1 Introduction

The water resources of the greater Himalayan region are under mounting pressure from the demands of growing populations and economies, and also from the ever-more evident impact of climate change. Wetlands are ecologically critical water resources found in a broad range of categories within various landforms throughout the greater Himalayan region. Himalayan wetlands[1] such as lakes, marshes, peatlands, wet grasslands, streams, glacial lakes, and rivers provide many important ecological functions and services to sustain livelihoods in the mountains as well as in the populous and economically and agriculturally valuable areas downstream.

Wetlands, including high altitude wetlands (HAWs), contribute to flow-regulation in major river systems like the Amu Darya, Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Salween, Tarim, Yangtze, and Yellow. Wetlands support high biological and cultural diversity: they are important staging points for migratory birds and many are breeding and nursery places for birds, fish, and amphibians. Wetlands store water, feed groundwater aquifers, trap sediments, and recycle nutrients, thereby enhancing both the quantity and quality of water in the water cycle. Wetlands also foster vegetation growth, which lessens soil erosion, and thus contribute to reduction of risk of disasters by landslides and floods. The land and water stabilising qualities of wetlands are often overlooked.

Sustainable development practice in general should include sound wetland management in order to maximise water-resource integrity, and this is particularly important in mountain areas where water loss is a constant challenge. The wetlands in the Himalayan region often do not receive appropriate recognition and hence are poorly documented. Figure 1 indicates the influence of Himalayan river water on the vast land areas where millions of people make their livelihoods.

Himalayan wetlands are extremely vulnerable to a wide range of human and environmentally-driven threats, including overgrazing by livestock, water diversion for agriculture and human use, increasing pollution due to change in lifestyle of the local inhabitants, and increased tourism. Climate change and variability will dramatically affect wetlands and the provision of their services, as the water cycle on which these wetlands depend will change.

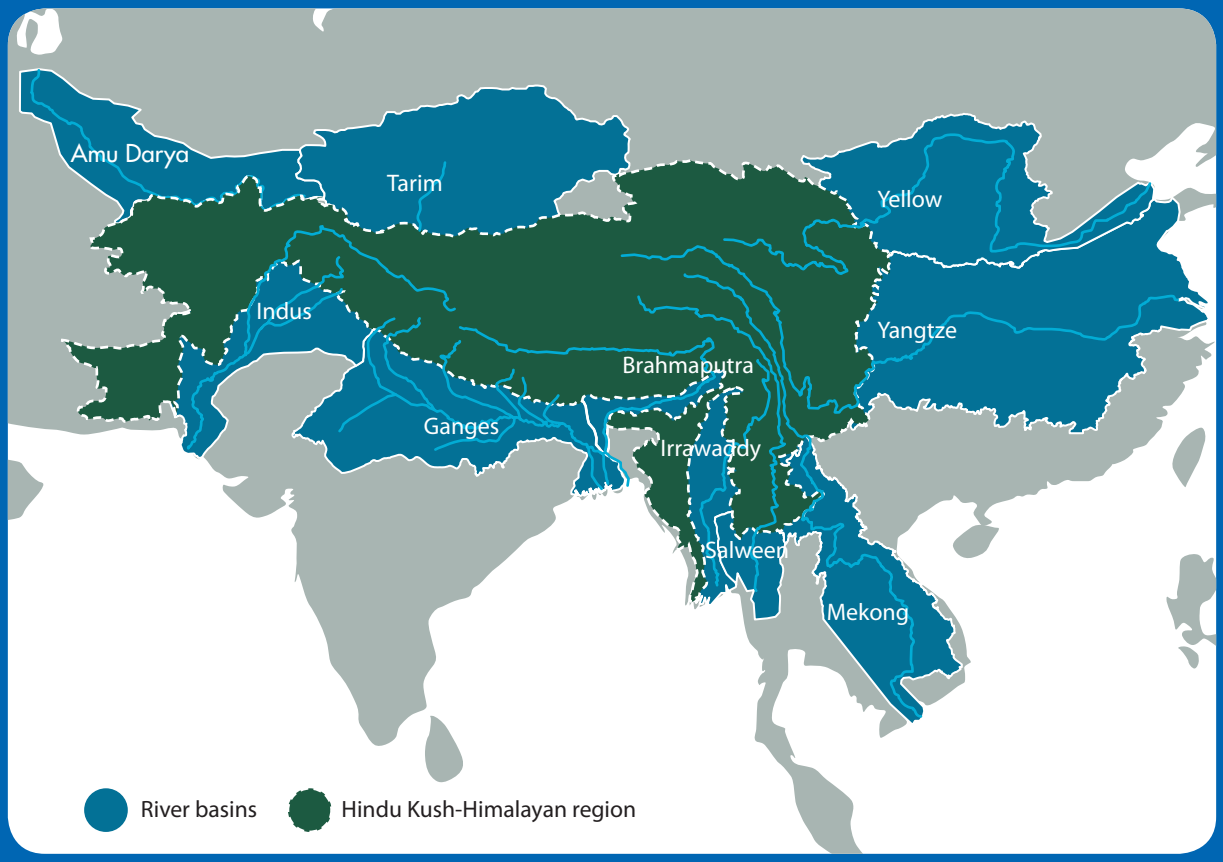
A significant aspect of Himalayan water resources, including for wetlands, is the great variation in altitude, terrain, and water location throughout the mountains, and the occurrence of high altitude wetlands. Ongoing climate change effects with melting of the ice of Himalayan glaciers are documented and show an alarming trend in glacier retreat and formation/expansion of glacial lakes (Bajracharya et al. 2007). A baseline study conducted between 1999 and 2003 reported about 15,000 glaciers and 9,000 glacial lakes in Bhutan, Nepal, Pakistan, and selected basins of China and India (Mool et al. 2005). Increased volumes of meltwater constitute threats to people's lives and livelihoods through flooding and landslides. Increased air and water temperatures also bring risks of changes in the quality of standing water, with lower salinity and increased photosynthesis and a change in biota (WWF 2006).

These factors constitute a special situation for the Himalayan wetlands, and specifically for HAWs. While wetlands in general have productive and protective functions and services, some HAWs have the potential to cause catastrophic damage to people and the landscapes they live in. These are the glacial lakes formed from melting glacier ice. The rising temperatures from global warming have now been melting mountain glaciers for some 40-50 years – a 'recent' phenomenon in our modern history. This is happening in mountains all over the globe and the resulting increase of glacier meltwater equates to an increase in the threat of glacial lake outburst floods (GLOFs). These can occur when the build up of meltwater breaks through the lake edge, resulting in destructive torrents and floods in downstream areas.

The potential negative effects on the ecology and economy of the Himalayan countries through changes to the mountains' water resources are serious and should prompt governments to immediately initiate remedial action programmes, should these not already be underway. This should be done at both national and regional levels. The transboundary nature of Himalayan rivers and some high altitude wetlands will require collaborative efforts between countries in the region, to achieve sustainable and effective management of wetlands and water ecosystems.

[1] *For the purpose of this document, 'Himalayan wetlands' indicates wetlands located within the greater Himalayan region (the Himalayan - Hindu Kush - Pamir-Alay region).*

Figure 1: **Overview of the major river basins of the greater Himalayan region**



There is an urgent need for management action that supports both conservation and wise use of the wetlands important for landscape productivity, and that supports risk reduction from potential GLOFs and other natural disasters. The first step towards achieving this is to establish wetland location, type, and character through an inventory system, and to build baseline information on their physical status and their ecological functions and services. Without baseline information, it is not possible to develop strategies to counter threats to Himalayan water resources and biodiversity. Neither can targeted actions be implemented in a systematic and prioritised way in the field.

The recognition of the ecological significance of wetlands led to the establishment in 1971 of the Ramsar Convention (The Ramsar Convention on Wetlands, Ramsar, Iran, 1971) as a leading framework for their conservation and sustainable use. Among the ICIMOD member countries in the greater Himalayan region, all except Afghanistan and Bhutan are currently (July 2008) Contracting Parties to the Convention. Afghanistan is already in the process for accession to become a contracting party and Bhutan has initiated dialogue for the same. As the leading framework for global technical knowledge transfer and national institutional strengthening concerning conservation and the sustainable use of wetlands, the Ramsar Convention provides overall support to the concept of the Greater Himalayan Wetlands Inventory (GHWI) and this Manual. Ramsar also provides substantial support to wetland inventory methodology through Convention Resolutions (see Annex 1). Decisions concerning the conservation, management, and wise use of wetlands should be made on the basis of reliable knowledge on wetland ecosystems, and wetland inventories can provide the crucial initial information (Dugan 1990, Finlayson 1996). The Ramsar Convention encourages its contracting parties to undertake efficient wetland inventories, particularly to identify all sites that meet the criteria for selecting wetlands of international importance.

In order to distinguish wetland inventory activities in the Himalayan region from other places, the term Greater Himalayan Wetlands Inventory (GHWI) will be used from now on in this Manual. The implementation partnership of ICIMOD and Wetlands International in the 'Support for the conservation of high altitude wetlands through application of the Asian Wetlands Inventory approach and stakeholder-led catchment management in Bhutan, China, India and Nepal' project enabled a seamless basis for the GHWI to adopt the Asian Wetland Inventory (AWI) developed by Wetlands International.

The key feature of the AWI approach is the use of a hierarchical, map-based approach to define the most appropriate land and resource management units at four levels of detail, from river basin to wetland habitat, that are related to the scale of the maps and contained within a standardised GIS (geographic information system) format. River basins or river catchments are important geographical units for wetland management. Wetlands are distributed from the top of the catchment to the deltas at the catchment-bottom, indicating clearly the network and interdependence of water resources. The interconnected nature of river systems highlights the fact that successful water management requires the adoption of an approach which helps to avoid the problems associated with isolated and often short-sighted use of water and land resources in one area, which often have adverse impacts elsewhere within the river basin. The hierarchical wetland inventory approach allows for strategic collection of information at these different geographical scales (see Chapter 3) within a river basin and, furthermore, provides a framework for considering individual habitats and sites within and outside of established jurisdictional boundaries. This promotes better planning for development and conservation of wetlands at national and sub-regional (transboundary) levels throughout the region.

It is in the context of the scenario described above that this GHWI Manual has been developed. The objective is to contribute to the conservation and management of greater Himalayan wetlands by providing countries with an easily accessible tool for collecting data which can be used as a base for informed management decisions, for example decisions on ensuring sustainable use of wetland benefits and on taking preventive action to avoid damage from GLOFs.

The GHWI Manual covers a broad range of inventory techniques and includes high-level technical aspects of remote sensing analysis. However, it is emphasised that the Manual should be used at the level that is appropriate for the users' capacity. It is important to collect as much wetland information as possible. Therefore, all categories of field officers and remote sensing analysts are encouraged to use the GHWI Manual to their ability, and to share their experiences with each other and other colleagues in the region.

The main users of the GHWI Manual are presumed to be line agency department heads and technical officers from land-use planning, agriculture, forestry, fishery, wildlife, and protected areas and water resources management, and their project partner organisations (bilateral, international, and non-government organisations, and others). Although one line agency would usually have the formal mandate for wetland management and be considered a 'lead agency', global wetland management experience has shown that a multi-disciplinary approach has many technical, field, and data management benefits. In this, the Ramsar authorities in each member country have important roles to play in coordination and support.

It is hoped that professionals such as lecturers, teachers, and technical advisers, working in such fields as biodiversity research and conservation, environmental sciences, geography, geology, and development assistance environment-oriented projects, will also contribute to achieving the aims of fulfilling their countries' wetland inventory needs. Moreover, there are many people in the ranks of civil society who can contribute to achieving a national wetland inventory. Keen amateur birdwatchers, entomologists, herpetologists, botanists, geologists, and so on can play a significant role in wetland inventory and wetland management and contribute to full wetland inventory coverage in the member states of the greater Himalayan region.

Global experience has shown the importance of including local knowledge in wetland inventories and it is strongly emphasised that local community members should be involved from the beginning as team members of wetland inventory in the greater Himalayan region. The methods described in the GHWI Manual provide guidelines for a full inventory at a high technical level. However, important information on the status of wetlands can be collected with simple means through field observations and local people's knowledge, should the capacity of the user not fully meet the relatively high technical requirements presented in this manual.

The structure of the Manual is as follows. The main text is preceded by this Introduction (Chapter 1) and a description of the Aims (Chapter 2), the Methods (Chapter 3), and the Information Management System developed for the Inventory (Chapter 4). The chief body of text is comprised of the step-by-step guidelines for data collection at each level of the wetland inventory hierarchy, Level 1 (river basin) to Level 4 (wetland habitats), which is presented in four sections in Chapter 5. Data-collection sheets for each level are presented in Annex 2. Reading the sections in Chapter 5 with the corresponding data sheet example at hand should enable a good understanding of the various data collections proposed in this Manual for each level.