or water use made of the habitat by local communities by refining / expanding upon the data collated earlier at Level 3 (Table 10) noting, where appropriate, whether or not these are undertaken for subsistence or for commercial purposes and using mainly traditional or modern techniques.

5.4.8 Management issues and threats

For each habitat describe the management issues that confront local communities as users of the habitat by refining / expanding upon the data collated earlier at Level 3 (Table 11). Deliberately highlight the management practices / plans (if any) being employed / developed by agencies working in the area and record the number of people interviewed, the names and status of the informants. Similarly, where the utilisation of a wetland habitat presents risks to human health, the type of disease carrying organisms living in the wetland and the incidence of disease within the human population should also be described.

5.4.9 Monitoring and management programmes

Provide details of any existing of proposed monitoring programmes and management plans for the habitat. This includes the names of any government agencies, NGOs or other interest groups working in the area and a brief indication of the programmes active (title of project, objectives, time frame, applicability to wetland management and person(s) / organisation(s) responsible).

5.4.10 Data sheet completion

- **Name and address of compiler :** The name and address of the compiler should be stated as shown in the datasheet (Appendix C).
- **Date sheet completed / updated:** The date the data sheet was completed should be stated (e.g. 02 October 2001).

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APPENDICES

APPENDIX A

Resolutions of the San José Conference

Resolution VII.20 on wetland inventory

'People and Wetlands: The Vital Link' 7th Meeting of the Conference of the Contracting Parties to the Convention on Wetlands (Ramsar, Iran, 1971), San José, Costa Rica, 10-18 May 1999

Priorities for wetland inventory

1. RECALLING Recommendation 1.5 which called upon Contracting Parties to prepare inventories of their wetlands '*as an aid to the formulation and implementation of national wetland policies*' to assist in promoting the wise use of wetlands in their territory;

2. RECALLING ALSO Recommendation 4.6, Resolutions 5.3 and VI.12, and Action 6.1.2 of the Strategic Plan 1997-2002 which recognised the value of national scientific inventories for identifying sites suitable for inclusion in the List of Wetlands of International Importance (Ramsar List) under the Convention;

3. AWARE of Action 6.1.3 of the Strategic Plan 1997-2002 which calls upon the Ramsar Bureau and the International Organization Partners to '*utilize information from regional wetland directories, national scientific inventories of wetlands and other sources, to begin development of a quantification of global wetland resources, as baseline information for considering trends in wetland conservation or loss*';

4. NOTING the report entitled *Global review of wetland resources and priorities for wetland inventory* and its recommendations as prepared and presented by Wetlands International to Technical Session IV of this Conference, in response to Action 6.1.3 of the Strategic Plan 1997-2002;

5. APPRECIATIVE of the financial support provided for the preparation of the above report by the Governments of the Netherlands, Norway, and the United Kingdom;

6. NOTING WITH CONCERN the findings of the Wetlands International report that, based on the information gathered within the constraints of this project, few countries, if any, have comprehensive national inventories of their wetland resources, and that it is therefore not possible to provide a baseline of the world's wetland resources with any confidence;

7. RECOGNIZING the priorities for future wetland inventory, both in terms of types and regions, as identified in the report and endorsed by the Second International Conference on Wetlands and Development (Dakar, Senegal, November 1998);

8. CONSIDERING that this Conference has also adopted *Guidelines for developing and implementing National Wetlands Policies* (Resolution VII.6), the *Wetland Risk Assessment Framework* (Resolution VII.10), the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance*

(Resolution VII.11), and Resolution VII.17 on *Restoration as an element of national planning for wetland conservation and wise use*, all of which, as noted by the previous Resolutions and Recommendations referred to in paragraphs 1 and 2 above, would be greatly assisted by the availability of national scientific inventories;

9. TAKING ACCOUNT of the findings given in the report prepared by the World Conservation Monitoring Centre and presented to COP7 Technical Session IV entitled *Shared wetlands and river basins of the world*; and

10. NOTING the scope of the proposed Millenium Assessment of the World's Ecosystems, currently under development, to deliver valuable related information of relevance to the application of the Convention;

THE CONFERENCE OF THE CONTRACTING PARTIES

11. URGES all Contracting Parties yet to complete comprehensive national inventories of their wetland resources, including, where possible, wetland losses and wetlands with potential for restoration (Resolution VII.17), to give highest priority in the next triennium to the compilation of comprehensive national inventories, in order for related actions such as policy development and Ramsar site designations to be carried out with the best information possible;

12. FURTHER URGES that in undertaking inventory activities Contracting Parties give consideration to affording highest priority to those wetland types identified as at greatest risk or with poorest information in the *Global review of wetland resources and priorities for wetland inventory* report;

13. REQUESTS Contracting Parties to give consideration in their inventory activities to adopting a suitable standardised protocol for data gathering and handling, such as that provided by the Mediterranean Wetlands Initiative (MedWet), and the use of standardised low-cost and user-friendly Geographic Information System methods;

14. ENCOURAGES Contracting Parties with shared wetlands or river basins to work cooperatively in the gathering of inventory and related management information, as urged through the *Guidelines for international cooperation under the Ramsar Convention* (Resolution VII.19);

15. REQUESTS the Scientific and Technical Review Panel, in collaboration with Wetlands International, the Ramsar Bureau, and other interested organizations, to review and further develop existing models for wetland inventory and data management, including the use of remote sensing and low-cost and user-friendly geographic information systems, and to report their findings to the 8th Meeting of the Contracting Parties with a view to promoting international common standards;

16. CALLS UPON Contracting Parties to review the arrangements they have in place for housing and maintaining their wetland inventory data where it exists, and, as necessary, to seek to establish a central repository or to ensure that access to this information resource is possible for all decision-makers, stakeholders and other interested parties, where possible through the World Wide Web and CD-ROM formats;

17. ALSO ENCOURAGES Contracting Parties and other interested organizations and funding bodies to provide the resources to allow Wetlands International to complete and document suitable standardised protocols for data gathering and handling as well as a comprehensive assessment of wetland inventory information, and to develop

procedures for regularly updating this information and making it readily available through the World Wide Web and CD-ROM formats;

18. FURTHER CALLS UPON the bilateral and multilateral donors to give priority to supporting the wetland inventory projects submitted by developing countries and those in economic transition, noting, as urged above, the desirability of such projects being undertaken; and

19. DIRECTS the Standing Committee to give special attention to appropriate wetland inventory projects in its consideration of projects submitted to the Ramsar Small Grants Fund.

APPENDIX B

Ramsar classification of wetland types

(Source: Ramsar Convention Bureau : (http://www.ramsar.org/key_ris_types.htm)

Marine/Coastal Wetlands

A -- **Permanent shallow marine waters** in most cases less than six metres deep at low tide; includes sea bays and straits.

B -- **Marine subtidal aquatic beds**; includes kelp beds, sea-grass beds, tropical marine meadows.

C -- **Coral reefs**.

D -- **Rocky marine shores**; includes rocky offshore islands, sea cliffs.

E -- **Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

F -- **Estuarine waters**; permanent water of estuaries and estuarine systems of deltas.

G -- **Intertidal mud, sand or salt flats**.

H -- **Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.

I -- **Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.

J -- **Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea.

K -- **Coastal freshwater lagoons**; includes freshwater delta lagoons.

Zk(a) – **Karst and other subterranean hydrological systems**, marine/coastal

Inland Wetlands

L -- **Permanent inland deltas**.

M -- **Permanent rivers/streams/creeks**; includes waterfalls.

N -- **Seasonal/intermittent/irregular rivers/streams/creeks**.

O -- **Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes.

P -- **Seasonal/intermittent freshwater lakes** (over 8 ha); includes floodplain lakes.

Q -- **Permanent saline/brackish/alkaline lakes**.

R -- **Seasonal/intermittent saline/brackish/alkaline lakes and flats**.

Sp -- **Permanent saline/brackish/alkaline marshes/pools**.

Ss -- **Seasonal/intermittent saline/brackish/alkaline marshes/pools**.

Tp -- **Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.

Ts -- **Seasonal/intermittent freshwater marshes/pools** on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

U -- **Non-forested peatlands**; includes shrub or open bogs, swamps, fens.

Va -- **Alpine wetlands**; includes alpine meadows, temporary waters from snowmelt.

Vt -- **Tundra wetlands**; includes tundra pools, temporary waters from snowmelt.

W -- **Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.

Xf -- **Freshwater, tree-dominated wetlands**; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.

Xp -- **Forested peatlands**; peatswamp forests.

Y -- **Freshwater springs; oases**.

Zg -- **Geothermal wetlands**

Zk(b) – **Karst and other subterranean hydrological systems**, inland

Human-made wetlands

1 -- **Aquaculture** (e.g., fish/shrimp) **ponds**

2 -- **Ponds**; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).

3 -- **Irrigated land**; includes irrigation channels and rice fields.

4 -- **Seasonally flooded agricultural land** (including intensively managed or grazed wet meadow or pasture).

5 -- **Salt exploitation sites**; salt pans, salines, etc.

6 -- **Water storage areas**; reservoirs/barrages/dams/impoundments (generally over 8 ha).

7 -- **Excavations**; gravel/brick/clay pits; borrow pits, mining pools.

8 -- **Wastewater treatment areas**; sewage farms, settling ponds, oxidation basins, etc.

9 -- **Canals and drainage channels, ditches**.

Zk(c) – **Karst and other subterranean hydrological systems**, human-made

APPENDIX C

Names and proposed codes of the major river basins, coastal regions and islands of Asia to be read in conjunction with **Fig 2**. Where known, the size and population density of the basin, coastal region or island is given. Names of major islands appear in *italics*. Codes for coastal regions need to be added.

(Data sources : WRI; The Times Atlas of the World; PNG Resources Information System (ANU); Lonely Planet website; MSN website; Wood et al 2000; K Tagi pers. comm.).

Name of river basin / *major island*	**Code**	**Size (km^2)**	**Population density (per km^2)**
Amur	Am	1 929 981	35
Amu Darya	AD	534 764	33
Borneo	BO	745 561	n/r
Brahmaputra	Bm	651 334	174
Chiang Jiang (Yangtze)	CJ	1 722 155	224
Chao Phyra	CP	178 754	118
Don	Do	458 703	48
Dnieper	Dn	531 817	67
East Timor	ET	153 870	5
Ganges	Ga	1 016 104	375
Godavari	Gd	319 808	195
Hainan	Hn	34 000	50
Halmahera	Ha	n/r	n/r
Hokkaido	Hk	78 073	72
Hong (Red)	Ho	170 977	180
Honshu	Hs	227 414	757
Huang He	Hh	945 065	162
Indigirka	Id	274 818	<1
Indus	In	1 081 733	145
Irrawaddy	Ir	413 674	80
Java	Ja	132 188	907
Kolyma	Ko	679 908	<1
Krishna	Ks	226 026	248

Kura - Araks	KA	205 040	72
Kuril archipelago	Ku	15 590	n/r
Kyushu	Ky	36 728	361
Lena - Viljuj	LV	2 306 772	1
Luzon and Mindoro (Philippines)	Lm	114 935	202 *
Ob - Irtysh	OI	2 972 497	9
Ozero (lake) Balkhash	OB	512 010	11
Mekong	Me	805 627	78
Mindanao (Philippines)	Md	94 630	202 *
Mahanadi	Mh	145 818	192
Narmada	Nm	96 260	192
Neva	Ne	204 467	35
New Britain	Nb	35 862	11
New Guinea	NG	824 931	8
North Dvina	ND	357 052	5
Sakhalin	Sa	76 400	n/r
Salween	Sw	271 866	76
Seram	Se	17 100	n/r
Sri Lanka	SL	65 610	n/r
Sulawesi (Celebes)	Sw	189 216	75
Sumatera (Sumatra)	Su	473 606	n/r
Syr Darya	SD	782 669	26
Taiwan	Tw	35 873	627
Tapti	Tp	74 620	233
Tarim	Ta	1 152 447	10
Tigris and Euphrates	TE	765 831	58
Ural	Ur	224 280	13
Visayas archipelago (Philippines)	Vs	65 044	202 *
Volga	Vo	1 410 994	42
Yalu Jiang	Yj	48 328	117
Yenisey–OzeroBaykal (Lake Baikal)	YB	2 554 482	2
Xi Jiang (Pearl)	XJ	409 458	210

n/r = no record

***** = national average for Philippines (Wood et al 2000)

APPENDIX D

LEVEL 1 DATA SHEET — MAJOR RIVER BASINS, COASTAL REGIONS AND ISLANDS

1. Name and code of major river basin, coastal region or major island

Name:

Code:

2. Geology

Name of geological zone(s):

Free text description of geology:

Source of information:

3. Climate

Name / code of climate class (Koeppen classification):

Free text description of climate:

Source of information:

4. Ecoregion

Name of ecoregion(s):

Free text description of ecoregion:

Source of information:

5. Vegetation

Name of vegetation zone(s):

Free text description of vegetation:

Source of information:

6. Wetland area and type

List of wetland types:

Free text description of wetland area and type:

Source of information:

7. Wetland goods and services

List of goods and services:

Free text description of goods and services:

Source of information:

8. Management issues and threats

Free text description of management issues and threats:

Source of information:

9. Data sheet completion

- Name and address of compiler:

Family name:

Other names:

Title (Ms, Mrs, Mr, Dr or Professor) : Institute/Agency/Organisation:

Postal address (street name and number, town/city, country, postal code):

Telephone number (country code, local code, number):

Fax number (country code, local code, number):

Email address:

- Date sheet completed / updated:

APPENDIX E

LEVEL 2 DATA SHEET — SUB-BASINS AND COASTAL SUB-REGIONS

1. Name and code of sub-basin or coastal sub-region

Name:

Code:

2. Geographic location

Geographical co-ordinates:

- latitude of most northern and southern point:
- longitude of most eastern and western point:
- centroid:

Source and date of information:

3. Climatic characteristics

Name of climate sub-class (Koeppen classification):

- Annual precipitation - average and range (mm):
- Air temperatures - average and range (^{o}C):
- Official name and location of recording station:

Free text description of climate:

Source of and date information:

4. Physical features

4.1 **Type of region:** (sub-basin; coastal region; aggregation of coastal islands)

4.2 **Altitudinal range:** (max / min – in m AHD)

Free text description of elevation:

Source of information:

4.3 **Wetland area and type:** (size class; area in km^2; proportion of region (%); length in km; stream order)

Free text description or wetland area and type:

Source of information:

4.4 **Geological characteristics**

List of geological features:

Free text description of geology:

Source of information:

4.5 **Water regime**

Mean annual runoff ($m^3 x\ 10^6$):

Tidal range (if applicable):

Free text description of hydrology:

Source of information:

5. Vegetation

List of vegetation types:

Free text description of vegetation:

Source of information:

6. Wetland goods and services

Categories of wetland goods and services and relative importance:

Free text description of wetland goods and services:

Source of information:

7. Management issues and threats

Categories of proximate drivers and relative importance:

Free text description of proximate drivers:

Source of information:

8. Jurisdiction

National or local:

Ownership (public or private):

Source of information:

9. Data sheet completion

- Name and address of compiler:
- Date sheet compiled / updated:

APPENDIX F

LEVEL 3 DATA SHEET — WETLAND COMPLEXES

1. Name and code of wetland complex

Name:

Code:

2. Geographic location

- Latitude: most northern and southern points
- Longitude: most eastern and western points
- Centroid:
- Projection:

Source and date of information:

3. Climatic characteristics

Official name and location of recording station: (name, lat. and long. & altitude)

- Period of record (years):
- Average and range of annual rainfall (mm):
- Range of max – min monthly temperatures (^{o}C):
- Range of relative humidity (9am and 3pm):
- Range of annual ClassA pan evaporation (mm):
- Prevailing winds:

Free text description of climate:

Source of information:

4. Ecological Character

4.1 Physical features

4.1.1 Altitudinal range

- Max – min (m above AHD):

Free text description:

Source of information:

4.1.2 Spatial

- Area (in km^2):

Free text description:

Source of information:

4.1.3 Current, waves and sediment movement

- Wave regime:
- Wind regime:
- Direction of littoral drift:
- Position & shape of inlets, shoals and sandspits:

Free text description:

Source of information:

4.1.4 Erosional status

Status (eroding, accreting or stable):

4.1.5 Soil types

- List soil categories:

Free text description:

Source of information:

4.1.6 Water regime

- For coastal systems: tidal range (micro-;meso-; macro- tidal)
- For inland systems: mean annual run-off (cumecs); length of rivers and streams; stream order differentiation

Free text description:

Source of information:

4.1.7 Groundwater

- Max – min depth of water table:
- Sources of inflows: (artesian; aquifers)

Free text description:

Source of information:

4.2 Physico-chemical features

4.2.1 Water quality

- Levels of contamination: (neglible, intermediate, high)

Free text description: (sources of nutrients, acidification or salinisation and impact of wastewater discharges)

Source of information:

- Levels of sedimentation: (neglible, intermediate, high)

Free text description: (sediment sources)

Source of information:

4.3 Biological features

4.3.1 Biological condition

Free text description: relative proportions of vegetation cover (%); trends in status / condition of vegetation; trends in fauna populations.

Source of information:

4.3.2 Species and associations of biological significance

Assessment of biological significance (using WWF and IUCN data):

Free text description:

Source of information:

4.3.3 Habitat(s)

List of habitat types:

Free text description:

Source of information / habitat classification:

5. Population demographics

Numbers of people (population density):

Major activities:

Free text description of population features and activities in complex:

Source of information:

6. Land and water use

List land and water uses:

Free text description major land and water uses:

Source of information:

7. Jurisdiction

Free text description jurisdiction and ownership of complex:

Source of information:

8. Management issues and threats

List management issues and threats:

Free text description of management issues and threats:

Source of information:

9. Data sheet completion

- Name and address of compiler:
- Date sheet compiled / updated:

APPENDIX G

LEVEL 4 DATA SHEET — WETLAND HABITATS

1. Name and code of wetland habitat

Name:

Code:

2. Geographic location

- Latitude: most northern and southern points:
- Longitude: most eastern and western points:
- Centroid:
- Projection:

Source and date of information:

3. Climatic characteristics

Official name and location of recording station:

- Period of record (years):
- Average and range of annual rainfall (mm):
- Range of max – min monthly temperatures (^{o}C):
- Range of relative humidity (9am and 3pm):
- Range of annual ClassA pan evaporation (mm):
- Prevailing winds:

Free text description of climate:

Source of information:

4. Ecological character

4.1 Physical features

4.1.1 Geomorphic setting

- Inland setting: (basin; channel; flat; slope; or highland)
- Coastal setting: (low-lying; steep)

Free text description:

Source of information:

4.1.2 Altitudinal range

- Max – min (m above AHD):

Free text description:

Source of information:

4.1.3 Spatial

- Area (in ha/km^2):
- Size class: (very small; small; medium; large; very large)
- Length (m/km):
- Width (m/km):

Free text description:

Source of information:

4.1.4 Basin morphology

- **Bathymetry:** (average and range of water depth)

Free text description:

Source of information:

- **Inlet stability:** (mouth condition, position & width; evidence of ebb- or flood-tide deltas; height & width of sandbar……)

Free text description:

Source of information:

4.1.5 Current, waves and sediment movement: (wave regime; wind regime; direction of littoral drift; position & shape of inlets, shoals and sandspits …):

Free text description:

Source of information:

- Erosional status: (eroding, accreting or stable)

4.1.6 Soil types

List of soil types:

Free text description:

Source of information:

4.1.7 Bottom sediments / substrata

Substrate class: (stony, coarse sand, fine sand, muddy sand, sandy mud, silt, silty clay, clay, peat, ooze)

Free text description:

Source of information:

4.1.8 Water regime

- For coastal systems: Range of both spring and neap tides.
- For inland systems: Hydroperiod (permanently inundated; seasonally inundated; intermittently inundated; seasonally waterlogged)

Inflow sources: (streamflow; overland; rainfall; groundwater)

Outflow sources: (permanent, seasonal, intermittent; episodic or none)

Free text description:

Source of information:

4.1.9 Groundwater

- Max – min depth of water table:
- Sources of inflows: (artesian; aquifers)

Free text description:

Source of information:

4.2 Physico-chemical features

4.2.1 Surface waters

- **Temperature**

Annual range of surface water temperature & average temperature: (^{o}C)

Recording station(s), depth and time of measurements:

Thermal classification: (amictic; oligomictic; monomictic; dimictic; polymictic)

Free text description:

Source of information:

- **Salinity**

Min - max and seasonal range:

Salinity classification: (fresh; brackish; semi-saline; saline; hypersaline; ultrasaline)

Recording station(s), depth and time of measurements:

Free text description:

Source of information:

- **pH**

Annual range:

Recording station(s), depth and time of measurements:

pH classification: (strongly acidic; acidic; weakly acidic; neutral; weakly alkaline; alkaline; strongly alkaline)

Free text description:

Source of information:

- **Transparency**

Annual range:

Recording station(s), depth and time of measurements:

Transparency classification: (opaque; very turbid; turbid; clear; very clear)

Free text description:

Source of information:

- **Nutrients**

Annual range of N (total N & nitrate): (μ gm/l)

Annual range of P (total P & ortho-P): (μ gm/l)

Recording station(s), depth and time of measurements:

Nutrient status classification: (ultra-oligotrophic; oligo-trophic; meso-eutrophic; eutrophic; hyper-eutrophic).

Free text description:

Source of information:

4.2.2 Groundwater

Free text description of chemical composition:

Source of information:

4.3 Biological features

4.3.1 Vegetation

- **Dominant assemblages**

List major vegetation assemblages:

Free text description of vegetation assemblages: (extent (ha), proportion of wetland area (%); physical / hydrological setting, stable state)

Source of information:

- **Dominant species**

List of species: (showing growth strategy, growth form and structural type)

Free text description of major features:

Source of information:

- **Alien invasive species and environmental weeds**

List of invasive species and environmental weeds:

Free text description (with cover estimates):

Source of information:

- **Species and assemblages of conservation significance**

List of species and assemblages of conservation significance (with information on status, level, legislation applicable):

Free text description:

Source of information:

- **Vegetation cover**

Relative proportions of vegetation cover (peripheral; mosaic or complete): %

Free text description:

Source of information:

4.3.2 Fauna

- **Dominant assemblages and species**

List of dominant assemblages and species:

Free text description of major features: (using species composition and species richness data for major invertebrate and vertebrate assemblages).

Source of information:

- **Species of conservation significance**

List of species of conservation significance: (with indication of whether endangered, vulnerable or rare)

Free text description:

Source of information:

- **Populations**

List of population abundance data:

Free text description: (key species, largest concentrations, breeding populations, key migration periods)

Source of information:

- **Alien invasive and vermin/pest species**

List of invasive and/or vermin / pest species:

Free text description:

Source of information:

4.3.3 Habitats

List of major habitats: (key taxa associated with each habitat, available information)

Free text description:

Source of information:

4.3.4 Biological significance of habitat

Assessment of biological significance of habitat(s) using Ramsar criteria:

Free text description:

Source of information:

5. Habitat classification

Wetland type: (permanently, seasonally or intermittently inundated basin; seasonally waterlogged basin; permanently, seasonally or intermittently inundated channel; seasonally waterlogged channel; permanently or seasonally inundated flat; seasonally waterlogged flat, slope or highland).

Free text description of habitats:

Source of information:

6. Wetland goods and services

List of wetland goods and services:

Free text description of goods and services provided by habitat:

Source of information:

7. Land and water use

List of habitat associated land and water uses:

Free text description major land and water uses:

Source of information:

8. Management issues and threats

List of management issues and threats:

Free text description of management issues and threats:

Source of information:

9. Monitoring and management programmes

List of monitoring programmes:

Free text description of organisations / persons and projects involved:

Source of information:

10. Data sheet completion

- Name and address of compiler:
- Date sheet compiled / updated:

Wetlands International

Wetlands International is a wetland conservation organisation, with offices in 16 countries and over 40 years of experience in wetland conservation activities. Its mission is to sustain and restore wetlands, their resources and bio-diversity for future generations through research, information exchange and conservation activities worldwide.

A major part of the acitivies of Wetlands International focuses on raising awareness through publications, the internet www.wetlands.org and other media. This means targeting policy developers and decision-makers in particular, then assisting in policy building, capacity building, and training.

As millions of people depend on the continued existence of wetlands, and ignorance of their importance is still leading to world-wide depletion, it is in everbody's interests that as much sound scientific information as possible is made available. This not only serves as a basis for developing national and international policies but also provides detailed technical information that can be used at the community level to support conservation activities such as wetland restoration. Wetlands International not only provides valuable information, it also assists on a practical level by providing training programmes and helping to implement and manage the projects that are developed. This extensive work can only be carried out in partnership with other organisations.

National Centre for Tropical Wetland Research (NCTWR)

The National Centre for Tropical Wetland Research (*NCTWR*), based in Darwin in northern Australia, is an initiative announced by the Australian Government to develop collaborative research and training programs related to tropical wetlands.

The following partner organisations form the *NCTWR* alliance:

- Environmental Research Institute of the Supervising Scientist
- James Cook University
- Northern Territory University, and
- The University of Western Australia

The mission of the National Centre for Tropical Wetland Research is to promote the wise use of tropical wetlands. This is achieved through comprehensive research and training programs and effective communication with all stakeholders.

Contact Information:
National Centre for Tropical Wetland Research, c/o Environmental Research Institute of the Supervising Scientist, GPO Box 461, Darwin, NT, 0801, Australia www.nctwr.org.au

Mission:

To sustain and restore wetlands, their resources and biodiversity for future generations through research, information exchange and conservation activities, worldwide.

A standardised protocol for wetland inventory has been developed through the Asian Wetland Inventory (**AWI**) in order to provide an information resource for the assessment and monitoring of wetlands. It builds on past inventory protocols that have been successfully developed. It has also provided support for the development of the proposed Ramsar Inventory Protocol. The main results to be achieved through this programme are:

- Increased awareness of the importance of wetlands and the need for a standardised inventory among relevant national government agencies across Asia.
- A dynamic and standardised Geographical Information System (GIS) and integrated relational database that can provide core data / information on Asian wetlands to guide and support planning and conservation efforts by national governments, International Conventions, NGOs and others.
- A strengthened network of personnel trained in data collection techniques and skills for implementation of the **AWI** at national and local level.
- Established national inventory programmes and databases in all participating nations.
- Established network of regional training programmes in wetland inventory.
- A monitoring programme for regular revision and updating information on wetlands of national and international importance in Asia.

http://www.wetlands.org/awi/

WETLANDS INTERNATIONAL

Further Information:

Wetlands International
3A39, Block A, Kelana Centre Point
47301 Petaling Jaya, Selangor
Malaysia
Tel: +60-3-7804-6770
Fax: +60-3-7804-6772
Email: alvin@wiap.nasionet.net

Wetlands International - Japan
402-Axes Nishishinjuku
8-5-3 Nishishinjuku Shinjuku-Ku
Tokyo 160-0023
Japan
Tel: +81-3-5332-3362
Fax: +81-3-5332-3364
Email: wijp@t3.rim.or.jp

Wetland Inventory & Monitoring Specialist Group
C/- NCTWR, PO Box 461
Darwin
NT 0801 Australia
Tel: +61-8-8920-1100
Fax: +61-8-8920-1199
Email: Max.Finlayson@ea.gov.au

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