Research Report 2014/3

ICIMOD 30

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An Integrated Assessment of the Effects of Natural and Human Disturbances on a Wetland Ecosystem

A Retrospective from the Koshi Tappu Wildlife Reserve, Nepal

United Nations Decade on Biodiversity

An Integrated Assessment of Effects of Natural and Human Disturbances on a Wetland Ecosystem

A Retrospective from the Koshi Tappu Wildlife Reserve, Nepal

International Centre for Integrated Mountain Development (ICIMOD)
Kathmandu, Nepal

and

Ministry of Forests and Soil Conservation
Government of Nepal, Kathmandu, Nepal

International Centre for Integrated Mountain Development, Nepal, August 2014

Published by

International Centre for Integrated Mountain Development, GPO Box 3226, Kathmandu, Nepal

ISBN 978 92 9115 317 6 (printed)

978 92 9115 318 3 (electronic)

Library of Congress Control Number 2014–347285

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Photos: All photos by Nabin Baral

Printed and bound in Nepal by

Quality Printers (P) Ltd., Kathmandu, Nepal

This publication is available in electronic form at www.icimod.org/himaldoc

Citation: ICIMOD; MoFSC (2014) *An integrated assessment of the effects of natural and human disturbances on a wetland ecosystem: A retrospective from the Koshi Tappu Wildlife Reserve, Nepal.* Kathmandu: ICIMOD

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Table of Contents

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The Koshi Tappu Wildlife Reserve (KTWR) is one of the most important protected areas for conservation of wetland ecosystems in Nepal. It is a critical habitat for many wetland migratory bird species and a number of globally significant species including the wild water buffalo. In order to protect this wetland ecosystem with its rich biodiversity, the Government of Nepal established the KTWR in 1976. The Reserve's Buffer Zone was established in 2004 to promote a more participatory approach to biodiversity conservation. In December 1987, the Reserve was designated as a Ramsar Site in recognition of its global importance.

These ecosystems are prime habitat for a number of wildlife and a source of ecosystem services to the local people. However, the Reserve faces a number of conservation and development challenges because of the anthropogenic and natural factors such as land use change and climate change. Government and other stakeholder organizations have been promoting integrated conservation and development programmes to reduce the human pressure on resources as well as improve the livelihood of the people. The Ministry of Forests and Soil Conservation (MOFSC) addressed some of these conservation and development related issues through Conservation and Sustainable Use of Wetlands in Nepal (CSUWN) programme.

This publication is an outcome of the efforts of MOFSC, ICIMOD and other stakeholders. The document provides an in-depth assessment of the socio-economic and ecological features of the Reserve, the drivers of change, and their impacts on biodiversity, ecosystem and ecosystem services, people and their livelihoods. This could be an important knowledge base for the Reserve and will contribute towards developing conservation priorities and actions for KTWR in a holistic manner.

The MOFSC appreciates the collaborative efforts of all the partners including ICIMOD, academic institutions, local communities and other stakeholder organizations and individuals and would like to thank all of them for their contribution in bringing out this publication.

Ganesh R. Joshi

Ganesh Raj Joshi, PhD
Secretary

Preface

The Koshi Tappu Wildlife Reserve, located at the foothills of eastern Nepal, was established as category IV protected area of the International Union for the Conservation of Nature (IUCN) in 1976, and as a Ramsar site in 1987. The reserve's ecosystem is rich in biodiversity and provides habitat for globally threatened species such as the wild water buffalo (*Bubalis bubalis*), Gangetic gharial (*Gavialis gangeticus*), Gangetic dolphin (*Platanista gangetica*), swamp partridge (*Francolinus gularis*), and Bengal florican (*Houbaropsis benghalensis*).

Some of the issues highlighted in this report pose prominent threats to the reserve's unique ecosystems and biodiversity. In particular, natural resource dependency and pressure from the communities living in the surrounding villages and changes in key ecosystems (such as forests and wetlands) due to river course change bring challenges for conservation and development.

The majority of people living in the buffer zones are poor, and thus are more dependent on the ecosystem. In recent years, the management has regulated access to the reserve to minimize human pressure, which otherwise was having a negative impact on the reserve.

Recognizing the need for a holistic approach to conservation, the Ministry of Forests and Soil Conservation (MoFSC) and the International Centre for Integrated Mountain Development (ICIMOD) worked together with others to develop this report. The report is based on interdisciplinary research on various drivers of change, such as land use and land cover change and climate change; the state of ecosystems, biodiversity, ecosystem services; and people's vulnerability. We greatly appreciate this collabourative effort to create a timely resource for action.

The study uses an integrated research framework that highlights the importance of both natural and social sciences for interpreting changes on the ground and understanding the vulnerabilities of ecosystems and communities so as to identify effective climate change responses. The report can be of great help in designing and implementing integrated and holistic programmes while improving the reserve management plan, fostering economic development, and increasing the socioeconomic resilience of the surrounding communities.

On behalf of ICIMOD, I would like to thank all the partners, teams, and individuals who contributed to this publication, including the MacArthur Foundation, which made this collaborative research possible.

David Molden, PhD
Director General, ICIMOD

Acknowledgements

We express our gratitude to Dr David Molden, Director General of ICIMOD, for his inspiration and for providing the required facilities. We are also thankful to Dr Ganesh Raj Joshi, Secretary and Mr Krishna Prasad Acharya, Joint Secretary, Ministry of Forests and Soil Conservation, Government of Nepal for their support. We would also like to thank Dr Yi Shaoliang, Dr Rajan Kotru, Dr Janita Gurung and Dr Zhang Xiaohong for their valuable review and suggestions to strengthen the publication. This publication was possible thanks to the untiring efforts of the team of professionals from ICIMOD, Conservation and Sustainable Use of Wetlands in Nepal (CSUWN), and others mentioned in the list of contributors. We would like to thank the Department of Meteorology for contributing the observed data from Phatepur and Barmajhiya. We also greatly appreciate the financial support received for this analysis from the MacArthur Foundation, Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Acronyms and Abbreviations

APEC	Association for Protection of Environment and Culture
BCN	Bird Conservation Nepal
BZCFUG	Buffer Zone Community Forest User Group
BZMC	Buffer Zone Management Committee
BZUC	Buffer Zone User Committee
BZUG	Buffer Zone User Group
CFUG	Community forest users group
CITES	Convention on International Trade in Endangered Species in Wild Fauna and Flora
CSI	Carbon Sequestration Index
CSUWN	Conservation and Sustainable Use of Wetlands in Nepal
ETM	Enhanced Thematic Mapper
GCM	General Circulation Models
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
KODEF	Nepal - Koshi Development Foundation-Nepal
KERP	Koshi Early Recovery Project
KVS	Koshi Victims Society
KTWRBZ	Koshi Tappu Wildlife Reserve Buffer Zone
LAT	Livelihoods Assessment Tool
LVI	Livelihoods Vulnerability Index
MEA	Millennium Ecosystem Assessment
MSLVI	Mountain Specific Livelihoods Vulnerability Index
MSS	Multispectral Scanner
NCEP	National Centre for Environmental Prediction
NDVI	Normalized Difference Vegetation Index
NPV	Net present value
NPWC	National Park and Wetland Conservation
OBIA	Object Based Image Analysis
SDSM	Statistical Downscaling Model
UNCHEP	Union for Culture, Human and Environment Protection
USD	United States Dollars
VDC	village development committee
v.s.	Vikram Sambat (official calendar of Nepal)
WWF	World Wildlife Fund

Conversion rate used at the time of assessment
USD 1 = NPR 86

Executive Summary

In the Koshi Tappu Wildlife Reserve (KTWR), land cover change and climate change have been major drivers of change, leading to alteration of critical habitats for many of the world's threatened species. These drivers also challenge the ecosystems' capacity to provide goods and services essential for human wellbeing. The KTWR, situated between 86°91'–87°08'E and 26°72'–26°56'N, is one of the most important wildlife reserves in Nepal. The reserve, which covers an area of 175 km^2, was established as a protected area in 1976, and as a wetland of international importance by the Ramsar Convention in 1987 owing to its special role in maintaining the genetic and ecological diversity of the region. Located in the floodplains of the Sapta Koshi, the KTWR is a mosaic of diverse ecosystems with rich biodiversity. The reserve, also designated as one of the Important Bird Areas of Nepal, provides habitat for a number of endangered bird species such as the swamp francolin and Bengal florican.

The KTWR has experienced various changes over the 37 years since its establishment, the most significant being land cover change, including change in the river course. Even after it was designated as a protected area, people from surrounding communities remain highly dependent on the KTWR. In addition, demographic changes and climate change pose many challenges for this important wetland. The International Centre for Integrated Mountain Development (ICIMOD) and the Ministry of Forest and Soil Conservation (MoFSC), Government of Nepal jointly designed a transdisciplinary research framework as part of a project on biodiversity and climate change adaptation in the eastern Himalayas. The project, which was funded by MacArthur Foundation, had the following objectives: 1) documenting the state of biodiversity, ecosystem goods and services, and dependency of people on the ecosystems, and 2) examining the linkages with drivers of changes such as climate change and land use and land cover change in the KTWR. Efforts have also been made to identify levels of vulnerability and coping strategies of the surrounding communities.

The methodologies applied and the results are summarized below.

Methodology

To develop linkages between drivers of change, ecosystems, and people, climate change trends and projections were modeled with downscaled observed data and global and regional climate change scenarios. The state of biodiversity, ecosystem services, and people's dependency on the KTWR was gleaned from literature. Selected services have also been valuated by a combination of market price and value transfer methods. The local community's vulnerability to climate change was assessed through extensive surveys and by using participatory rural appraisal tools. Finally, the impacts of these drivers were assessed through geospatial analysis.

State of biodiversity and ecosystems goods and services

The KTWR provides habitat for the last remaining population of wild water buffalo in Nepal. It houses a recorded 670 species of vascular plants, 21 species of mammals, 23 species of herpetofauna, 77 species of butterflies, and 494 species of birds including the swamp francolin and Bengal florican. The wetland is also home to the Gangetic dolphin, gharial, and smooth-coated otter.

The reserve provides a large number of ecosystem goods and services. Analysis revealed that local communities residing in the buffer zones of the KTWR use a wide range of these services: a total of 18 provisioning services, 8 regulating services, 4 cultural services, and 2 supporting services were recorded. Fuelwood ranked as the most highly used service; 91% of the local population depend on this energy source for cooking. Thatch dependency ranked second highest (82%), followed by timber (54%), and grasses (51%). People are also dependent on poles/shafts (44%), fish (38%), and driftwood (31%). These results indicate a high level of dependency on goods and services from the reserve (CSUWN 2009).

Rivers/lakes and swamps/marshes were found to be the most important ecosystems in providing provisioning services, followed by forests, grassland, and agricultural land. Forests, swamps/marshes, and grassland have a higher capacity to provide regulating services than agricultural land and sand/gravel. Despite rivers/streams

covering only 10% of the total area, and swamps/marshes just 12%, both ecosystems have a high capacity to provide provisioning services. Similarly, forests, covering just 1% of the reserve, have an equally high capacity compared with ecosystems with greater coverage. This indicates that these ecosystems with less coverage have intense pressure from people's higher dependency.

The economic benefits generated by provisioning, regulating, and cultural services from the study area amount to around 1.4 billion Nepali rupees (NPR) (USD 16 million) per year. This is around NPR 78,840 (USD 916) per hectare (ha) considering an area of 17,500 ha. This translates to a net present value (NPV) of around USD 444 million at the assumed discount rate of 3% and constant flow of current benefit over the period of 60 years. Among the four types of services, the highest benefit (85%) was recorded from provisional services.

Socioeconomic profile

Local livelihoods in the KTWR buffer zone were based on a combination of farming, animal husbandry, wage and salaried labour, and remittances. Based on the Livelihoods Assessment Tool (LAT) survey, mean percentage contribution of primary sector income sources to total yearly household income in KTWR buffer zone was 41.2%; and from the secondary and tertiary sector income sources, it was 38.2%. Farming households in the KTWR buffer zone grow a diverse range of cash crops. Onion (34.2%), winter potato (28.7%), garlic (26.8%), legumes (24.1%), and chili pepper (10.8%) were the major cash crops grown by surveyed households in the area during the 12 months preceding the LAT survey. Around 77 household, which is 20.9% of the total surveyed household had members managing or running non-agricultural business. Out of these household, more than half (58.4%) were involved in managing wholesale or retail trade. More than half of the households (53.1%) had at least one member employed in a non-agricultural occupation such as construction (29.6%), manufacturing (17.4%), domestic helpers (10.7%), mining and quarrying (6.1%), wholesale and retail trade (5.6%), and security services (5.1%). More than 50% of the surveyed households had at least one member who had migrated either internally or internationally in search of work. However, percentage of households with international labour migrants (29.5%) was slightly higher than those with internal labour migrants (24.9%). Most of these migrants worked in urban areas. Major international destinations of the migrants include Malaysia, Qatar, India and Saudi Arabia. Around 50.1% of the surveyed households reported they had received remittances during the 12 months prior to the LAT survey. The mean amount of remittances received from within Nepal during the 12 months prior to the LAT survey was USD 617.1, whereas the mean amount of remittances from outside the country during the same period was USD 554.80.

Drivers of change, community perception, and impacts

The observed scenarios from the downscaled data at Phatepur showed a minimum temperature of 8.9°C in the winter and a maximum temperature of 33.2°C in the summer. The annual minimum and maximum temperatures are 19.9°C and 30.6°C respectively. Projection of maximum temperature scenarios ranged between 0.48°C and 1.11°C, and minimum temperature increase ranged between 0.62°C and 1.46°C. Community perceptions have also reflected changes in various climatic phenomenons, such as rainfall pattern and higher temperatures.

Land use and cover change analysis revealed that the KTWR has experienced significant changes in land cover and ecosystems over the last 34 years due to changes in the river course and anthropogenic pressure leading to direct changes in species' habitats. Forest coverage has been reduced by 94%, while grassland has increased by 79%. In terms of total land cover, forests, rivers/streams, and swamps/marshes decreased by 16%, 14%, and 3% respectively over the last 34 years, while grassland increased by 45% over the same period. The reduced coverage results in habitat loss as these ecosystems are home to a majority of species. Notably, the wetland ecosystems (marshes/swamps and river/streams), some of the most important habitats for many globally threatened species, have reduced by more than 30%. Since major human dependency for provisional services was observed on rivers/lakes, and swamps/marshes, followed by forests, these ecosystems have significantly changed since 1976.

The projections of change in temperature, rainfall, and land cover change including other drivers of change are likely to have direct impacts on the biodiversity of the KTWR. In particular, the impact of land use and cover change on biodiversity and ecosystem services is likely to be significant for species that have a narrow habitat range and are habitat specific, such as the Bengal florican. Swamps/marshes were reported to support the highest number of species with 15, followed by forests (14), rivers/lakes (13), and grassland (12). The lowest number of species was

reported on agricultural land (2). Forested ecosystems of the KTWR were observed to be one of the most important habitats used by 15 globally significant species, followed by rivers/lakes and grassland. As a result of land use and cover change, the ecosystems also experienced changes in supply of various ecosystem services, mainly due to changes in area coverage of these ecosystems on which people are most highly dependent.

There is ample opportunity for conservation and development in the KTWR. A large number of organizations have already contributed their efforts and enaged in various activities. However, special attention is needed given the KTWR's small size and dynamic nature resulting from frequent river course change. KTWR conservation and development planning should consider the reserve's catchment areas, as well as connectivity to a network of other adjacent protected areas in Nepal. In order to increase both ecological and socioeconomic resilience, the study recommends the following eight responsive strategies:

I. Take cognizance of climate uncertainty and monitor changes continuously.
II. Understand the dynamics and linkages with an integrated system approach.
III. Improve social protection services by providing access to services such as micro-credit and insurance.
IV. Diversify livelihood options in the buffer zone to reduce poverty and social inequality.
V. Support the implementation of policies and institutions.
VI. Move from coping to adaptation and build resilience.
VII. Build the capacity of community institutions.
VIII. Raise awareness among all stakeholders.

Introduction

Wetlands, as defined by the Ramsar Convention (Ramsar Convention Secretariate 2013) are "the 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". As a transitional ecosystem between terrestrial and aquatic habitats, wetlands are one of the most productive ecosystems, encompassing water, soil, and organisms that are adapted to the unique wet environment. Wetland ecosystems cover about 6% of the total global land area – of which 2% is lakes, 30% bogs, 26% fens, 20% swamps, and 15% floodplains. The natural functioning of wetlands supports rich agricultural and wild biodiversity and provides environmental services that benefit society such as food, flood regulation, nutrient and sediment retention, and maintenance of groundwater table. Wetlands provide habitat for 40% of the world's species and 12% of all animal species (Mitsch and Gosselink 2000). They have been described as "the kidneys of the landscape and biological supermarkets", because of the functions they perform in the hydrological and chemical cycles (Barbier et al. 1997) and the role they play in providing tremendous economic benefits at local, national, regional, and international levels through a wide range of ecosystem services. One estimate indicates that the total economic value of 63 million hectares of wetlands around the world is USD 3.4 billion per year (TEEB 2010). From this, it follows that the global wetland area of 12.8 million square kilometres, as identified by the Ramsar Convention, has the total economic value of about USD 70 billion per year (Schuijt and Brander 2004).

Ecosystem services are benefits people derive from ecosystems, which include provisioning services (food and water); regulating services (regulation of floods, drought, land degradation, and disease); supporting services (soil formation and nutrient cycling); cultural services (recreational, spiritual or religious); and other non-material benefits (MEA 2005). These services are critical to the functioning of the Earth's life support system that contributes to human welfare, both directly and indirectly, representing part of the total economic value of the planet (Costanza et al. 1997). Dynamic ecosystems and their services are intricately linked to human wellbeing. Research on ecosystems is hence important for understanding the socioecological aspects of human life and people's adaptive capacity (Holling 1986; Gunderson and Holling 2002). Various drivers of change, such as excessive demands from a growing population, land use and land cover change, and climate change can lead to biodiversity loss (SCBD 2010). The Millennium Ecosystem Assessment (MEA) documented the importance of ecosystem services to human wellbeing and showed that continued supply of these services is threatened by unsustainable anthropogenic activities (MEA 2005). Approximately 60% of the ecosystem services examined during the MEA are being degraded or used unsustainably, including food, fresh water, air and water purification, and the regulation of regional and local climate and natural hazards. As a result, the focus has been gradually widening from biodiversity conservation to management and sustenance of the ecosystems from which people derive goods and services (Naidoo et al. 2008; Nelson et al. 2009; TEEB 2010; Costanza et al. 2011). This evolving approach to conservation is rooted in the belief that if local institutions are strengthened, and the people who depend on these ecosystems gain collective ownership over the resources, they may use resources sustainably, thus resulting in conservation benefits (Ostrom 1990).

The Himalayan region is a storehouse of exceptionally rich biodiversity (Pei 1995; Chettri et al. 2008). The varied ecosystems in the region provide numerous ecosystem services; freshwater in particular is used by more than 200 million people living in the region, and by 1.3 billion people living in downstream river basins (Schild 2008). Still, the region is densely populated and the growing demand for ecosystem services, combined with unsustainable use of natural resources, is leading to biodiversity loss (Bawa 2006; Jha and Bawa 2006; Tse-ring et al. 2010). Even protected areas are under immense pressure as people living in and around them place increasing stress on the ecosystems (Sharma and Yonzon 2005; Chettri and Sharma 2006). Although the Himalayan region has made significant conservation achievements over the last three decades (Chettri et al. 2008; Sharma et al. 2010), the state of ecosystems and their role of delivering goods and services to people have not been properly understood and documented. Exacerbating the situation, local people are often unsupportive of reserves as they limit their access to natural resources and create conflicts (Badola 1998; Nagendra et al. 2004; Jha and Bawa 2006; Allendorf et al. 2007; Sodhi et al. 2009). To alleviate anthropogenic pressure, conservationists frequently argue that protected areas should be preserved for their ecosystem services and not just for the conservation of biodiversity (Maharana et al. 2000; Sharma et al. 2002; Badola et al. 2010).

The MEA conceptual framework (MEA 2003) states that people perceive the condition of an ecosystem in relation to its ability to provide desired services. Studies in the Himalayas have long underscored the importance of biodiversity for the rural poor, who tend to depend on natural resources for their survival (Ives and Masserli 1989; Sharma et al. 1992; Chettri and Sharma 2006). A body of research emerging from the region suggests a higher dependency of people on biodiversity for ecosystem services (Acharya 2000; Ambastha et al. 2007; Chettri and Sharma 2006; Joshi and Negi 2011; Pant et al. 2012). However, protected areas, which are the last resort of people who need ecosystem services, are facing numerous threats such as the overextraction of resources, land cover change, and climate change (Chettri et al. 2010; Tse-ring et al. 2010). Understanding the role of ecosystem services in the context of human wellbeing is therefore necessary for justifying conservation and improving ecosystem management in the region.

The International Centre for Integrated Mountain Development (ICIMOD), an intergovernmental regional knowledge and enabling centre, has been working on the conservation and wise use of wetlands in the Hindu Kush Himalayan (HKH) region for a decade. In 2010, ICIMOD, in consultation with the Ministry of Forests and Soil Conservation, and in collabouration with Tribhuvan University, Koshi Victims Society (KVS), and Bird Conservation Nepal (BCN) conducted a study to better understand the impacts of climate change on biodiversity and ecosystem services, as well as its impact on adaptation and sustainable development in the eastern Himalayas. The specific objectives of the project were to:

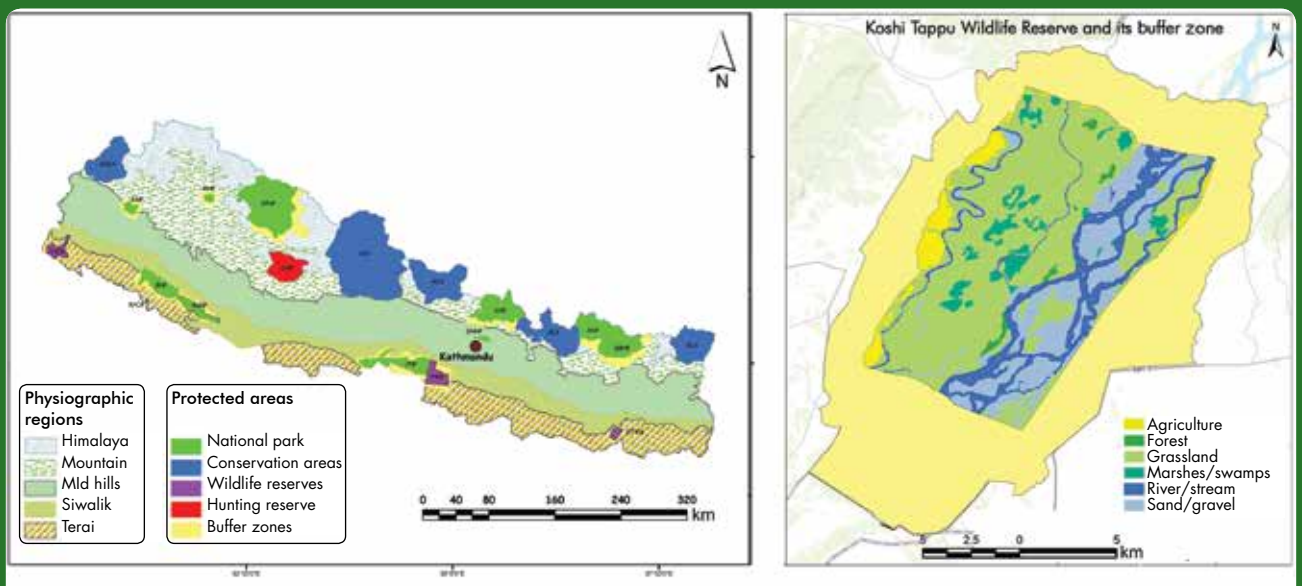
- Assess the state of ecosystems and examine people's dependency on the KTWR's ecosystem goods and services;
- Identify the drivers of change, detect the spatial and temporal changes, and assess their impact on ecosystems and their services;
- Identify livelihood vulnerabilities and promote evidence-based adaptation strategies, capacity development, and policy inputs for biodiversity related to ecosystem services;
- Understand people's perception of change and stressors, and identify coping strategies practised by the local communities; and
- Recommend conservation and adaptation strategies that help maintain the integrity of the reserve's ecosystems, and build the socioeconomic resilience of people in the area.

This report synthesizes the assessments of the project "Biodiversity and Climate Change Adaptation in the Eastern Himalayas". Prepared with financial support from the MacArthur Foundation, the report provides an integrated overview of the state and dynamics of ecological, socioeconomic, and livelihood features of the reserve and its buffer zone. The report also summarizes climate change scenarios and potential impacts on biodiversity, reserve ecosystem services, and people's livelihoods. It highlights the overuse of resources, with emphasis on land use and land cover change, and discusses the factors affecting people's adaptive capacity, livelihood options, and adaptation practices adopted by local communities in response to environmental and socioeconomic changes. Finally, the report makes recommendations for building ecological and socioeconomic resilience of the reserve and the people in surrounding communities.

Koshi Tappu Wildlife Reserve

Situated between 86°91′ to 87°08′E and 26°72′ to 26°56′N, the Koshi Tappu Wildlife Reserve (KTWR) is one of the most important wildlife reserves in Nepal (Figure 1). The reserve, a protected area established in 1976 under the International Union for the Conservation of Nature (IUCN) category IV, spreads over an area of 175 km^2 (IUCN 1990; Karki 2008). It is the only habitat for the last remaining population of wild water buffalo, and was also designated as a wetland of international importance by the Ramsar Convention in 1987 for its special role in maintaining genetic and ecological diversity of the region (Shah 1997; Karki 2008). The reserve is rich in biodiversity with 670 species of vascular plants (Shah 1997; Bhandari 1998; Siwakoti 2006), 21 species of mammals (Chhetry and Pal 2010), 45 species of herpetofauna (DNPWC 2009), 77 species of butterflies, and 494 species of birds (BCN 2011). It is also habitat for a large number of globally and nationally threatened species (DNPWC 2009; WWF 2008; CSUWN 2009) and is designated as one of the Important Bird Areas of Nepal with habitat for a number of endangered bird species such as the swamp partridge and Bengal florican, among others (Baral and Inskipp 2005). The reserve is also home to globally threatened species like the Gangetic dolphin, gharial, and smooth-coated otter. These globally important species play a vital role in maintaining the ecological

Figure 1: **Map of Koshi Tappu Wildlife Reserve**



Source: Department of Survey, GoN and DNPWC, 2068 Prepared by: GIS Lab/DNPWC

integrity of the area. Along with the rich biodiversity, the reserve is equally diverse in land cover types. This diversity is important for the reserve's multifunctional role in providing a range of ecosystem goods and services to local communities (Heinen 1993; Shrestha and Alavalapati 2006). Local people are particularly dependent on provisioning services, which have contributed considerably to their livelihoods and the local economy (CSUWN 2009). Despite the flow of these services, and the vital ecological and economic importance of these ecosystems, they have been continuously degrading (Goit and Basnet 2011).

Historical perspective

Koshi Tappu was originally a river floodplain of the Sapta Koshi River. 'Tappu' is a derivative of the Sanskrit word 'Tapu,' meaning an isle. The name may come from the fact that during the rainy season, heightened water levels give the river an ocean-like appearance with the landmass resembling an island. After the eradication of malaria from Nepal's sub-tropical areas during the 1950s, people started settling in the country's Terai areas. The migration tide originated from different parts of the country, particularly from the hills. Forests were cleared to make way for houses and agriculture, and people eventually became dependent on the surrounding natural resources for their livelihoods. The entire floodplain has since been regarded as the natural capital of the region. The Koshi Tappu wetland was created after the construction of the Koshi Barrage in 1962 to protect the downstream flood-prone Indian territory of Bihar. The KTWR was first declared as a protected area to protect the last remaining populations of wild water buffalo.

Before its declaration as a reserve by the Government of Nepal, the area was accessible to local communities for fishing, hunting, grazing, livestock, and collecting fodder, fuelwood, and other resources (CSUWN 2009). The harvest and use of resources from this important floodplain play a prominent role in local people's occupations and way of life. Besides subsistence farming, livestock rearing is a major economic activity, and income from livestock contributes a substantial proportion of local household income (Sah 1997; CSUWN 2009). The establishment of the reserve in 1976 resulted in displacement of more than 12,000 people, many of whom lost their land without receiving adequate compensation. The National Park and Wildlife Conservation (NPWC) Act of 1973 prohibited the harvest of resources and grazing of livestock within protected areas. Local people near the KTWR, however, continued to access resources despite the restrictions imposed by reserve authorities. These opposing interests have escalated conflicts between local people and reserve management agencies (Heinen 1993; Shrestha et al. 2007). These issues created negative attitudes among local people towards the reserve and its conservation (IUCN 2004).

In order to address some of the local issues related to livelihoods, conservation, and local discord, the Ministry of Forests and Soil Conservation (MoFSC), Government of Nepal, with the financial and technical support of the United Nations Development Program-Global Environment Facility (UNDP-GEF), implemented the Conservation and Sustainable Use of Wetlands in Nepal Project (CSUWN) in 2009.

In 1996, Buffer Zone Management Regulations came into effect with the amendment of the National Parks and Wildlife Conservation Act, 1973, which empowered local communities to carry out conservation and development related work in their buffer zones. An area of 173.5 km^2, encompassing 16 village development committees (VDCs) from Sunsari, Saptari, and Udayapur districts, was established as a buffer zone in 2004 (CSUWN 2009). The total population of the buffer zone comprises 93,000 people from 16,280 households (CSUWN 2009). The overall literacy rate is 44.6% and agriculture is the dominant mode of production for 87.3% of households. Only 20% of households are food secure. Livestock density is very high with 1.5 cattle per household. Tourism has just started to sprout in the KTWR and its buffer zone area (DNPWC 2009); as a result, 30-50% of the revenue earned by the reserve went to the local community for development, and local people were able to use the reserve's resources.

In 2010, CSUWN supported the reformation and revitalization of all 506 user groups, nine user committees, and one Buffer Zone Management Committee (BZMC). In order to ensure gender and social inclusion in the process, various orientations were held at different levels. After the reformation, the secretarial positions in all nine user committees were occupied by women who were not previously on the committees. The Buffer Zone Users Committee (BZUC) received institutional support to conduct regular meetings and strengthen all the committees. The users also attended different trainings including leadership development, account and bookkeeping, and institutional development. Now, the BZMC meets at least once every three months, and BZUC meetings take place every alternate month. A total of eight buffer zone cooperatives have been formed to promote saving and credit schemes and provide financial capital for users. Cooperatives have also started accessing loans from the Biodiversity Conservation Fund, a revolving loan facility developed during the project tenure. A total of 20 community forest users groups (CFUGs) have been formed; 12 of them have amended their status to integrate gender and social inclusion issues. The BZMC, in coordination with district level line agencies, is now able to award contracts for sand/gravel and driftwood collection, a major income source for buffer zone revenue. A resource use strategy for the KTWR has been developed and rolled out. Income from tourism and sand/gravel extraction have boosted local incomes since 2013. CSUWN interventions in the KTWR include, among others, targeted livelihood interventions for 308 wetland dependent communities, whose household incomes have increased by 33% compared to the baseline. Similarly, 133 methane digesters, a pater enterprise for 25 Bantar women, a 14.7 km solar electric fence in the eastern sector, a mallah-majhi network, 14 wetland clubs, and a teachers' network have been put in place along with biological monitoring of key indicator species. A fish hatchery centre was also established and is operating in Madhuban VDC.

Enhancing economic development without compromising the quality of the wetland and its services has emerged as a serious challenge (Shrestha et al. 2007). Little effort has been made to understand the role of the reserve's biodiversity and its services to local community livelihoods (Heinen 1993; Nepal and Weber 1995; Shrestha et al. 2006; CSUWN; 2009; Rayamajhi 2009). Moreover, policy makers and local people alike are unaware of the economic costs of the vast array of services derived from the reserve, which are of regional and global importance (Shrestha et al. 2007). As a floodplain area, various drivers of change such as land use change, climate change, and demographic change can play a pivotal role in the long-term existence of the KTWR and the people living in the buffer zones. Thus rationalizing conservation and improving ecosystem management in the area requires understanding the roles and impacts of various drivers of change on biodiversity, ecosystem services, and people's livelihoods. Understanding local people's vulnerability and adaptive capacity in the context of climate change is equally imperative.

Strategic importance

Koshi Tappu is the transition zone for all waters that flow into the Koshi River and receives drainage from major rivers such as the Sunkoshi, Arun, and Tamor. The Arun and Sunkoshi originate from the Tibetan Autonomous Region of China. These tributaries flow through Nepal's Himalayan mountains and enter India to meet the Ganges in Kursela (Bhagalpur, Bihar), about 430 km away from the Koshi barrage in Nepal (Sinha et al. 2003). Koshi

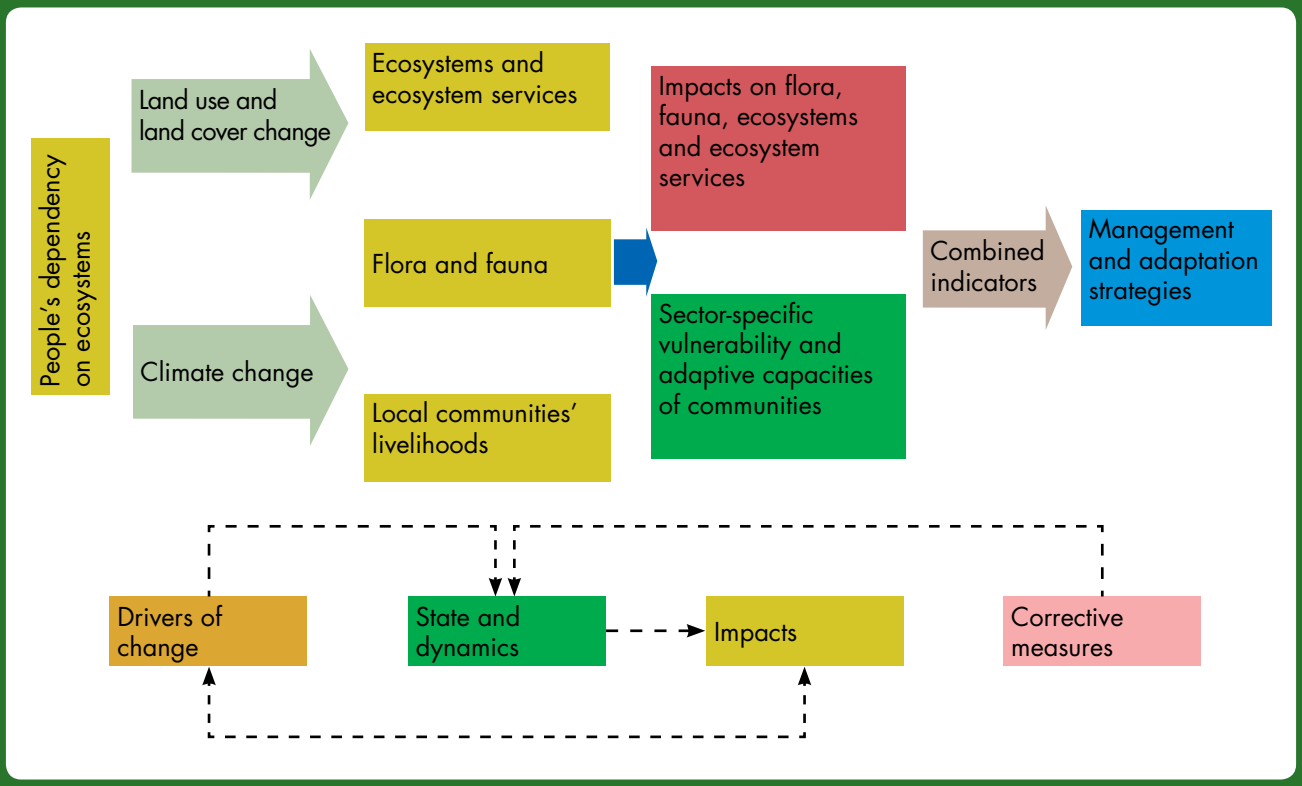
Tappu is an important remnant habitat, connected with the Langtang National Park, Sagarmatha National Park, Makalu-Barun National Park and Kangchenjunga Conservation Area through various tributaries. The KTWR is also a transboundary habitat between Nepal and India for the Gangetic dolphin, a globally threatened species and a protected species in Nepal (HMG 1973).

Conceptual Research Framework and Research Methodologies

A conceptual research framework (see Figure 2) was prepared to guide understanding about the interlinkages between major drivers of environmental change and their impacts on the state of ecosystem dynamics, ecosystem goods and services, and community livelihoods. To identify management and adaptation strategies, inferences were made based on the potential impacts of climatic and non-climatic stressors, considering socioecological vulnerability on communities as well as on ecosystems.

Research methodology involved both primary action research and review of secondary sources. Participatory action research focused on assessments of the state of biodiversity, ecosystem services, and livelihood vulnerability. Geospatial analysis included land use and land cover change and analysis in relation to the spatial and temporal changes in ecosystem services and threatened habitat matrix. The overall purpose was to understand the impact of various drivers of change – particularly land use and land cover change and climate variability – on wetland biodiversity, ecosystem goods and services, and people's livelihoods, and to make inferences on ecosystem management and climate change adaptation strategies. 'Drivers of change' was used as a generic term encompassing anthropogenic pressure, climatic change, and land use and land cover change as drivers or as influenced by other drivers. For example, land use and land cover change is highly influenced by drivers such as disasters, land management policies, and overexploitation. At the same time, land use and land cover change can influence biodiversity. Details of methodologies for each action research are described below.

Figure 2: **Conceptual research framework**



Source: ICIMOD

Livelihood vulnerability assessment

Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (McCarthy et al. 2001). Exposure is "the nature and degree to which a system experiences environmental or sociopolitical stress" (Adger 2006, p 270). Exposure can be broadly classified as perturbations (such as natural disasters like tidal waves or hurricanes) or stress (such as soil degradation). The scale of the system determines whether a disturbance is external or internal (Turner et al. 2003). The perturbations and their impacts on the system are multi-scale in nature, and most systems are exposed to multiple and interacting perturbations (van der Leeuw 2001; Turner et al. 2003). In the context of climate change, sensitivity is defined as "the degree to which a system is affected, either adversely or beneficially, by climate related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)" (McCarthy et al. 2001 cited in Adger 2006, p 207). Adger (2006) describes adaptive capacity as "the ability of a system to evolve in order to accommodate environmental hazards or policy change and to expand the range of variability with which it can cope" (Adger 2006, p 270). Despite diverse interpretations of vulnerability, the key concepts of exposure, sensitivity, and adaptive capacity are common elements of many dominant approaches (Miller et al. 2010). The vulnerability of a system to environmental change is interlinked with the wider political economy of resource use. Vulnerability research usually focuses on the response to hazards and shocks, rather than on long-term or medium-term adjustments and change (Miller et al. 2010). The consequences of short-term actions on longer term social-ecological resilience have also often been neglected in vulnerability studies (Venton and la Trobe 2008).

Data on various indicators of livelihood vulnerability were collected using the Livelihoods Assessment Tool (LAT). The LAT is a household questionnaire based on the Mountain Specific Livelihoods Vulnerability Index (MSLVI) framework developed by Gerlitz et al. (forthcoming), which is based on the Livelihoods Vulnerability Index (LVI) provided by Hanh et al. (2009). The LVI framework was adjusted for the mountain context considering 'mountain specificities,' as defined by Jodha (1992). These include inaccessibility, fragility, marginality, biological niches, and human adaptation mechanisms. The tool covered thematic areas like socio-demographic profile, access to basic facilities, health and healthcare, accessibility, housing, education, assets, use of ecosystem services, household consumption, food security, water security, and exposure and adaptive capacity to shocks and medium-term climatic and environmental changes. According to the IPCC's Third Assessment Report (IPCC 2007), vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. So, vulnerability is defined as a function of exposure, sensitivity, and adaptive capacity. Considering that improvements in adaptive capacity actually reduce vulnerability (Brooks 2003), while the dimensions of exposure and sensitivity contribute to it, vulnerability can be expressed as follows:

$$\text{Vulnerability} = f\,(\text{Exposure} + \text{Sensitivity} - \text{Adaptive Capacity})$$

Exposure refers to the magnitude and duration of the climate-related exposure, such as drought or a change in precipitation. Sensitivity is defined as the degree to which a system is affected, either adversely or beneficially, by climate variability or climate change. Adaptive capacity is defined as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC 2007). Each of these dimensions has further sub-dimensions and indicators (Annex 1), which were assessed to determine the vulnerability of livelihoods in the KTWR buffer zone. This formula was used to construct the overall Mountain Specific Vulnerability Index.

Before implementation, the LAT was field tested by local partner institutions in Nepal and Bhutan. The resulting feedback was used to further adjust the tool for local contexts and the practical aspects of a survey. A total of 369 households were randomly surveyed across the KTWR buffer zone. The LAT was implemented following the steps described below:

- Orientation and training session: Discussions with the field team on the objectives of the study, research design, sampling method, survey technique, ethics, confidentiality protocol, and questionnaires.
- Pre-survey preparation: Debriefing sessions to collect feedback from enumerators and provide clarification and preparation for household survey.

- Household survey: Individual household interviews were conducted in the primary local language of the region and required an hour and a half to administer. Completed questionnaires were collected and reviewed by the local coordinator in close consultation with enumerators.
- Post-survey follow-up visit: In cases of discrepancies, enumerators revisited particular households to seek clarification.
- Data entry and compilation: LAT information was entered into a data entry mask designed with the SPSS Statistics software package. After entering the data, plausibility checks were performed to control entry errors and inconsistencies and to guarantee data quality.

Biodiversity assessment

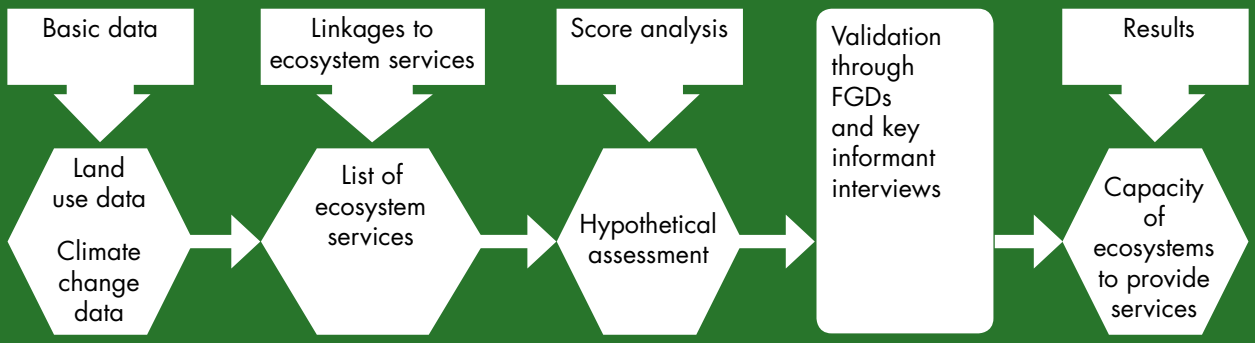
Published literature on Koshi Tappu was reviewed to determine the status of ecological features, including updates on floral and faunal diversity, non-timber forest products and other biomass resources collected by local communities, and the spread of alien invasive species in the reserve. In addition, biodiversity data – in particular of the swamp francolin – were validated by the point count method on the ground. The call count was used to assess the distribution of swamp francolin in the area. The swamp francolin was designated an indicator species for the KTWR by CSUWN in 2009; monitoring has been conducted on a regular basis.

Based on the IUCN Red List and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list, a total of 20 species found in the KTWR were chosen for inclusion in a habitat use matrix. Six habitat types – grassland, swamps/marshes, forest, rivers/lakes, barren land (freshly swept river beds), and agricultural fields – were used for the matrix. Under each habitat type, use and non-use by the listed species were categorized as (1) and (0) respectively. For instance, if the wild water buffalo uses three habitat types (such as grassland, swamps, and rivers/lakes) each type was given (1) point. If the same species avoids a certain habitat type (such as barren land) this habitat was given a score of (0). By adding the use and non-use values for all species, habitats were ranked in terms of use by selected species.

Ecosystem services assessment

Based on the literature review and questionnaires, an exhaustive list of ecosystem goods and services from the KTWR was prepared. The list was then categorized into provisioning, regulating, supporting, and cultural services following the MEA framework (MEA 2005). Goods and services from the reserve were further ranked as high, medium, and low based on local perceptions of dependency and use. High-ranking goods and services were those considered widely used and essential for local subsistence. Medium-ranking goods and services were considered preferred, but could be done without if unavailable. Low-ranking goods and services were those whose use was considered optional.

Figure 3: **Assessment framework for ecosystem services**



Adapted from Burkhard et al. 2009

To understand the dependency and linkages to diverse ecosystems, major land cover types reported from the reserve (CSUWN 2009) were assessed within the framework developed by Burkhard et al. (2009). The basic idea of the assessment framework (Figure 3) was to individually evaluate the capacities of different ecosystems to provide ecosystem services. An assessment matrix of land cover versus ecosystem services was made to assess the capacity of each land cover type to provide provisioning, regulating, supporting, and cultural services individually at a scale of 0–3, with 0 = no service, 1 = low service, 2 = medium service, and 3 = high service. A value was then given to each land cover type based on experts' judgment (hypothetical assessment) and triangulated with local communities through focus group discussions. The given values were then summed up to determine the capacity (highest and lowest) of land use type, considering the four broad categories of ecosystem services in the matrix. A total of 22 provisioning services, eight regulating services, four cultural services, and two supporting services were thoroughly analysed (Table 14 and Table 15).

Economic valuation of ecosystem services

The overall framework for valuation was considered from Hein et al. (2006) and a combination of market price and value transfer methods (Wilson and Hoehm 2006; Navrud and Ready 2007; Pant et al. 2012) was applied in the study to estimate the economic value of the most important wetland goods and services (both direct and indirect). The method used to estimate the economic value of identified ecosystem services is briefly discussed below.

Provisioning services

The average annual value of wetland products per household has been evaluated in terms of average gross and net household incomes, depending on available information (CSUWN 2009). Income from agriculture and wetland resources was estimated based on average quantities harvested, their prices, and associated costs, irrespective of what proportion was sold (in other words, valuing subsistence consumption at market prices). The average annual net values of each product were then calculated by subtracting the annual cost of the products from their respective gross value using the net benefit method suggested by Viboonpun (2000). The equation used in calculating the values of provisioning services is

$$NV_i = (Q_i P_i - C_i) \quad (1)$$

where, NV_i = average annual net benefit value of i^{th} wetland products per household (NPR); Q_i = average annual quantity of i^{th} wetland products per household (unit); P_i= price of i^{th} wetland products (NPR/unit); C_i = average annual cost of harvesting/producing i^{th} wetland products (NPR); and i = nine different wetland product types considered in the present valuation.

The above equation was used to find the average value per household for all provisioning services considered in the study except for domestic water supply benefit, which was estimated using the unit adjusted value transfer method discussed below. While the cost involved in realizing the benefits from some wetland ecosystem services (for example, flood plain agriculture, livestock, fishery, and mat making) are included, it has not been possible to estimate the direct cost of collecting or gathering other wetland products in the absence of adequate information on imputing opportunity cost (shadow wage) of labour time involved in the collection process. However, considering the high unemployment rate in the study area, the shadow price of labour involved in collecting resources can also be considered equal to zero (Mmopelwa 2006).

The total value of the wetland provisioning services for all dependent households residing in the buffer zone was calculated as the average annual value of resources harvested per household (estimated from equation 1) multiplied by the estimated total number of the dependent households using the following equation.

$$TVP_i = \sum_{i=1}^{n} (\%hh_i \times HH \times NV_i) \quad (2)$$

where i represents the different wetland provisioning services, $\%hh_i$ is the percentage of total households dependent on each of the i^{th} provisioning services (for example, dependency weight); HH represents the total number of

households residing in the buffer zone; and NV_i is the average annual net benefit per user household from the wetland provisioning services estimated from equation 1 above. This information provides the basis for estimating the weighted average of resources harvested per household and per hectare.

The total number of dependent households residing in the buffer zone were estimated by applying the household dependency weight (the percentage of households extracting or realizing benefit from different wetland products) to the projected total households in the buffer zone. For this, the total household population residing in the 16 buffer zone VDCs surrounding the KTWR in 2011 was first estimated using information from the 2011 population census (CBS 2012), which was then projected to 2012 using the corresponding district level inter census household population growth rates (2001-2011). The information on household dependency on wetland resources was mostly taken from the 2009 baseline survey of households in the buffer zone (CSUWN 2009).

Net present value: The NPV of these resources was also derived using 3% discount rate over a period of 60 years on the assumption that the current flow of value will continue into the future with no degradation or depletion (Stuip et al. 2002).

Domestic water supply benefit: In the absence of scientific biophysical or hydrological information on ground-water recharge of wetlands as a source of domestic water supply for surrounding buffer zone populations, an attempt was made to find a suitable unit value transfer through extensive review of contemporary literature in the region. Emerton and Kekulandala (2003) estimated avertive expenditures avoided NPR 3.78 million per year +(NPR 1,232 ha/NPR 2,363 hh) as domestic water supply benefit from the Muthurajawela Maresh wetland, covering an area of 3,068 ha in Colombo, Sri Lanka. This gives the inflation adjusted unit transfer value of USD 37.7 per household in 2010 prices, as estimated by CSUWN (2011) for its use in Nepal where wetlands are the only source of water provision. Considering that the KTWR is the only source of maintaining groundwater levels for domestic water supply (which over 97% of households rely on as their source of drinking water) this transfer value was used to estimate the value of domestic water supply benefits, after converting it to 2012 prices using the consumer price index.

Regulating and cultural services

The unit adjusted value transfer method was used to calculate the economic value of flood prevention benefit and carbon sequestration considered in the present valuation study. The simple expenditure method was used for estimating the value of ecotourism, as described below.

Flood control or prevention: In the absence of reliable past research in Nepal on the quantification and valuation of regulating services, this study relied on the unit adjusted transfer value derived from a study by Thompson and Colavito (2007) in Bangladesh's Hail Haor wetland, a 14,000 ha flooded basin. The authors estimated the value of flood control at 1,910 Bangladeshi taka (BDT) per hectare in 2000, using a cost avoided approach based on a proposed flood control scheme for the haor. CSUWN (2011) inflated this unit value to USD 50 per hectare in 2010 prices as a recommended lower bound transfer value for estimating the flood control benefit of wetlands in Nepal. Ban et al. (2010) applied this value to estimate the flood prevention benefit of Ghodaghodi Lake in western Nepal. For the present study, this recommended unit value was inflated to USD 53 per ha in 2012 prices for application using a consumer price index factor of 2.1805 for Bangladesh between 2000 and 2012, and the prevailing exchange rate of 78.2495 BDT per USD on 30 December 2012.

Carbon sequestration: In the absence of a comparable carbon sequestration estimate for Nepal's wetlands, this study used the default value based on the carbon sequestration index (CSI) provided by Pagiola et al. (2007) for different land use types according to their capacity to sequester stable carbon in soil and in hard wood. It is assumed that only forests and pasture/grassland sequester carbon in Koshi Tappu. The areas under these land types are adjusted using CSI values of disturbed secondary class and natural pastures with low tree density (less than 30 trees/ha) respectively. The total value of carbon sequestration is then calculated as the CSI adjusted area multiplied by the price of USD 75 per unit of index (Pagiola et al. 2007).

Ecotourism: The travel cost method is the best way to estimate the economic value of recreational tourism. In the absence of such studies, however, the net economic value of ecotourism was estimated using the expenditure method. The expenditure method takes into account the revenue generated from entry fees for tourists, as well as the total amount spent by foreign tourists during their average length of stay. A flat rate of 35% of the gross unit value is assumed to be the annual cost of management to arrive at the net tourism benefit.

Land use and cover change analysis

Remote Sensing data of 1976, 1989, 1999, and 2010 covering the KTWR core area were acquired to assess spatio-temporal land cover changes over a period of 34 years. High spatial resolution Indian Remote Sensing (IRS) Satellite, Linear Imaging and Self Scanning Sensor (LISS-4) of 2005, and medium spatial resolution Landsat Multispectral Scanner (MSS) of 1976; Thematic Mapper (TM) of 1989; Enhanced Thematic Mapper Plus (ETM+) of 1999; and TM of 2010 were used to generate a river course change analysis (Table 1). Landsat MSS, TM and Enhanced Thematic Mapper Plus (ETM+) imagery were accessed from USGS Global Visualization Viewer (GLOVIS 2008) whereas a Shuttle Radar Topography Mission (SRTM) Digital Elevation Model was accessed from Consultative Group on International Agricultural Research (CGIAR)-Consortium for Spatial Information (CSI) GeoPortal (CGIAR-CSI 2008).

Acquired IRS LISS-4 and Landsat imagery was orthorectified into Universal Transverse Mercator (UTM), Zone 45 based on generated digital terrain model (DTM) from a topographic map and ground control point (GCP) from the field. After rectifying all the images, eCognition developer software was used for object-based image analysis (OBIA). The OBIA provides a methodological framework for machine-based interpretation of complex classes, defined by spectral, spatial, contextual, and hierarchical properties. Using both spectral and spatial information, OBIA yields better classification results, with a higher degree of accuracy, than pixel-based methods (Lang et al. 2011). A hierarchical classification scheme was used with six major land classes based on Di Gregorio's Land Cover Classification System (2005). This was necessary to synchronize the land use and cover legends

Table 1: **List of Landsat imagery considered for analysis**

S. No	Satellite	Senior	Path	Row	Acquisition date
1	Landsat	MSS	150	42	13 November 1976
2	Landsat	TM	140	40	17 January 1989
3	Landsat	ETM+	140	40	28 October 1999
4	Landsat	TM	140	40	04 February 2010

with global standards (Bajracharya et al. 2010). The major land cover classes considered were forest, agriculture, grassland, marshes/swamps, rivers/streams, and sand/gravel. To classify these classes the 'multiresolution segmentation' algorithm was used, which consecutively merges pixels or existing image objects, essentially identifying single image objects of one pixel in size and merging them with their neighbours based on relative homogeneity criteria (Blaschke et al. 2001). Multiresolution segmentations are groups of similar pixel values that merge homogeneous areas into larger objects and heterogeneous areas in smaller ones (Baatz et al. 2006).

During class modelling, information on spectral values, vegetation indices like the Normalized Difference Vegetation Index (NDVI), and a land-water mask created through band ratio and texture information were used. NDVI is a standardized index allowing generation of an image displaying greenness (relative biomass). Index values can range from -1.0 to 1.0. Areas containing dense vegetation canopy normally tend to positive values (around 0.3 to 0.8), while clouds and snow fields tend to negative values. In a pre-processing stage, the NDVI image was created using customized features applying the formula: NDVI = (RED – IR)/ (RED + IR). The land-water mask was created using the formula IR/Green*100. Land and water mask index values can range from 0 to 255, while water values typically fall between 0 and 50. The next step was to label those image objects according to their attributes, such as NDVI, land-water mask, layer value, colour, and position in relation to other objects using user-defined rules. Objects with an area smaller than the defined minimum mapping unit were merged with other objects. The classified land cover map was also exported to a raster file format to correspond with the matrix code obtained from matrix analysis. Spatial analysis of information on services (including provisioning services, regulating services, supporting services, and cultural services) was related to each land cover map and the necessary statistics were calculated.

Downscaling climate change scenarios

Climatic data from 1985 to 2003 were collected from the weather station established in Phatepur and Barmajhiya. Downscaling of the general circulation models (GCM) outputs based on the observed data was carried out for the whole study area. The outputs of two GCMs: CGCM3 and HadCM3 were used for the study. Emission scenarios

A1B and A2 were used for CGCM3 and A2 and B2 for HadCM3 were considered (IPCC 2001). The statistical downscaling model (SDSM), based on the observed predictor variables from the National Centre for Environmental Prediction (NCEP), was used following Wibly and Dawson (2007) and GCM predictor sets under the special report of emission scenario were applied for temperature and precipitation changes.

People's perception of environmental changes

A community-level study was conducted to ascertain climatic and non-climatic pressures on the wetland ecosystems as well as impacts of such pressures on and changes in community livelihoods and wellbeing in the Koshi Tappu Wildlife Reserve buffer zone (KTWRBZ). Targeted participatory tools were used to understand local communities' perceptions of changes in the weather and the impact on livelihoods and the wetland ecosystem. A Vulnerability and Capacity Assessment (Maachi 2011) was slightly modified and applied so as to focus not only on the impacts of climate change and other stressors on livelihoods, but also to encompass aspects of the provision of ecosystem services. Primary data was collected at the community level in six locations in the KTWRBZ. Participatory rural appraisal exercises were conducted in all of the selected locations, followed by focus group discussions. These results were then analysed to identify local trends.

Results and Discussion

Overview of socioeconomic features

Socio-demographic profile

The buffer zone covers 108 administrative wards with an estimated 16,710 households in 2012 (Table 2). Based on the 369 households surveyed in this thematic study, 89% of households were headed by a male member and only 10.6% of the surveyed households were female-headed (Table 3). The mean size of a household was 6.4 members. The dependency ratio was estimated as 64.4 persons of dependent ages (0–14 years, and 65 years and above) per 100 persons of working age (15–64 years).

According to the LAT, most households had at least one literate member; only 7.6% of households did not have any literate members aged six years and above. Unsurprisingly, there were more households with at least one male literate member (88.6%) than a female one (71%) (Figure 4).

Table 2: **Household population in buffer zone areas of the KTWR**

VDCs	District	Wards	Settlements	Number of households		
				2000	2011	2012
Prakashpur	Sunsari	9	21	1,111	3,206	3,530
Madhuwan	Sunsari	9	27	993	1,471	1,525
West Kushaha	Sunsari	9	32	1,423	2,106	2,182
Laukahi	Sunsari	5	9	248	345	356
Shreepur	Sunsari	4	6	540	751	774
Haripur	Sunsari	5	12	417	580	598
Tapeshwari	Udaypur	6	27	1,192	1,577	1,618
Odraha	Saptari	9	13	603	977	1,021
East Pipra	Saptari	9	9	707	819	830
Jagatpur	Saptari	9	16	655	880	904
Badgamma	Saptari	9	18	670	900	924
Bairawa	Saptari	9	7	775	762	761
Kamalpur	Saptari	8	8	684	834	849
Barmajhiya	Saptari	4	4	326	397	405
Ghoghanpur	Saptari	2	4	265	323	329
Dharampur	Saptari	2	2	84	102	104
Grand total		108	215	10,693	16,032	16,710

Note: Village Development Committee (VDC) wise household population figures for 2000 are taken from the Department of National Parks and Wildlife Conservation (DNPWC 2000); Figures for 2011 and 2012 are based on the 2011 population census and projection estimate, based on the inter census household growth rate between 2001 and 2011.

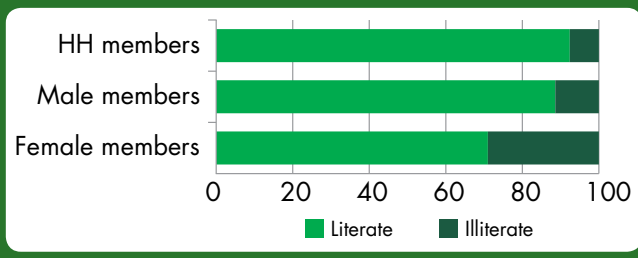
Table 3: **Head of household's gender by district (in %)**

Wetland	Male	Female	Total	N
Saptari	83.63	16.37	100	171
Sunsari	98.18	1.82	100	165
Udaypur	75.76	24.24	100	33
Koshi Tappu	89.43	10.57	100	369

N = 369 HH, 100%; data: LAT 2011

Livelihood strategies

Figure 4: **Percentage of households with at least one literate household member (in %)**



Local livelihoods in the KTWR buffer zone were based on a combination of farming, animal husbandry, wage and salaried labour, and remittances. This study further assessed households' dependency on primary, secondary/tertiary, and other income sources (Table 4). Only 7.9% of households were exclusively dependent on primary sector income sources. Primary sector income sources contributed a mean of 41.2% to total yearly household income in the KTWRBZ. At the same time, 13.3% of households in the KTWRBZ received no contribution from primary sector income sources to yearly household income. Secondary and tertiary sector income sources contributed a mean 38.2% to total yearly household income. Other income sources (for example, rent, gifts, and social benefits) contributed a mean 20.7% to total yearly household income.

Farming households in the KTWRBZ grew a diverse range of cash crops. Onion (34.2%), winter potato (28.7%), garlic (26.8%), legumes (24.1%), and chilli pepper (10.8%) were the major cash crops grown by households in the area during the 12 months preceding the survey (Table 5). Around 77 households, 20.9% of the total surveyed households had members managing or running non-agricultural businesses. Out of these household, more than half (58.4%) were involved in managing wholesale or retail trade. More than half of the households (53.1%) had at least one member employed in a non-agricultural occupation (Table 6), such as construction (29.6%), manufacturing (17.4%), private household with employed persons (10.7%), mining and quarrying (6.1%), wholesale and retail trade (5.6%), or security services (5.1%).

More than 50% of households had at least one member who had migrated domestically or internationally. The percentage of households with international labour migrants (29.5%) was slightly higher than those with domestic labour migrants (24.9%). Most of the migrants worked in urban areas. Major international destinations for migrants included Malaysia, Qatar, India, and Saudi Arabia. The mean amount of remittances received from within Nepal during the 12 months prior to the survey was USD 617.1, whereas the mean amount of remittances from outside the country during the same period was USD 554.8. This difference could be due to the frequency of remittances as internal labour migrants return home more frequently than international migrants.

Table 4: **Sources of income**

Primary sectors	Secondary and tertiary sectors	Other sectors
■ Crop, vegetable, and fruit sales (grown and collected) ■ Livestock and livestock product sales ■ Fish sales ■ Forest product sales (fuelwood/non-timber forest products) ■ Herb sales ■ Medicinal and aromatic plant sales	■ Daily wages ■ Salaried employment ■ Tourism ■ Other business and trade income	■ Remittances ■ Development aid projects ■ Gifts or begging ■ Governmental social benefit schemes

Table 5: **Types of cash crops grown by households during the 12 months preceding the LAT survey (in %) by members of the household of KTWR**

Cash crop type	%	Cash crop type	%	Cash crop type	%
Main paddy	0.54	Summer potato	0.27	Onion	34.15
Winter/spring maize	0.27	Mustard	5.96	Garlic	26.83
Summer maize	2.44	Linseed	1.90	Coriander seed	8.94
Black gram	0.54	Other oilseed	1.90	Winter vegetables	4.34
Lentil	5.15	Sugarcane	1.63	Summer vegetables	2.98
Cow pea	0.54	Jute	4.07	Mango	1.08
Other legumes	17.89	Other cash crops	1.90	Jackfruit	0.27
Winter potato	28.73	Chilli pepper	10.84	Bamboo	1.36

N = 369 hh, 100%; Data: LAT 2011.

Dependency on ecosystem services

An extremely high number of local people (over 70,000) were found to be dependent on ecosystem services from the reserve. The collection and use of reserve resources greatly contributed to individual livelihoods, as well as the local economy, showing the deep links between ecosystem services and poverty (Shrestha and Alavalapati 2006; CSUWN 2009; Rayamajhi 2009). A review of the literature showed local people are highly dependent on the KTWR's natural resources, specifically forest and wetland resources. Of the forest products, the local population relies most on fuelwood (91% of the local population is dependent), followed by thatch (82%), timber (54%), and grasses (51%). People also depend heavily on wetland ecosystems of rivers/streams and swamps/marshes for a variety of goods and services such as fish (38%), driftwood (31%), and snails (23%), among others (Table 7). As seen in Table 7, local people are highly dependent on reserve products not only for subsistence livelihoods, but also for the contributions the harvesting of these products make to the local economy.

The 2009 data was further validated through household surveys, which provided more detailed information on dependency and resource use patterns.

Table 6: **Type of non-agricultural occupations hhs are employed in by district and country**

Type of occupation	Wetland %
Mining or quarrying	6.1
Manufacturing	17.4
Electric, gas or water	5.6
Construction	29.6
Wholesale or retail trade	5.6
Hotel and restaurant	2.0
Transport, storage and communication	2.6
Financial intermediate	0.5
Public administration	4.1
Security services	5.1
Education	2.6
Health and social worker	2.6
Other community, social and personal service activities	5.1
Private household with employed persons	10.7
Extra territorial organizations and bodies	0.5

N = 369 hh, 100%; data: LAT 2011.

Primary construction material: According to the LAT, most of the surveyed households in the KTWRBZ used natural material – thatch/bamboo (80.5%), wood branches (7.6%), burnt bricks (6.2%), and grass/leaves/reeds (3%) – as the primary construction material for the exterior walls of their houses. Many surveyed households (47.3%) also used thatch/bamboo as the primary construction material for roofs.

Primary source of fuel for cooking and heating: According to the LAT, the majority of the surveyed households (92.1%) used wood, sawdust, grass, or other natural materials for fuel for cooking. The majority of surveyed households also used wood, sawdust, grass, or other natural materials (58.2%) and vegetable/animal based fat (13%) as the primary source of fuel for heating.

Water supply for domestic use and agriculture: Borewells were the most common source of drinking water for a majority of the surveyed households. Of the surveyed households engaged in agriculture, 44.3% reported that the majority of their agricultural land was irrigated, while 45.4% stated theirs was rain-fed.

Table 7: **Dependency of local people on ecosystem services from the KTWR**

Products	Purpose	Percentage	Rank
Fuelwood	Cooking food, animal feed	91	1
Thatch	Roofing	82	2
Timber	Construction, cattle-shed, fencing, agriculture	54	3
Grasses	Livestock feeding	51	4
Poles/shafts	House construction	44	5
Fish	Food and sale	38	6
Driftwood	Fuelwood	31	7
Pater	Mat weaving (use and sale)	30	8
Edible green vegetables	Food and sale	26	9
Snails	Food and sale	23	10
Reeds/canes	Construction, repairing of houses	20	11
Wild edible fruits	Food	19	12
Fodder	Livestock	17	13
Crabs	Food	14	14
Litter	Animal bedding, manure	10	15
Sand	Construction material	9	16
Edible fruits	Food (pickles and vegetables)	5	17
Medicinal plants	Use and sale	3	18
Tortoise	Food	2	19
Birds	Food and sale	2	20
Edible roots/tubers	Sale	1	21

Source: CSUWN 2009

Dependence on primary sector activities: The livelihoods of most households were based on a combination of primary, secondary, and tertiary sources. According to the LAT, the yearly household incomes of 13.9% of the surveyed households received no contribution from primary income sources. The mean percentage contribution of primary income sources to total yearly household incomes was 41.2%.

Livestock grazing patterns: The grazing patterns of major livestock illustrated extensive use of community land, the KTWR, and community forest. Interestingly, according to the LAT the reserve area was a significant grazing area: 39.5% of households used it to graze bullocks/cows, 15.1% for buffaloes, and 9.9% for goats.

Fish catching or breeding: About 6% of households reported breeding or catching fish during the 12 months preceding the LAT survey.

Collection of timber and non-timber forest products: Fuelwood was the most important product collected from the watershed. According to LAT, an average of 211.2 kg per annum per household was collected in Saptari, 520 kg in Sunsari, and 1328.8 kg in Udaypur. Other important products were grass/forage (Saptari: 214.5 kg, Sunsari: 217.3 kg, and Udaypur: 45.8 kg), and thatch (Saptari: 61.3 kg, Sunsari: 108.2 kg, and Udaypur: 46.1 kg). Wild edible vegetables (44.3 kg), reed/cane (29.9 kg), and dried/fallen leaves (29.1kg) were important products collected from the KTWRBZ in Saptari District. Timber (88.2 ft^3) was an important product collected from the KTWRBZ in Udaypur District (see Table 8).

Nature-based tourism: According to the LAT, less than 1% of the surveyed households had members employed in managing nature-based tourism businesses.

Perceived importance of ecosystem services

According to the LAT, the watershed is perceived as being of considerable importance to households for goods and services like religious, cultural, and recreational activities (75.1%), livestock use (65.8%), and non-timber forest products (53.3%). Other ecosystem services and goods perceived as being of significant, though lower, importance

Table 8: **Quantity of products collected from the watershed in the 12 months preceding the survey**

Products collected	Numbers	Saptari	Sunsari	Udaypur	Koshi Tappu
Timber (in cuft)	Mean	0.2	0.2	88.2	8.1
	Sum	37	41	2,912	2,990
	N	171	165	33	369
Fuelwood (in kg)	Mean	211.2	520.0	1,328.8	449.2
	Sum	36,120.3	85,800	43,850	165,770.3
	N	171	165	33	369
Wild edible vegetables (in kg)	Mean	44.3	5.2	17.2	24.4
	Sum	7,572	859.1	568	8,999.1
	N	171	165	33	369
Wild edible fruits (in kg)	Mean	1.7	0.1	0	0.9
	Sum	295	20.1	0	315.1
	N	171	165	33	369
Dried/fallen leaves (in kg)	Mean	29.1	9.6	0.5	17.8
	Sum	4,980	1,582	16	6,578
	N	171	165	33	369
Grass/forage (in kg)	Mean	214.5	217.3	45.8	200.6
	Sum	36,672	35,850	1,510	74,032
	N	171	165	33	369
Fodder (in kg)	Mean	4.4	2.8	29.2	5.9
	Sum	750	460	965	2,175
	N	171	165	33	369
Bamboo (in kg)	Mean	0	0.4	0	0.2
	Sum	0	70	0	70
	N	171	165	33	369
Reed/cane (in kg)	Mean	29.9	2.6	1.4	15.1
	Sum	5,105.1	432	47	5,584.1
	N	171	165	33	369
Thatch (in kg)	Mean	61.3	108.2	46.1	81.0
	Sum	10,489.1	17,860	1,522	29,871.1
	N	171	165	33	369
Medicinal or aromatic plants (in kg)	Mean	0.1	0.5	0	0.3
	Sum	16	80	0	96
	N	171	165	33	369
Crab (in kg)	Mean	0.4	0.5	0.2	0.4
	Sum	60	81	5	146
	N	171	165	33	369
Snail (in kg)	Mean	6.2	0.7	0.3	3.2
	Sum	1,067	112	10	1,189
	N	171	165	33	369
Game animal (in kg)	Mean	0.01	0	0	0.01
	Sum	2	0	0	2
	N	171	165	33	369

100%; data: LAT 2011

are fish breeding and catching (36.5%), timber (20.2%), and collection of crabs and snails (18.1%). Households did not perceive the watershed as important for providing services like game animals (9.3%), boating (5%), irrigation (3.3%), and domestic water supply (1.4%) (Table 9). It should be noted that the figures presented in Table 9 refer to people's perceptions, which are different from the figures presented by valuation (Table 13). For example, the figures may differ for domestic water supply because people use water for free and thus do not perceive it as important, while livestock use and non-timber forest products are perceived as very important because their economic returns are visible and high.

Table 9: **Perceived importance of ecosystem services from the KTWR during the ten years preceding the survey**

Services provided	Very important	Fairly important	Less important	Not important	Total	N
Domestic water supply	1.1	0.3	0	98.6	100	366
Irrigation	1.4	1.6	0.3	96.7	100	365
Livestock use	46.0	12.1	7.7	34.3	100	365
Timber	2.5	2.7	15.0	79.8	100	366
Non-timber forest products	18.4	13.2	21.7	46.7	100	364
Fish breeding/catching	5.2	19.7	11.5	63.6	100	365
Collection of crabs/snails	1.1	10.4	6.6	81.9	100	365
Game animals	0.3	6.9	2.2	90.7	100	364
Religious/cultural/recreational activities	23.8	20.6	30.7	24.9	100	365
Boating	2.8	1.1	1.1	95.0	100	363

100%; data: LAT 2011

Community institutions

According to the Buffer Zone Management Regulation of 1996, three-tier institutional systems were set up to manage activities.

User Group: The first tier includes user groups at the lowest level, such as hamlet or settlement, called buffer zone user groups (BZUGs). These groups are managed by a committee of a chairperson, vice chairperson, and a secretary.

User Committee: The second tier includes user committees at the area level. Called Buffer Zone User Committees (BZUCs), these are formed by chairpersons and secretaries, who are representatives of the user groups. According to the Buffer Zone Management Regulation (1996), BZUCs should have at least nine members comprising a president, vice-president, secretary, treasurer, and at least five members. The administrative unit of the BZUCs are divided into six 'ilakas' (areas). Guidelines indicate that there should be at least three women in BZUC executive committees.

Management Committee: The highest-level groups are called Buffer Zone Management Committees (BZMCs). The committees are composed of nine chairpersons from each user group, a warden, and three district representatives, one each from three district development committees. The warden serves as member-secretary to the committee.

In addition, there are separate community forest user groups, called Buffer Zone Community Forest User Groups (BZCFUGs). A CSUWN study (2009) reported only 506 active user groups: 244 male-headed groups and 262 female-headed groups. Altogether, there are 15,961 members in user groups from households in the buffer zone area. Findings of the CSUWN study in relation to the effectiveness of buffer zone institutions in Koshi Tappu are briefly summarized below.

- The Buffer Zone Management Regulation (1996) states that buffer zone institutions should engage in different activities such as biodiversity conservation, natural resource mobilization, income generation, and mobilization of savings and credit. While almost 94% carry out biodiversity conservation activities, only 6% are engaged in savings and credit activities.
- The interaction between BZUGs and BZUCs was limited after some of the project activities were wrapped up; in this regard BZUCs were non-functional and conducted few meetings.
- Gender representation remained unbalanced at 89% male in BZMCs and 81% male in BZCFUGs. Similar trends were found in the first tier. In BZUCs, however, representation of males and females was about equal at 48% male and 51% female.
- According to the regulation, it was mandatory for BZUGs to hold elections for the posts of chairperson, vice-chairperson, and secretary every two and a half years. Though not initially practised, this was corrected during the reformation process in 2010.
- There is no special provision for including the poor, minorities, and Dalits in decision-making positions in the buffer zone institutions. Revised buffer zone regulations have taken this issue into account, but a provision has not been approved due to the current political stalemate.
- Although the BZMCs are required to meet four times a year, they did not hold meetings during the initial two years. About eight BZMCs reported that they have meetings only once a year; and the rate of participation is also very poor. Only 6% of BZUGs said they organize meetings regularly at 15-day intervals.
- The institutions in the buffer zone were unable to implement programmes or activities for the first three years after formation. This was mainly due to a lack of resources as there was neither buffer zone revenue, nor support from other projects. Therefore, all BZUGs were inactive and no benefits were reported in the area. It was found that only BZCFUGs are sharing their benefits.
- Buffer zone institutions are weak in terms of human, financial, and material resources; their performance decreases in successive institutional tiers due to various external and internal factors.

Overview of ecological features and ecosystem goods and services

Floral diversity

There have been a number of extensive studies on the flora of the KTWR (WMI/IUCN 1994; IUCN 1998; DNPWC 2009). These studies reported 514 species of higher plants from the reserve. Siwakoti (2006) conducted a detailed study and updated the list of flora of the KTWR, reporting as many as 670 species of vascular plants, including 448 species of dicotyledons, 200 species of monocotyledons, and 22 species of ferns and fern allies. Other species of conservation significance found in the reserve include three tree species – satisal (*Dalbergia latifolia*), simal (*Bombax ceiba*), and khair (*Acacia catechu*) – which have been legally protected by the Government of Nepal, and two species of orchids listed under Appendix II of CITES – tutia (*Zeuxine strateumatica*) and lawn orchid (*Spiranthes sinensis*) (IUCN 1995). Shrestha (1996) conducted a field study of aquatic macrophytes in the KTWR and reported 78 species. These species belong to the following major groups: Algae (1), Bryophyta (1), Pteridophyta (4), Monocotyledons (40), and Dicotyledons (31). Among them, two emergent floating hydrophyes – pondsilk (*Spirogyra species*) and water hyancinth (*Eichhornia crassipes*) – were most prominent. In addition, about eight genera and 26 species of phytoplanktons/desmids have been reported from ponds and barrages in Koshi Tappu. Among them, some 11 taxa are new records for Nepal. New records for Nepal include *Euastrum platycerum*, *Cosmarium subspeciosum validius*, *Cosmarium zonatum javanicum*, *Staurastrum leptocladum cornutum Staurastrum sexangulare productum*, *Onychonema filiforme Onychonema leave latum Desmidium baileyi baileyi* (Rai and Misra 2009). Among the diverse floral species reported from the KTWR, about 11 species of flora have been reported as threatened and protected under Forest Regulations of Nepal 2051 v.s., CITES, and IUCN (DNPWC 2009). Overall floral diversity of the KTWR is summarized in Table 10, and a detailed list of plant species reported from the reserve is given in Annex II.

Table 10: **Status of floral diversity in the KTWR**

Flora	Number of species	Sources
All vascular plants	670	Siwakoti 2006
Protected species	11	IUCN 1998; DNPWC 2009.
Aquatic species	78	Shrestha 1996
Species of ethno-botanical use	63	Shrestha 1996, 209-210; DNPWC 2009
Desmids	26	Rai and Misra 2009

The local communities have inherited rich knowledge on the use of cultivated and wild plants. Several species of ceremonial plants are used in 11 different rituals, rites, and worship practices (DNPWC 2009). For instance, the fruit of Gorgan nut (*Euryale ferox*), or makhana, is used for a ritual performed on the full moon night in October. Similarly, various uses of aquatic macrophytes have also been studied in Koshi Tappu. About 63 species have been documented according to their use by local communities. These uses include food for humans, birds, and fish; fodder for domestic livestock; medicinal plants for primary healthcare; and other uses such as fuelwood, fibre, and material for small handicrafts. Aquatic plants are also used as biofertilizers, for poisoning fish, and for other purposes. Four species are reported to have toxic properties (*Datura metel, Mimosa pudica, Persicaria punctata*, and *Pogostemon amarantoides*).

Faunal diversity

The KTWR is equally rich in faunal diversity. So far, 21 species of mammals (Chhetry and Pal 2010), 45 species of herpetofauna (DNPWC 2009), 77 species of butterflies, and 494 species of birds (BCN 2011) have been recorded in the reserve. Despite enormous anthropogenic pressure, the reserve continues to support a large number of globally and nationally threatened species (DNPWC 2009; WWF 2008; CSUWN 2009). Systematic study of faunal diversity in the KTWR began with a pioneering study by WMI/IUCN in 1994, which provided baseline data on various species. The study reported a total of 23 species of vertebrates (13 species of mammals, eight species of reptiles and two species of amphibians), 21 species of invertebrates (15 species of arthropods, five species of mollusks, and one species of annelid), and 167 species of birds. A recent study on the distribution of swamp francolin in a part of the KTWR (15 km^2) recorded at least 13 breeding pairs-based on call counts. The maximum number of calls were recorded in woodland and dry grassland areas (Katti 2012). General statistics on faunal diversity in the KTWR according to DNPWC (2009) and other sources are given in Table 11.

Of the 21 mammal species reported in the reserve, 12 have been categorized as threatened according to the National Park and Wildlife Conservation (NPWC) Act (1973) of Nepal. Most have also been listed under the IUCN Red List as well as the CITES Appendix. The list of mammals is given in Annex III.

Table 11: **Status of faunal diversity in the KTWR**

Fauna	Number of species	Sources
Mammals	21	DNPWC 2009
Herpetofauna	45	IUCN 1998; DNPWC 2009
Fish	200	DNPWC 2009
Birds	494	BCN 2011
Butterflies	77	DNPWC 2009
Invertebrates	21	WMI/IUCN 1994

Among the 45 species of herpetofauna reported in the KTWR, nine species are listed as protected according to the NPWC Act, which also appear in the IUCN Red List and CITES Appendix-IV. Two species of herpetofauna – Burmese rock python (*Python morulus bivittatus*) and golden monitor lizard (*Varanus flavescens*) – have been legally protected by the Government of Nepal. Six species are listed as threatened under the IUCN Red List, with only the marsh crocodile (*Crocodylus palustris*) under the vulnerable category. Local people said the Gangetic gharial (*Gavialis gangeticus*) used to be found in the reserve. The park management released several batches of gharials into the reserve a few years earlier; however, despite repeated observations, no gharial sightings have been reported in recent years (Chhetry 2010; Goit 2011; Goit and Basnet 2011). A detailed list of herpetofauna is given in Annex IV.

Eight species of fish found in the KTWR are listed in the Red Data Book (Suwal et al. 1995) under the vulnerable category, and one species, the sahar (*Tor tor*), falls under the endangered category. A detailed list of fish is given in Annex V. The KTWR is also one of the most important habitats for birds, with about 19 threatened species. A detailed list of birds is given in Annex VI.

Invasive species

The most dominant invasive species (both aquatic and terrestrial) in the KTWR are the water hyacinth (*Eichhornia crassipes*) and the Chinese creeper (*Mikania micrantha*), both of which are found almost everywhere. The former occupies wetlands and smaller water bodies, while the latter is common in moist, open forests, affecting the regeneration of fodder species. Other alien invasive species are listed in Table 12.

State of ecosystems

The KTWR has four major types of ecosystems: forest ecosystem, freshwater ecosystem, grassland ecosystem, and agro-ecosystem.

Forest ecosystem: The forest ecosystem covers about 1% of the total land of the reserve. Located between 75-81 metres above sea level, the forest ecosystem is associated with land masses roofed with trees, shrubs, and grasses. It is characterized by a mixed deciduous riverine forest predominated by sisso (*Dalbergia sissoo*), khair (*Acacia catechu*), and simal (*Bombax ceiba*). Vellar (*Trewia nudiflora*), and jamun (*Syzugium cumini*) are found associated with the major tree species. Besides these, *Strebulus asper*, *Albizzia chinensis*, and *Phyllanthus emblica* are also found in the reserve.

Freshwater ecosystem: Located on the floodplains of the Sapta Koshi River – a natural and permanent freshwater river system – the reserve is characterized by grassy marshes, oxbow lakes, back swamp lakes, and many other depressions that retain water throughout the year. Rivers and streams cover about 10%, marshes cover 5%, and lakes and ponds cover 1% of total area of the reserve. The freshwater ecosystem consists of diverse vegetation,

Table 12: **Common invasive plant species in the KTWR**

Family	Scientific name	Common name	Local name	Rank
Pontederiaceae	*Eichhornia crassipes*	Water hyacinth	Jalkumbhi	High risk
Convolvulaceae	*Ipomea carnea*	Shrubby morning glory	Besaram	High risk
Asteraceae	*Mikania micrantha*	Chinese creeper	Lahare banmara	High risk
Amaranthaceae	*Alternanthera philoxeroides*	Alligator weed	Jaljambhu	Medium risk
Araceae	*Pistia stratiotes L.*	Water lettuce/duck weed	Kumbhika	Low risk

Source: Tiwari et al. 2005

including submerged and floating aquatic plants such as *Hydrilla* sp., water hyacinth, Kamal (*Nelumbo nucifera*), water lily (*Nymphaea nouchali*), pater (*Typha* sp.) and *Coca* sp. This ecosystem is critically important, supporting mammals, birds, amphibians, herpetofauna, invertebrates, and most of the fish.

Grassland ecosystem: Grassland is the dominant ecosystem, covering 56% of the total area of the reserve. This vegetation is frequently flooded during the monsoon and remains wet for several months. The grassland is dominated by *Catapogonium mucuniodes, Nsphrolepsis species, Lantana camera, Cyperus species, Phragmites karka, Carex species, Sagina species, Eurya species, Cyanoden species, Vertiveria lawsonii, Stellaria species, Sambucus species, Polygonum species, Rumex nepalensis*, and others. According to WMI/IUCN (1994), there are five types of grasslands in this reserve:

- ***Saccharum-Phragmitis* grassland:** This type of grassland is common along the banks of the Koshi River. In addition to the two dominant species of *Saccharum* and *Phragmitis*, other species, including *Desmodium* sp., *Eclipta prostrate*, *Cucurbita* sp., *Cyperus* sp., and *Setaria palledifusca,* are commonly found.
- ***Saccharum-Typha* grassland:** One of the many colonizers in water bodies is *Typha*. Other species such as *Saccharum spontaneum*, *Persicaria barbata*, *Tetrastigma serrulatum*, and *Cucurbita* sp. were also reported.
- ***Saccharum* grassland:** Grasslands dominated by *Saccharum* species can be found near water bodies. Dominant species include *Saccharum spontaneum*, *Desmodoum* sp., *Diplazium esculentum*, and *Eupatorium odoratum*.
- ***Imperata* grassland:** This type of grassland occurs in drier parts of the KTWR and between forest patches, especially in open areas. *Imperata* generally stands alone, though *Desmodium triflorum* is sometimes an associated species.
- ***Cymbopogon-Saccharum* grassland:** This type of grassland also occurs in drier parts of the area. Dominant species are *Cymbopogon pendulus, Desmodium trifolium, Phragmites karka*, and *Saccharum spontaneum*.

Agricultural ecosystem: About 5% of the reserve area has been encroached on and is under cultivation by local people. As about 98% of the area is located in the buffer zone, the agricultural ecosystem interacts heavily with other ecosystems such as forest, freshwater, and grassland. These interfaces provide a good habitat for diverse mammals and birds due to their edge effects and high nutrients following the application of manures and fertilizers.

State of ecosystem goods and services

The reserve provides a diverse array of goods and services; local people mostly rely on its provisioning services. A total of 18 provisioning services, eight regulating services, four cultural services, and two supporting services have been reported from the reserve (Table 13). The religious, cultural, and aesthetic services that the reserve provides are equally important. The KTWR has been supporting and protecting natural systems and processes that directly and indirectly support and benefit human activities. For instance, the reserve offers services such as irrigation, water storage, carbon sequestration, and pollution control, which help regulate local and regional climate and maintain local temperature. The reserve also plays a significant role in facilitating processes like biodiversity, nutrient cycling, and pollination, which all help to maintain habitats for endangered species and pollinators in the area, in storage and acquisition of nutrients, and in sediment retention.

Land use and land cover systems differ in their potential to provide ecosystem goods and services. Using the land cover and land use information generated from geographic information system (GIS) and remote sensing (RS) software, and the list of ecosystem services, an assessment was conducted to analyse the potential of each land use.

Table 13: **Ecosystem goods and services reported from the KTWR**

Types of services (number)	Services recorded
Provisioning (18)	Birds, crabs, fish, snails, tortoises, edible plants, fodder, grass, medicinal plants, litter, timber/poles, fuelwood/driftwood, thatch, pater/reeds, sand, drinking water, irrigation, water use by livestock, bathing/washing
Regulating (8)	Carbon sequestration, flood control, pollination, groundwater recharge, habitat for endangered species, climate regulation, nutrient regulation, water purification
Cultural (4)	Recreation, aesthetic value, education and research, spiritual/inspirational value
Supporting (2)	Biodiversity maintenance, soil formation

The results, based on the sum of the matrix (Table 14), revealed that rivers/lakes and swamps/marshes are the most productive ecosystems in terms of provisioning services with scores of (33) each, followed by forest (29), grassland (18), and agricultural land (16). Despite covering relatively low percentages of the total area of the reserve, rivers/streams (10%) and swamps/marshes (6%) have a high capacity to provide provisioning services. Similarly, forests, covering only about 1% of the reserve, have a high capacity compared to other land uses that have greater coverage. This means land uses with lower coverage are under intense anthropogenic pressure as a result of both higher dependency and higher production capacity.

A similar assessment was undertaken considering the eight regulating, four cultural, and two supporting services (see Table 15). The assessment showed similar results as those for provisioning services. Forested areas, swamps/marshes, and grassland were the most valuable land cover types for these services. However, it should be noted that scores for cultural and supporting services were comparatively lower than scores for provisioning and regulating services, mainly due to the lower number of variables used to score these services.

Table 14: **Matrix for assessment of different land cover types to provide provisioning services**

Land use	Provisioning services (Sum)	Birds (poaching)	Crabs	Fish	Snails	Tortoises	Edible plants	Fodder/grass	Medicinal plants	Litter	Timber/poles	Fuelwood/driftwood	Thatch	Pater/reeds	Sand	Drinking water	Water use by livestock	Bathing/washing	Irrigation
Grassland	18	3	1	0	0	2	2	3	1	2	0	1	3	0	0	0	0	0	0
Swamps/marshes	33	3	3	3	3	3	3	2	2	1	1	1	0	3	0	1	2	1	1
Forest	29	3	2	0	0	2	3	3	3	3	3	3	0	2	0	0	1	0	1
Rivers/Lakes	33	3	3	3	3	3	1	0	0	0	0	2	0	0	3	3	3	3	3
Barren land	10	2	1	0	0	1	1	1	1	1	0	0	1	0	1	0	0	0	0
Agricultural land	16	1	2	2	2	2	1	2	1	1	0	0	0	0	0	0	1	0	1

0 = no service, 1 = low service, 2 = medium service, and 3 = high service

Table 15: **Matrix for assessment of different land cover types to provide regulating, supporting, and cultural services**

Land use	Regulating services (Sum)	Co_2 sequestration	Erosion/flood control	Pollination	Groundwater recharge	Habitat for endangered species	Local/global climate regulation	Nutrient regulation	Water purification	Cultural services (Sum)	Recreation	Aesthetic value	Education and research	Spiritual/inspirational value	Supporting services (Sum)	Biodiversity maintenance	Soil formation
Grassland	17	2	2	1	3	3	2	2	2	6	2	1	2	1	6	3	3
Swamps/marshes	22	2	3	2	3	3	3	3	3	9	2	2	3	2	5	3	2
Forest	22	3	3	3	3	3	3	2	2	12	3	3	2	1	6	3	3
Rivers/lakes	16	1	0	1	3	3	3	2	3	9	3	3	2	3	4	3	1
Barren land	8	1	1	1	1	1	1	1	1	4	1	1	1	1	2	1	1
Agricultural land	11	2	0	2	2	1	1	2	1	5	0	1	2	2	4	2	2

Value of ecosystem services

Provisional services: Local people residing in the KTWRBZ harvest numerous products from the KTWR, most of which they consume to meet survival needs. The provisioning services that are most valued are crops, fish, wild edibles, animal fodder, fuelwood, timber, and non-timber forest products including domestic water supply. Table 16 shows the annual value of different provisioning services per household, as well as the aggregated values for all dependent households residing in the buffer zone, using the methods stated earlier.

The aggregate value of provisioning services was estimated from the total number of households dependent on each type of harvested resource from the KTWR. The overall value of provisioning services was estimated at USD 13,675,225 per year, equivalent to USD 781.4 per ha per year or USD 818.4 per household per year. In other words, an average household in the KTWR derived USD 818.4 worth of annual economic benefit from provisioning services provided by the reserve. Comparing this estimate to the average annual household income of the study area estimated at USD 1,113 in 2012 prices, it is clear that the aggregate value of provisioning services extracted from the reserve contributes more than 70% of annual household income, although some of these benefits were not immediately visible in terms of direct household income. Floodplain agriculture, livestock fodder, and fish were found to be the most important provisioning services, together accounting for 81% of the total value of provisioning services and 60% of annual household income. In the next section, a discussion of the economic value of each provisioning service, estimated using available data from different sources, and their relative share in the total economic value are provided.

Floodplain agriculture: Paddy and wheat crops grown in the summer and winter seasons, respectively, were considered in the valuation of floodplain agriculture. With the estimated total number of households dependent on floodplain agriculture, the total annual net benefit generated from these crops is estimated at NPR 357.5 million (USD 4.15 million) accounting for 30% of the total value of provisioning services, and 25% of the total economic value. Estimates derived by Rayamajhi (2009) and Joshi (2012) are lower than the estimates made in this study. This

Table 16: **Estimated annual and total economic value (TEV) of provisioning services (PS) provided by the KTWR**

	Average value (NPR/hh)	HH dependency weight	Estimated dependent HHs in 2012	Total value (NPR/yr)	Total value (USD/yr)	Average value/ hh/yr (USD)	Average value/ ha/yr (USD)	% Share of TEV	% Share of PS	% Share in annual HHs income
Cow and buffalo	33,214	0.61	10,193	338,547,891	3,933,004	235.4	224.7	24.5	28.8	21.1
Goats and sheep	2,608	0.63	10,527	27,451,822	318,915	19.1	18.2	2.0	2.3	1.7
Floodplain agriculture	25,471	0.84	14,036	357,508,717	4,153,277	248.6	237.3	25.9	30.4	22.3
Fish (captured fishery)	36,290	0.38	6,350	230,427,353	2,676,938	160.2	153.0	16.7	19.6	14.4
Fuelwood	6,867	0.80	13,368	91,796,517	1,066,425	63.8	60.9	6.7	7.8	5.7
Driftwood	738	0.31	5,180	3,822,850	44,411	2.7	2.5	0.3	0.3	0.2
Timber	3,804	0.12	2,039	7,754,243	90,083	5.4	5.1	0.6	0.7	0.5
Poles	666	0.05	869	579,110	6,728	0.4	0.4	0	0	0
Pater/typha mat	3,998	0.30	4,946	19,771,943	229,696	13.7	13.1	1.4	1.7	1.2
Neuro (edible plant)	414	0.26	4,294	1,775,856	20,631	1.2	1.2	0.1	0.2	0.1
Thatch	2,645	0.82	13,618	36,018,002	418,431	25.0	23.9	2.6	3.1	2.2
Domestic water supply	3,806	0.97	16,209	61,691,280	716,685	42.9	41.0	4.5	5.2	3.9
Aggregate value				1,177,145,583	13,675,225	818.4	781.4	85.3	100.0	73.5

Note: Domestic fresh water supply is treated as a provisioning service following the MEA classification, although it is also regarded as a regulating service by other classifications. The estimated number of total households dependent on each wetland product was derived by applying the household dependency share to the projected total number of households (16,710) residing in the KTWRBZ in 2012.

is because Rayamajhi used only paddy crop while Joshi used a fairly low yield rate of wheat – 384 kg/ha, which is about 16% of the eastern Terai's average 2,420 kg/ha in 2008 (CBS 2009).

Fishery products: The net annual income from fishery products was estimated to be NPR 36,290 per household. This translates to a total net annual value of NPR 230,427,353 (USD 2,676,938) generated from the wetland for all fishing households (40% of total households) in the area. This represents 20% of the total value of provisioning services and 17% of the total economic value. Estimates derived by Rayamajhi (2009) and Joshi (2012) are lower than the estimates made in this study.

Livestock fodder: Considering over 60% of households own cows and buffaloes, the total net benefit from grassland fodder was estimated at NPR 338.5 million per year (USD 3.9 million/year). Assuming 63% of households owned goats and sheep (CSUWN 2009), the total net value of goats and sheep was estimated to be NPR 27,451,822 (USD 318,915). Thus, the overall annual net value of grassland fodder in terms of all livestock income was estimated to be NPR 365,999,713 (USD 4,251,919). This represents about 31% of the provisioning services value, 27% of the total economic value of the KTWR, and about 23% of the average annual income of households in the buffer zone.

Domestic water supply benefit: In addition to supporting extensive rice plantations, groundwater has been identified as the main source of drinking water and water for other household work (BCN 2011). The value transferred based on CSUWN (2011), which provided a unit adjusted transfer value of USD 37.7 per household in 2010 prices, was applied to Nepal where wetlands are the source of drinking water. The value was further adjusted to 2012 prices (USD 44.2 per household) to derive the water supply benefit provided by the KTWR. With an estimated 16,209 households (97% of the total households rely on groundwater tube wells for drinking water) in the buffer zone, this translates to a total annual value of NPR 61,691,280 (USD 716,685), and accounts for 4.5% of the estimated total economic value of the KTWR wetland.

Other wetland products: The estimated combined annual value of fuelwood and driftwood amounts to NPR 95,619,367 (USD 1,110,837), accounting for 8% of the total value of provisioning services and 7% of the total

economic value of the KTWR. Timber and poles were collected by very few households; the average annual value of these products per household amounted to NPR 3,804 and NPR 666 respectively. An average household harvests 912 kg of thatch grass annually (CSUWN 2009). Some households also sell thatch to others at about NPR 2.9/kg. The average annual value of thatch per household was NPR 2,645 or a total of NPR 36,018,002 (USD 418,431) per year for all thatch-dependent households, accounting for 3% of the total provisional services value (see Table 16). Pater or typha (cattail) collection, processing, and production of mats for home use and selling was practised by about 30% of households; at an average annual collection of 246 kg per household (CSUWN 2009), a value of NPR 3,998 per household was estimated after deducting costs. Fern (*Dryopteris chochleata*), called 'neuro' locally, is a widely used wild edible harvested from the reserve. About 26% of households collect fern from the KTWR, although the annual collection rate (7.6 kg per household) was very low (CSUWN 2009). Most of the collected fern was consumed at home, and the surplus sold in nearby markets at NPR 50/kg (Joshi 2012); this translates to average annual household income of NPR 414, or NPR 1,775,856 per year for all dependent households.

Value of regulating services

Flood protection: In Koshi Tappu, flood control applies mostly to the buffer zone area (17,888 ha). The total value of flood protection is USD 952,075 per year, which represents 6% of the total estimated value of the KTWR (Table 17). Given that agriculture is practised in about 94% of the buffer zone, and many fish ponds are also in the buffer zone, a flood such as that in 2008 can wipe out all standing crops for the season and also deposit large amounts of sand and other debris. This makes large tracts of farming land unsuitable for cultivation for several years, unless major investments of labour are made to bring the soil back to its former stage. For the present purpose, this lower range value is accepted as the benefit from flood protection in the Koshi Tappu buffer zone area where cultivation occurs.

Carbon sequestration: With no comparable carbon sequestration estimate available for wetlands, the present study relied on the default value based on the carbon sequestration index provided by Pagiola et al. (2007) for different land use types according to their capacity to sequester stable carbon in soil and in hard wood, as stated in the methodology section. Of all the different types of land uses in Koshi Tappu, only forests and grassland are assumed to sequester carbon. The total value of carbon sequestered by forests and grassland is NPR 72.21 million per year (USD 199,928/year), or USD 23.3 per ha per year, accounting for 1% of the total economic value in the KTWR.

Value of cultural services – Ecotourism

Among cultural services, only the value of ecotourism benefits was estimated. Religious and educational services also exist, but their values could not be estimated due to a lack of information. The gross value of total annual net

Table 17: **Aggregate economic value of wetland ecosystem services provided by KTWR**

	Total value (NPR/yr)	Total value (USD/yr)	Average value/ hh/yr (USD)	Value/ha/yr (USD)	% Share of total ecosystem value
Provisioning services	**1,177,145,583**	**13,675,225**	**818.4**	**781.4**	**85.3**
Livestock fodder	365,999,713	4,251,920	254.5	243.0	26.5
Floodplain agriculture (paddy, wheat)	357,508,717	4,153,277	248.6	237.3	25.9
Fish (captured fishery)	230,427,353	2,676,938	160.2	153.0	16.7
Energy	95,619,367	1,110,837	66.5	63.5	6.9
Domestic water supply	61,691,280	716,685	42.9	41.0	4.5
Other	65,899,153	765,569	45.8	43.7	4.8
Regulating services	**99,162,947**	**1,152,003**	**68.9**	**65.8**	**7.2**
Flood control/prevention	81,953,376	952,075	57.0	54.4	5.9
Carbon sequestration	17,209,571	199,928	12.0	11.4	1.2
Cultural services (ecotourism)	**103,399,108**	**1,201,216**	**71.9**	**68.6**	**7.5**
Total economic value	1,379,707,639	16,028,444	959.2	915.9	100.0

benefit from tourism services is estimated to be NPR 103,399,108 (USD 1,201,216), or equivalent to USD 68.64 per ha, or USD 211 per tourist per year. This represents about 8% of the estimated total value of the KTWR.

Aggregated economic values and some comparison

The economic benefits generated by provisioning, regulating, and cultural services from the study area amount to around NPR 1.4 billion (USD 16 million) per year. This is around NPR 78,840 (USD 916) per ha, considering an area of 17,500 ha, which translates to a net present value (NPV) of around USD 444 million at the assumed discount rate of 3% and constant flow of current benefit over the period of 60 years. A study conducted by IUCN Nepal (2003), estimated the annual economic value of the KTWR in terms of biodiversity, wetland products and services, and community dependence to be over USD 9 million, or equivalent to USD 514 per ha in 2003; when inflated to 2012 prices, this gives an annual value of USD 834 per ha, fairly close to the total value estimated in the present study. Even though many of the ecosystem services do not enter directly into household income, the finding that over 80% of the total value of wetland ecosystem services is contributed by the provisioning services is a clear manifestation of the vital importance of these services for local livelihoods. This is consistent with the estimated share of provisioning service value (80%) reported by Pant et al. (2012) for forest ecosystem value of the Kanchenjunga landscape in eastern Nepal. The average benefit generated by provisioning services in this study (NPR 70,445 per household per year) is higher than the estimate (NPR 53,195 per year) reported by Pant et al. (2012) mainly due to the inclusion of more provisioning services (floodplain agriculture and water supply benefit) in this study than in others. However, it compares fairly well with the estimate reported by Rayamajhi (2009) for the KTWR (about NPR 67,294 per household in 2012 prices). The results show that the forest ecosystem of the study area provides immense economic benefits to local people, and that people are highly dependent on forest ecosystem services for their subsistence and wellbeing.

Flood control and carbon sequestration account for 83% and 17% of regulating services, respectively. The high value of flood control reflects the fact that in addition the KTWR area, floods also affect the entire buffer zone area. Both of these areas have low tree density, hence the low value of carbon sequestration. The value of cultural services (namely ecotourism) represents about 8% of the estimated total value of the wetland ecosystem services provided by the KTWR and generates about NPR 103.39 million worth of benefit per year. The value of regulating services and cultural services together represent about 15% of the estimated total value of the wetland ecosystem services provided by KTWR and generate about NPR 202.56 million worth of benefit per year, providing a benefit per household of about NPR 12,102 per year. In comparison, the estimated values (mainly provisioning services) of the KTWR from Rayamajhi (2009) and Joshi (2012) are fairly low compared to the estimate of the present study, mainly because of the inclusion of some regulatory and cultural services in this study. Most of the estimated unit values from this study on a per hectare per year basis are within the range of values summarized by the Food and Agriculture Organization for developing countries. The only exception is agriculture and grazing (USD 480 per hectare per year) which is higher than the value range for developing countries (USD 300-370).

Drivers of change and community perception

Climate variability and change

The Fourth Assessment Report (AR4) of the IPCC clearly indicates that during the 20th century, global average surface temperature has increased by about 0.6°C and precipitation by 2% (IPCC 2007). The report projects further rises in temperature and precipitation with impacts on ecosystems, development, and people in the coming century. The HKH region, too, will experience climate change, which will have impacts on the mountains and its people. In particular, climate change will impact the hydrological regime, and ultimately agriculture. This will have major ramifications as the majority of the rural poor in the region rely on varied ecosystems, including agriculture, and most livelihood problems are associated with this sector. Therefore, an assessment was undertaken to determine the changes in temperature and rainfall in Phatepur and Bharmajhiya of the Koshi Tappu area.

Changes in temperature and rainfall in Phatepur: The annual cycles of monthly temperature during the period (1995-2003) – both observed and simulated by the National Centre for Environmental Prediction (NCEP) – of the downscaling model are shown in Figures 5 and 6. The baseline scenarios at Phatepur showed a winter minimum

Figure 5: **Observed and NCEP simulated annual cycles of monthly maximum temperatures in Phatepur (1995-2003)**

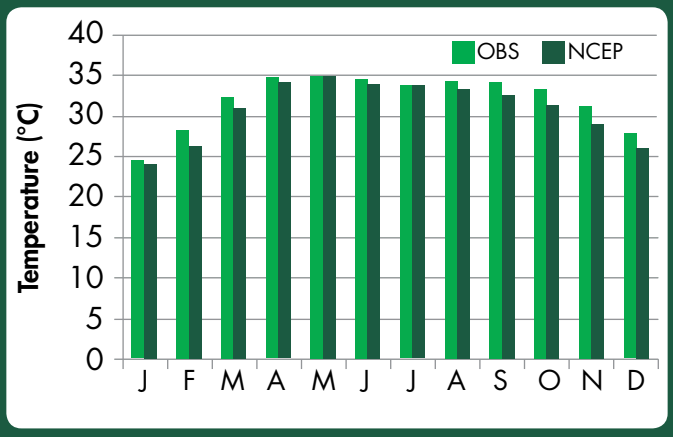


Figure 6: **Observed and NCEP simulated annual cycles of monthly minimum temperatures in Phatepur (1995-2003)**

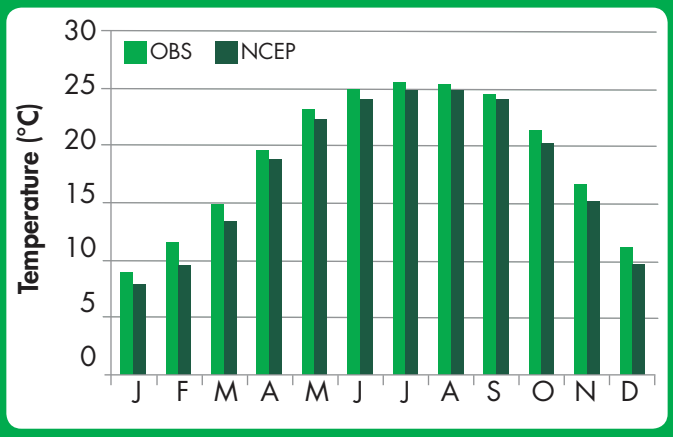
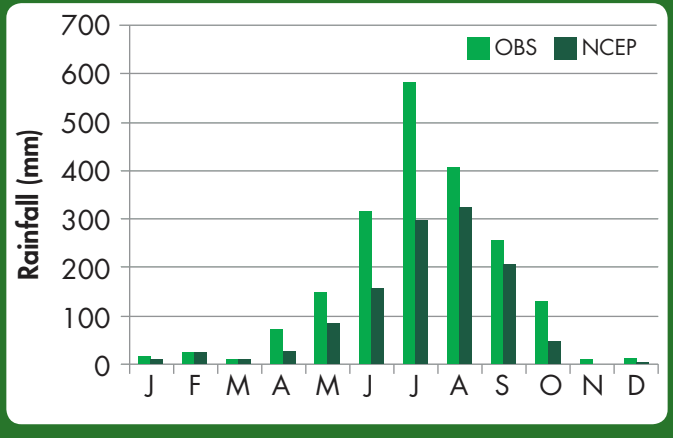


Figure 7: **Observed and NCEP simulated annual cycles of monthly precipitation in Phatepur (1995-2003)**



temperature of 8.9°C and a summer maximum temperature of 33.2°C. The annual maximum and minimum temperatures are 30.6°C and 19.9°C, respectively.

Annual cycles of monthly observed and NCEP simulated monthly precipitation during the independent verification period (1995-2003) are shown in Figure 7. The figure shows that the model underestimates precipitation throughout the year. The relatively large biases are evident particularly in the summer months, which explain limited reliability of the statistical downscaling model (SDSM) precipitation calibration process for Phatepur.

The annual temperature scenarios from general circulation models (GCM) simulation were also done for three future time periods (2020s, 2050s, and 2080s) for Phatepur. The climate change scenarios developed by GCMs based on baselines (1995-2003) for maximum and minimum temperatures showed increasing trends in temperature. The projections of emission scenarios for the scenario 2080s maximum temperature increased in different scenarios (CGCM3 for A1B and A2; and HadCM3 for A2 and B2) ranging from 0.48°C to 1.11°C; and the minimum temperature increase ranged from 0.62 °C to 1.46 °C (see Figure 8). Such a rise in temperature associated with other drivers of change, such as land use change and demographic change, would obviously impact the fragile ecosystems of the reserve as well the livelihoods of the people in the area.

Similarly, the annual precipitation scenario obtained from the NCEP simulation and GCM simulation for three future time periods (2020s, 2050s and 2080s) for Phatepur is provided in Figure 9. The projections for 2080s annual precipitation in different scenarios (CGCM3 for A1B and A2) showed annual precipitation increase by 7%, and in other scenarios (HadCM3 for A2 and B2) increase by 3–5%. Although different models and emissions provide very different precipitation projections, they all suggest that Phatepur will be wetter by the end of the twenty-first century (Figure 9).

Changes in rainfall in Barmajhiya, Koshi Tappu: The annual cycles of observed and NCEP simulated precipitations during 1995-2003 in Barmajhiya are presented in Figure 10. The annual precipitation scenarios obtained from NCEP simulation and GCM simulation for three future time periods (2020s, 2050s and 2080s) in Barmajhiya are presented in Figure 11. The projections for 2080s annual precipitation in

Figure 8: **Future scenarios for NCEP and GCMs simulated annual maximum and minimum temperatures at Phatepur, Koshi Tappu**

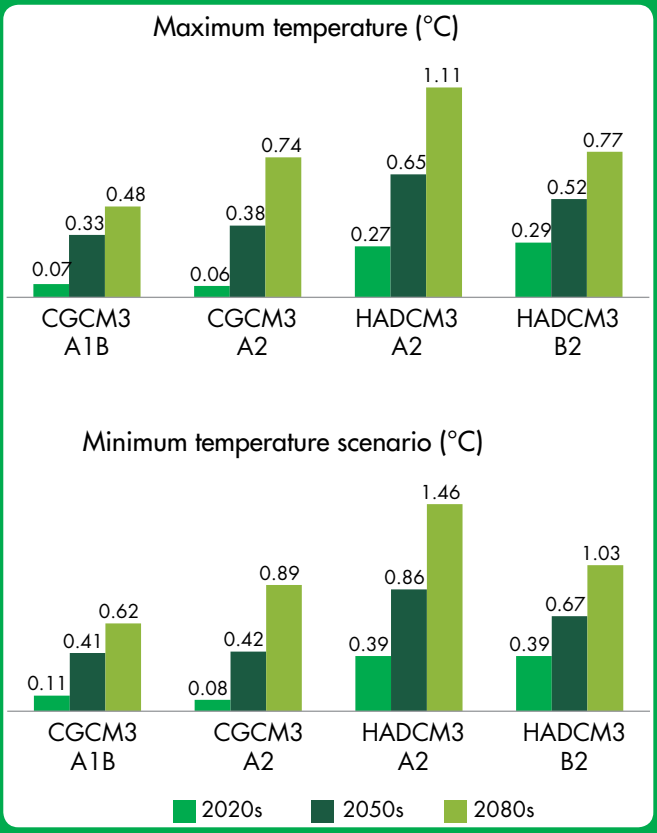


Figure 9: **Future scenarios for NCEP and GCMs simulated annual precipitation at Phatepur, Koshi Tappu**

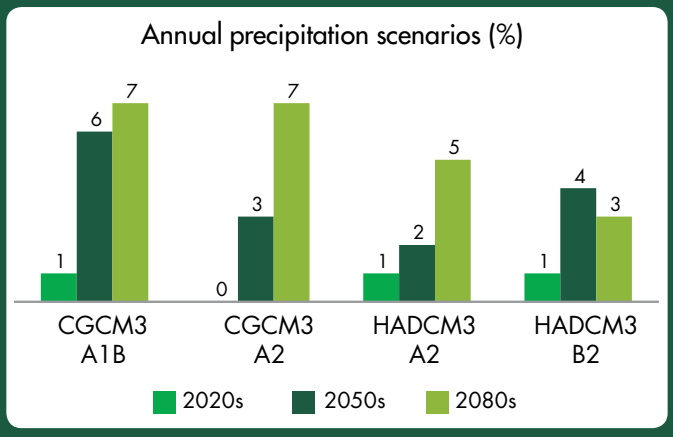
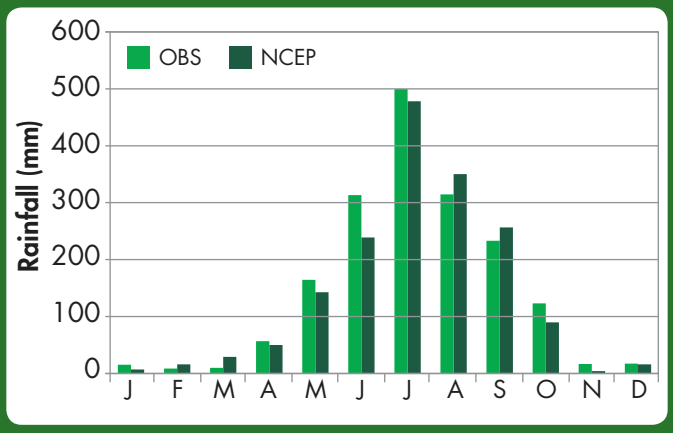


Figure 10: **Observed and NCEP simulated annual cycles of monthly precipitation at Barmajhiya, Koshi Tappu (1995-2003)**

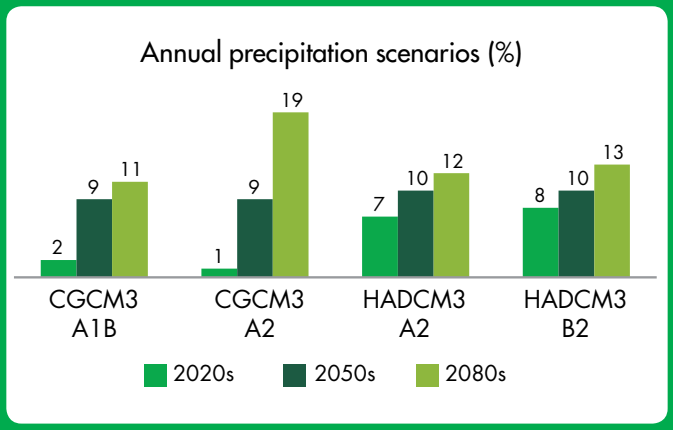


different scenarios, CGCM3 (for A1B and A2) and HadCM3 (for A2 and B2), showed an increase in annual precipitation by 11–19% and 12–13%. In the case of Barmajhiya, despite differences in the model, precipitation is likely to be significantly higher by the end of the twenty-first century.

Land use and cover change

According to 2010 data analysis, the KTWR showed six major land cover types, with predominant ecosystems including grassland, forest, freshwater, and marshes. Time series land use and land cover change analyses (1976–2010) showed some interesting facts about the dynamic ecosystems of the KTWR. The first observation focused on course change of the river from west to east (see Figure 12). Significant changes in land cover and ecosystem types have been observed over the last 34 years (Figure 13). In 2010, forested ecosystems showed a reduction of 94% compared to 1976, covering only 150 ha of the original 1,853 ha. During the same period, grassland increased by 79% from its original state

Figure 11: **NCEP and GCMs simulated annual precipitation future scenarios for Barmajhiya**



of 1,716 ha. On the basis of total land cover, forests, rivers/streams, and swamps/marshes decreased by 16%, 14%, and 3%, respectively, over the last 34 years, whereas grassland increased by 45% (Table 18). It is also interesting to note that rivers/streams, covering 10% of the total area of the KTWR, and swamps/marshes, covering 5% of the total land, provide people with a high number of provisioning services. Forests, with just 1% coverage, also provide a large number of important goods and services compared to other ecosystems. This means that ecosystems with less coverage have intense pressure due to people's higher dependency.

Community perceptions of environmental change

Communities increasingly see climate variability as a driver of change. However, scientific data is limited in

Figure 12: **Map showing river course change in the KTWR from 1976 to 2010**

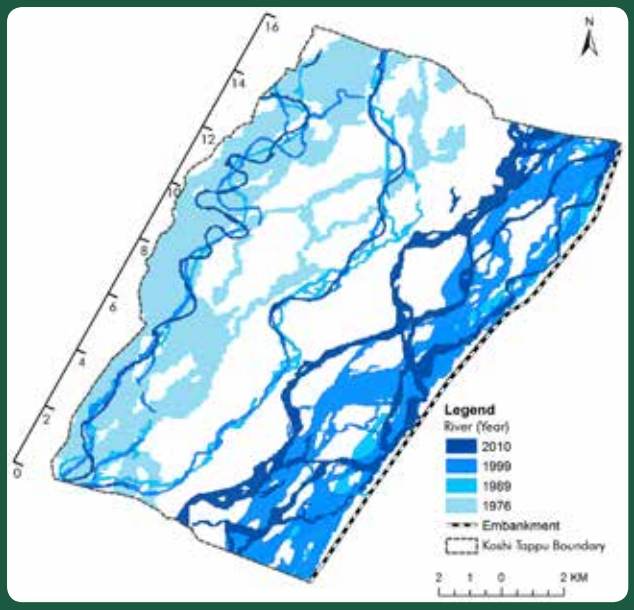


Figure 13: **Land use and land cover changes in the KTWR from 1976 to 2010**

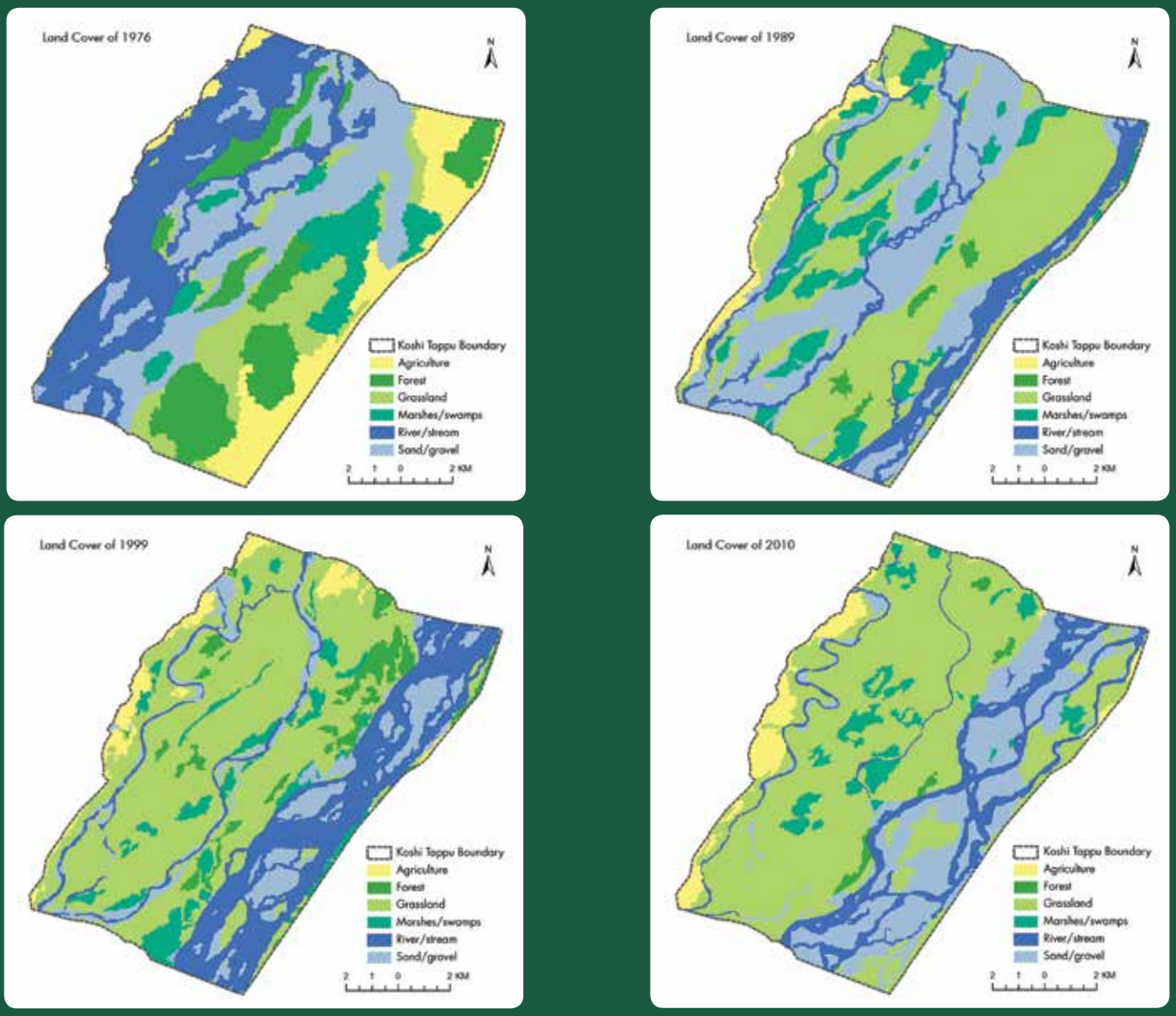


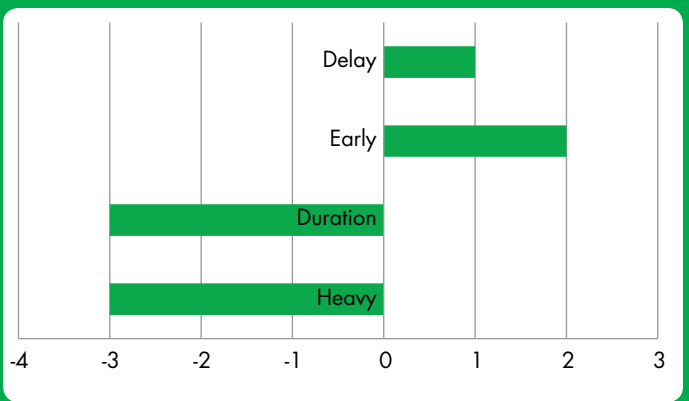
Table 18: **Land use and land cover change in the reserve from 1976 to 2010** (in hectares; number in parentheses is % of total)

Land cover and ecosystems	1976	1989	1999	2010	Change between 1976–2010
Agriculture	1,853 (12)	408 (3)	608 (4)	774 (5)	-1,079 (-7.2)
Forest	2,507 (17)	180 (1)	736 (5)	150 (1)	-2,357 (-15.7)
Grassland	1,716 (11)	6,632 (44)	7,744 (51)	8,409 (56)	+6,693 (+44.5)
Lakes/ponds	1 (0.01)	9 (0.06)	2 (0.01)	2 (0.01)	+1 (+0.01)
Marshes/swamps	1,282 (9)	1,877 (13)	1,087 (7)	822 (6)	-460 (-3.06)
Rivers/streams	3,620 (24)	1,428 (9)	2,567 (17)	1,546 (10)	-2,074 (-13.8)
Sand/gravel	4,066 (27)	4,512 (30)	2,301 (15)	3,342 (22)	-724 (4.8)
Total	**15,045**	**15,045**	**15,045**	**15,045**	

many places, particularly in the HKH region. Perceptions of change should be collected from communities because common livelihoods (particularly crop farming, livestock rearing, and fishery work) are weather dependent. As such, communities are aware of past and present trends in weather patterns. Furthermore, studies show that perceptions related to weather changes can be verified scientifically and accurately (Chaudhary and Bawa 2011). Therefore, in this particular study, along with scientific data, perceptions of changes were also collected. Environmental stress factors such as rainfall, temperature, wild animal attacks, crop pests and diseases, and floods were considered. An aggregation of the hazard-ranking tool from the KTWRBZ reveals that changes in precipitation and temperature are the highest-ranking events affecting lives and livelihoods. The overall perception was that erratic rainfall of very short duration, higher temperatures, frequent attacks by wild animal, and an increase in crop pests and diseases have all impacted harvest quality and quantity. According to the local communities, the frequency of floods has decreased, but impacts are more severe. The change in the river course caused by floods has impacted water seepage from the reserve to the agricultural fields, leading to further drying of the fields. The low altitude negates the presence of snow and frost, and hence has no impact on these communities' livelihoods.

Perception of change in rainfall: Precipitation has been erratic and of much shorter duration; this could be linked to delays in the onset of rainfall as well as early completion (Figure 14). Respondents from around the buffer zone universally reported that the monsoon traditionally brought at least a week of continuous rain with over 15 rainy days a month; this has changed to heavy rain for 24 hours followed by complete dryness. Even this only occurs once or twice a month. High intensity monsoon rainfall appears to have decreased as well. Local respondents considered this decrease in intensity a positive development resulting from the associated incidence of floods. In their words, "*Pani parepo badhi aucha, paninai naparepachi badhi kasari aucha?*" (There would be flooding if it rained. How would there be flooding when there's no rain?) However, the decrease in high intensity rainfall could also mean that there is insufficient rainfall during the monsoon, and resultant severe impacts on crop production. Additionally, although the incidence of related extreme events has decreased, the devastation caused by floods is still immense, and keenly experienced by communities living in the study area. Residents from Tapeswori village, located between three rivers (Trijuga, Koshi, Khahare), responded, "*Ahile pani kam aucha tara chhyati badi huncha*". (There's less rainfall now, but more destruction than before.) Respondents noted this greater impact could be a result of deforestation in the woods surrounding the village.

Figure 14: **Perceived increase or decrease in rainfall events as ranked by community members (1–10)**



Source: PRA Report

Tube wells were extremely common across the entire buffer zone and were primarily for drinking water purposes. In areas without irrigation canals (only Kamalpur and East Pipra get year-round irrigation), water from deeper tube wells is drawn up and crops are manually watered as a prevalent coping strategy. More affluent households own private tube wells,

whereas others share communal wells. Unfortunately, groundwater supplies appear to be depleting; drinking water wells have to be dug deeper (12 ft compared with 9 ft in the past) and irrigation wells now have to be dug at 40 ft (compared with 30 ft in the past). Residents regularly complained about iron in the drawn water, with arsenic mentioned in some places. As erratic weather continues, communities depend more heavily on these underground aquifers; as these are not replenished, this could lead to maladaptation for these communities.

Perception of change in temperature: Every community in the study area perceived changes in temperature, although the impact was less directly related to livelihoods than changes in rainfall. The KTWRBZ lies in the lower tropical bioclimatic zone (Bhuju et al. 2007) and high temperatures in the summer are common. However, it appears that summers are warmer than before; as seen in the graph below, the hot season starts earlier and ends later. Temperatures are especially high during key working months. Farming in the intense heat has become very difficult, with increasing complaints of dry skin and fainting corresponding with the increase in high intensity temperature days (see Figure 15). A respondent from Tapeswori noted, "Working in the summer with rain doesn't feel as hot, but now with less rain, it feels much hotter". Snake encounters are more likely in the hot season; karet, a small snake, enters people's houses during the day and can cause fatalities. Higher temperatures also dry out vegetables and crops remaining in the fields, affecting overall yields.

Perception of change in attacks by wild animals: Local residents are most deeply concerned about human-wildlife conflict. Every single community mentioned that wild elephants damage fields and attack homes and that wild water buffaloes damage crops. Although these attacks were common in the past, they appear to have risen in the past eight to ten years, impacting local lives and livelihoods. The extended duration of these attacks may be slightly exaggerated. However, respondents said that compared to the last 20 years, elephant attacks have increased considerably. Residents of Madhuban said that electric fencing on the Sunsari side (eastern border) of the KTWR has reduced the problem to some extent in that area. However, the entire reserve has not been fenced and predation remains common in the other areas. As one respondent explained, "It's a feast for the elephants. Instead of having to look for grass and graze all day, they can loot our fields or stores and eat all they want in a short time. So why wouldn't they come?". Others acknowledged that human dwellings have been constructed on the elephants' traditional migratory path, and that is the reason behind some of the attacks. The shifting of the river's course also appears to have affected the incidence of attacks.

The Koshi River used to flow along the western border. Respondents from East Pipra claimed that when it re-braided to the eastern side, attacks increased in the western VDCs. Others from Tapeswori believed that the lack of lush forests and other food in the reserve led to more attacks. Attacks seem to be more frequent during harvest season, with elephants consuming cereals as well as trampling plants, affecting both the quantity and quality of yield (Figure 16).

Perception of crop disease and pest event change: Local communities connect the increase in crop disease with various factors, such as change in the climatic variables, monoculture, and invasive pests and diseases. As with the

Figure 15: **Perceived changes in temperature events as ranked by community members (1–10)**

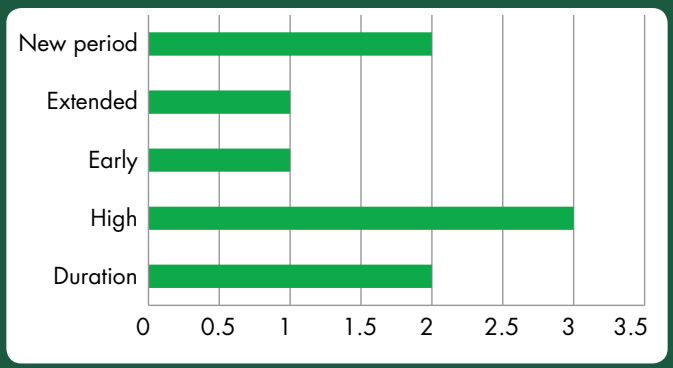


Figure 16: **Perceived changes in wild animal attack events as ranked by community members (1–10)**

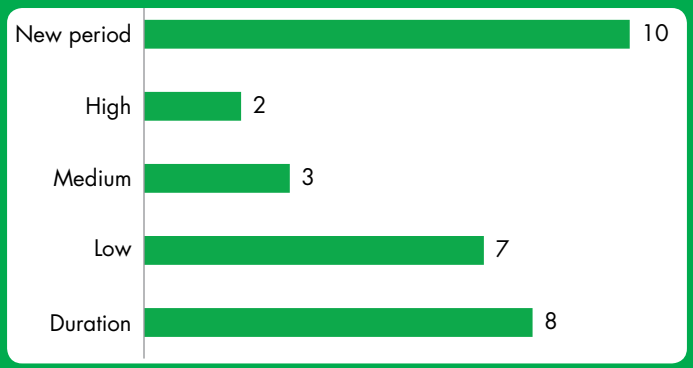


Figure 17: **Perceived changes in crop disease and pest events as ranked by community members (1–10)**

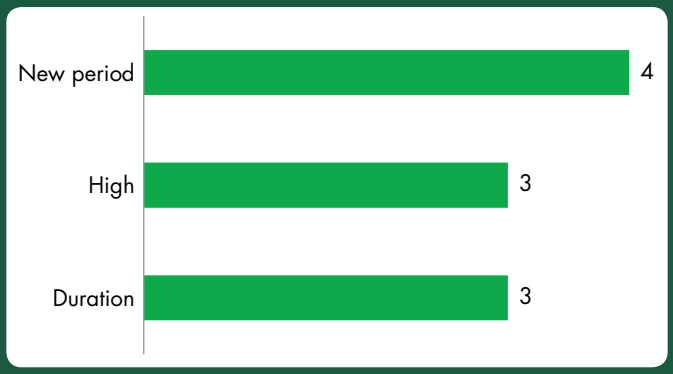
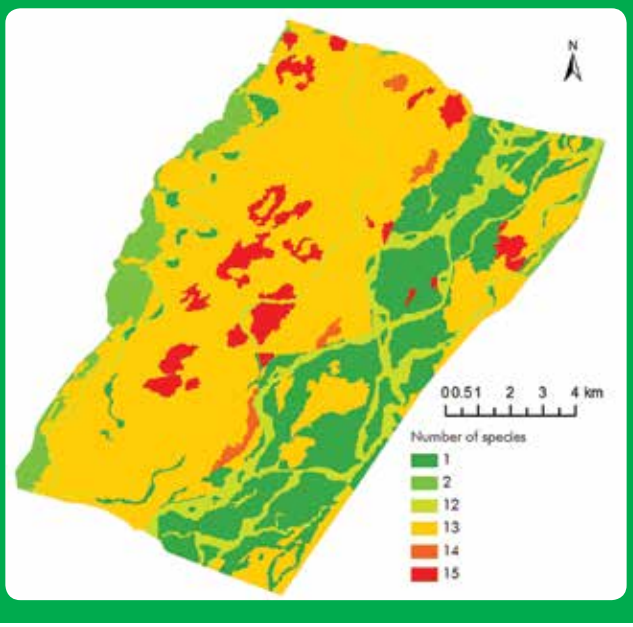


Figure 18: **Distribution and habitat use patterns of threatened species in the KTWR**



rise in animal attacks, local communities believe that the incidence of crop pests and diseases started increasing around ten years ago (Figure 17). Crops affected include the main cereals such as maize, paddy, and wheat, as well as lentils, fruits, and vegetables. Numerous pests and diseases attack different crops.

A disease locally called 'daduwa' starts at the top of the plant and continues toward the base, killing the entire plant in the process. Pesticides and chemical fertilizers, including urine, are applied universally. Respondents in Tapeswori claimed that cultivation without pesticides severely limited yield. Some respondents from East Pipra believed that the use of improved seeds and pesticides reduced organic nutrients and led to the increase in pests and diseases. Several communities mentioned that the incidence of fog appears to induce crop diseases in vegetables and wilting of plants; therefore, respondents felt that chemicals must be applied as a preventative measure.

Impact assessment

Impact on biodiversity

The projections of change in temperature and rainfall, land cover change, and other drivers of change are likely to have direct impacts on the biodiversity of the KTWR. In particular, land use and land cover change is likely to significantly impact biodiversity and ecosystem services. The land cover, or ecosystem, and habitat matrix showed that a majority of species use a wide variety of land cover or ecosystems, and in many cases they overlap (Table 19). For example, rock python (*Python molurus*), red-crowed roofed turtle (*Kachuga kachuga*), elongated tortoise (*Indotestudo elongate*), greater adjutant stork (*Leptoptilos dubius*), and swamp francolin were reported from more than three land cover types or ecosystems. Many species were also reported to have narrrow habitat choices. The gharial crocodile (though not reported recently) and mugger crocodile were restricted to swamps/marshes, and rivers/lakes. Likewise the wild water buffalo, Indian bison (not reported recently), and Bengal florican were found to have a narrow habitat choice. In the matrix analysis, swamps/marshes scored the highest number of species (15), followed by forests (14), rivers/lakes (13), and grassland (12). Agriculture scored the lowest with two species. Forested ecosystems of the KTWR were observed to be one of the most important habitats used by 15 globally significant species, followed by rivers/lakes, and grassland. These matrix ranking values were then converted to the raster maps prepared for 2010 land cover to show the potential richness (number of species) of each of the ecosystem types defined earlier (Figure 18).

The KTWR is home to many globally threatened species (Table 19). Swamps/marshes, forests, grassland, and freshwater ecosystems are important habitats for a majority of species of global importance (Figure 13). Decadal change analyses have already revealed that these ecosystems have significantly changed over the last 34 years. The

Table 19: **Species Habitat Matrix of the KTWR**

Species	Status		Land use					
	IUCN	CITES	Grassland	Swamps/ marshes	Forest	Rivers/ lakes	Sand/ gravel	Agriculture
Wild water buffalo (*Bubalus bubalis arnee*)	EN	III	1	1	0	1	0	0
Gangetic dolphin (*Platanista gangetica*)	VU	I	0	0	0	1	0	0
Black giant squirrel (*Ratufa bicolor*)	NT	I	1	0	1	0	0	0
Hog deer (*Axis porcinus*)	EN	I	1	0	1	0	0	0
Smooth-coated otter (*Lutrogale perspicillata*)	VU	II	0	1	1	1	0	0
Fishing cat (*Prionailurus viverrinus*)	EN	II	0	1	1	1	0	0
Asiatic elephant (*Elephas maximus*)	EN	I	1	1	1	0	0	0
Spotted leopard (*Panthera pardus*)	NT	I	1	0	1	0	0	0
Gharial (*Gavialis gangeticus*)	CR	I	0	1	0	1	0	0
Mugger crocodile (*Crocodylus palustris*)	VU	I	0	1	0	1	0	0
Rock python (*Python molurus*)	NT	II	1	1	1	1	1	0
King cobra (*Ophiophagus hannah*)	VU	II	1	1	1	0	0	0
Red-crowned roof turtle (*Kachuga kachuga*)	CR	II	1	1	1	1	0	0
Elongated tortoise (*Indotestudo elongata*)	EN	II	1	1	1	1	0	0
Indian softshell turtle (*Aspederetes gangeticus*)	VU	I	0	1	0	1	0	0
Greater adjutant stork (*Leptoptilos dubius*)	EN		0	1	1	1	0	0
Pallas's fish eagle (*Haliaeetus leucoryphus*)	VU	II		1	1	1	0	0
Bengal florican (*Houbaropsis bengalensis*)	CR	I	1	1	0	0	0	0
Swamp francolin (*Francolinus gularis*)	VU	III	1	1	1	1	0	1
Total			**12**	**15**	**14**	**13**	**1**	**2**

Table 20: **Impacts of human-wildlife conflict on biodiversity of the KTWR and on people in the buffer zone**

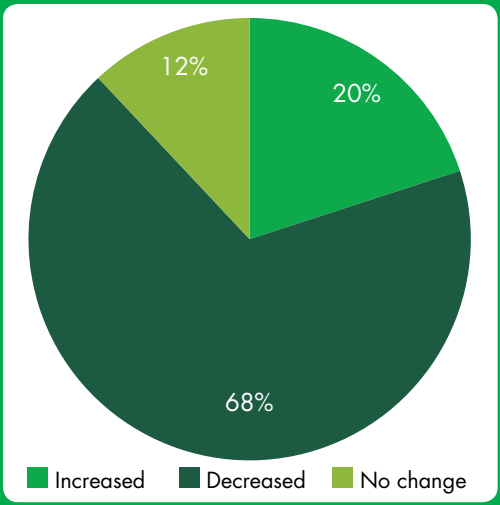
Impact on local community	Impact on the reserve
■ Ban on collecting resources (fuelwood, building materials, fishing) ■ Livestock raising hampered due to ban on grazing ■ Low crop production due to wildlife depredation, less manure due to decrease in livestock population ■ Human injuries, casualties, and harassment ■ Socio-cultural interference in local community	■ Habitat loss due to illegal grazing, logging, and soil erosion (e.g., the felling of simal (*Bombax ceiba*), a roosting tree for the lesser adjutant stork) ■ Food competition between livestock and wildlife. ■ Threat to genetic integrity due to out-breeding with domestic buffalo ■ Occurrence of rinderpest, and foot and mouth disease ■ Poaching, poisoning, and vandalism (poles removed, fences pulled down)

changes have brought remarkable alterations in the habitats of these species. Forested ecosystems have experienced the most significant loss over the last 34 years, followed by wetland ecosystems such as marshes/swamps and rivers/ streams. Moreover, degraded ecosystems such as forests and marshes/swamps are also highly used habitats of a number of key faunal communities. Rivers/streams, covering 10% of the total area of the KTWR, and swamps/ marshes, which constitute 6% of the total land, are important habitats for the majority of species (Table 19). Reduction in the total area of these habitats poses a challenge for long-term conservation of species, particularly those that are exclusively dependent on such habitats. Similarly, forested ecosystems, with only about 1% coverage in 2010, are an important habitat for many threatened species. This means that ecosystems facing a decreasing trend may have direct impact on the habitats of these threatened species. Conservation and reserve management challenges have also increased due to the dynamic nature of ecosystems, manifested in the changing river course. Moreover, human-wildlife conflict, as stated above, is acute and severely impacts the reserve as well as local people (Table 20).

Impact on ecosystem goods and services

Similarly, all the drivers of change stated above have a direct impact on the ecosystems, and consequently, on the flow of goods and services. According to the LAT, the dependency of households on the watershed's provisioning

Figure 19: **Perceived change in household dependency on the watershed's provisioning services during the ten years preceding the LAT survey**

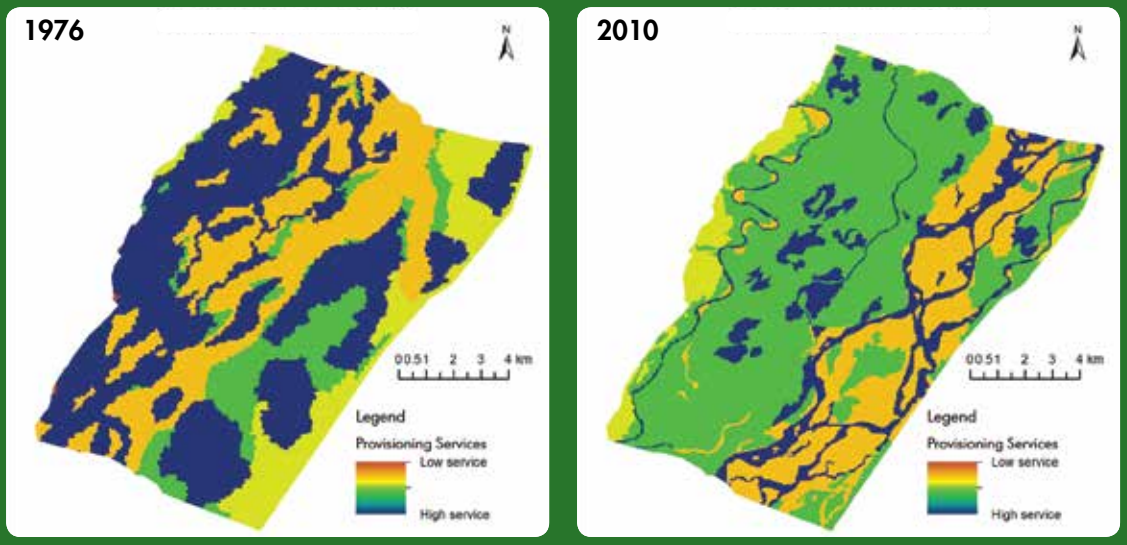


LAT (2011)

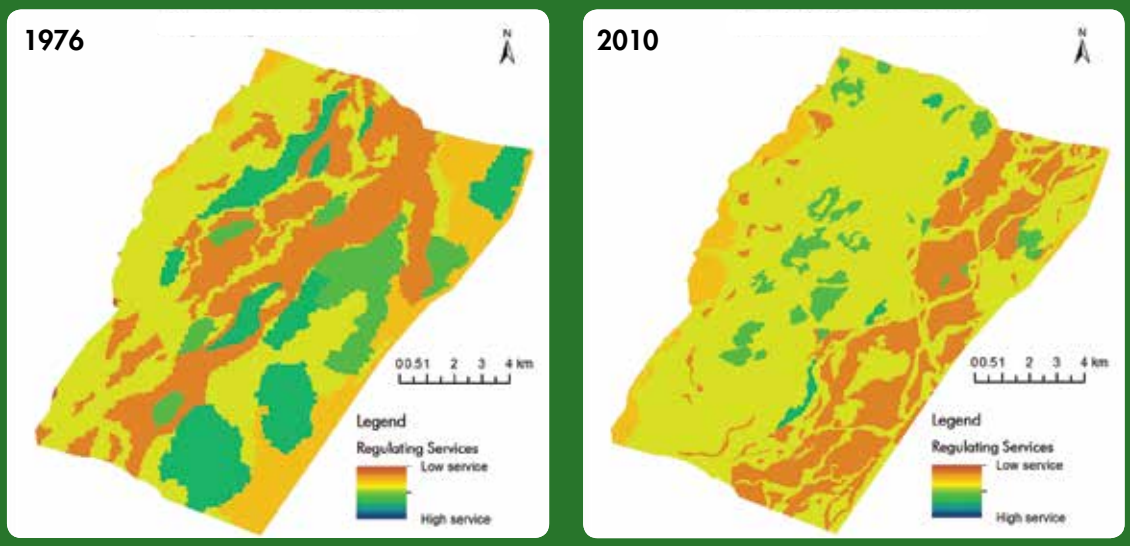
services has reduced over the ten years preceding the LAT survey, with 67.7% reporting a decrease in dependency. Only 20.4% reported an increase in dependency, and 12% reported no change in their dependency status (Figure 19).

As stated, the capacity of specific land uses and ecosystems were assessed. Based on the capacity of providing ecosystem services, GIS and RS tools were used to analyse the impacts of land use and land cover change on the flow of ecosystem services. The impacts of change on the flow of provisioning, regulating, supporting, and cultural services were analysed for a period of 34 years. The analysis showed that the flow of ecosystem services was drastically lower in 2010 than in 1976. Provisioning services in particular decreased significantly (Figure 20).

Figure 20: **Maps showing the impacts of land use and land cover change on the flow of ecosystem services (1976–2010)**

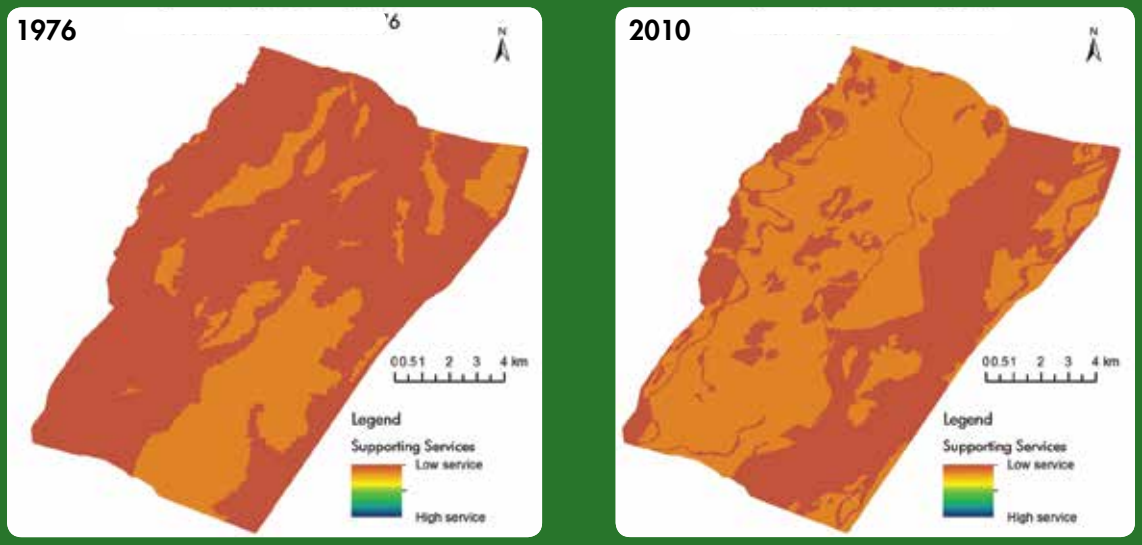


Provisioning services

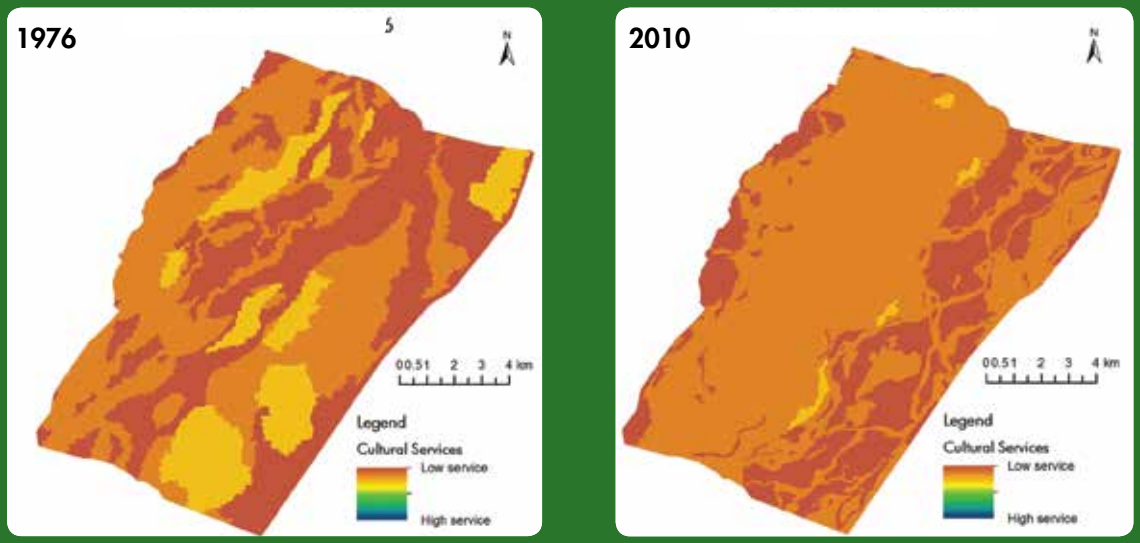


Regulating services

Figure 20, continued



Supporting services



Cultural services

Impacts on crop and food production

Table 21: **Impacts on crop production**

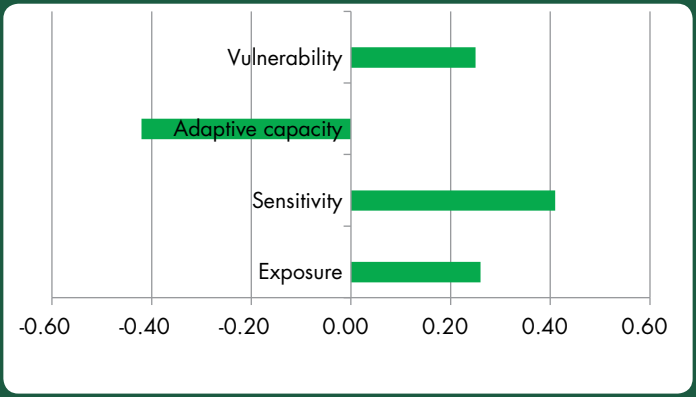
Factors	Decrease in production	Delayed activity	Reduced quality
Rainfall	↑	↓	↓
Snow			
Frost/fog	↑		→
Pest	↑		↑
Temperature	→		
Hailstorms	↓		↓
Wildlife attack	↑		↓
Windstorm	→		↓

High=↑, Medium=→, Low = ↓

Table 21 shows all of the factors – both environmental and non-environmental – that negatively impact crop production in the KTWRBZ. These factors have been further classified to analyse which factors had the greatest impact on crop quality, crop quantity, and changes in activity. Harvests dramatically decrease with changes in rainfall, pest incidence, frost or fog, and animal attacks. Harvest quality is primarily affected by pest incidence; while yield might still be high, pest or disease-ridden crops have little value in the market and may not even be edible. Rainfall is the only event that affects agricultural activities seasonally. However, the implications of changes are still important. Delaying the plantation of paddy shortens the growing season and thus reduces the eventual yield.

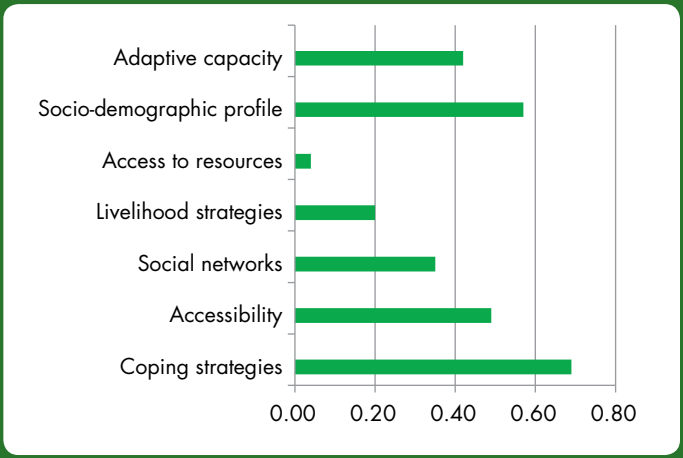
Livestock and dairy products are significant elements of livelihood generation as well as a source of energy in the KTWRBZ. Most households owned heads of cattle, which are left to graze freely inside the KTWR, or sent with herders who lived inside the reserve on a semi-permanent basis. The authorities forbid grazing inside the reserve, but enforcement is weak and grazing is rampant. The genetic purity of the wild water buffalo is at risk due to

Figure 21: **Mountain Specific Livelihood Vulnerability Index and its main indices by site**



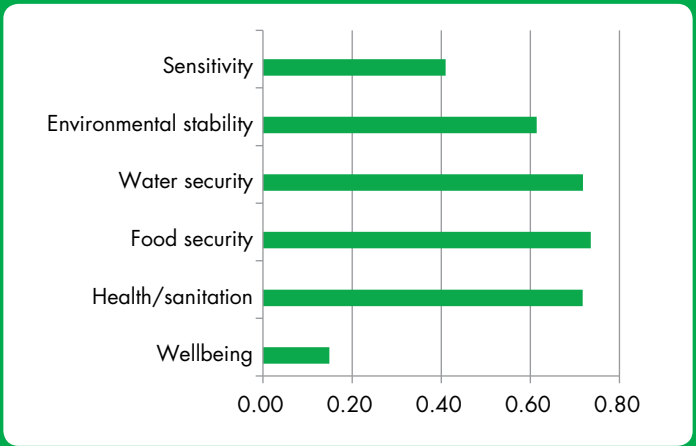
N=369 HH, data: LAT 2011

Figure 22: **Adaptive Capacity Index and its sub-indices**



N=369 HH, data: LAT 2011

Figure 23: **Sensitivity Index and its sub-indices**



N=369 HH, data: LAT 2011

interbreeding with domesticated cattle grazing inside the KTWR. Fodder is also a crucial provisioning service offered by the wetland ecosystem in the KTWR. Lacking a steady source of fuelwood for cooking, locals plaster cattle dung onto bamboo sticks or other twigs, dry them, and use them as briquettes; this manure could have been applied to fields for higher agricultural productivity instead. Milk, eggs, and other livestock products are also sold for additional income, particularly during festival times. The community from Bairwa attributed up to 25% of their income to livestock and dairy products. Although the level of income from agriculture and livestock rearing is determined by weather events – primarily in rain-fed agriculture – income generation is greatly influenced by non-environmental forces (Table 20).

Impact on tourism

Tourism in the KTWR has been increasing since its establishment, and especially after the end of the civil war. The total number of visitors jumped from 817 in 1996-97 to 4,660 in 2010-2011. However, drivers of change including climate change, land use change, and other stressors will significantly impact tourism as well. Bird watching, the prime tourist activity, could be negatively affected by climate change and other anthropogenic activities. The sighting of birds, seasonality, and behaviour could be negatively affected by changes in the weather or climatic patterns. Moreover, the combined effects of these drivers of change could also affect the production and supply of tourism supply chain products such as food, vegetables, and handicrafts, among others (Sedai 2012), which would definitely affect local lives and livelihoods.

Impact on people and their livelihoods (vulnerability)

The drivers of change, including climate change and other anthropogenic changes, significantly impact local people and their livelihoods. Based on LAT data, the vulnerability of livelihoods in the KTWRBZ was examined through the Mountain Specific Livelihoods Vulnerability Index (MSLVI) framework (see Gerlitz et al. 2012). The assessment demonstrated that the MSLVI of the KTWRBZ is high, with particularly high sensitivity and exposure (Figure 21).

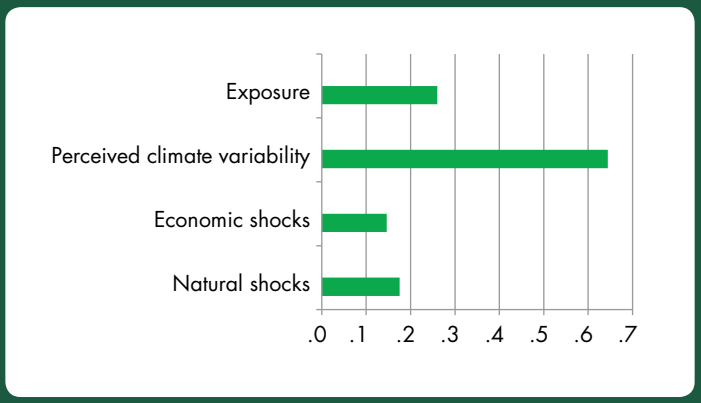
At the same time, the KTWRBZ's adaptive capacity is also high because its sub-components, such as the socio-demographic profile, livelihood strategies, social networks, accessibility, and coping strategies

are high (Figure 22). For instance, there are many opportunities for income generation (including remittance inflow), a diverse crop base, and a wide range of livelihood opportunities in the KTWRBZ.

The KTWRBZ's sensitivity index was high (Figure 23); conditions such as consumption, health and sanitation, wellbeing, food security, water security, and environmental stability were weak.

In terms of exposure, although the damages caused by environmental shocks during the 12 months preceding the LAT survey were not high (Figure 24), the perceived changes in temperature, precipitation patterns, and other environmental changes during the ten years prior to the survey were quite high. During the 12 months preceding the LAT survey, the impacts of socioeconomic shocks and stresses were comparatively low.

Figure 24: **Exposure Index and its sub-indices**



N=369 HH, data: LAT 2011

Environmental stresses faced by local communities

Communities living in the KTWRBZ face numerous environmental stresses in their daily lives. One of the major environmental shocks is human-wildlife conflict. Conflicts between the reserve and people are acute due to crop depredation, lack of compensation mechanisms, human fatalities or injury, and illegal livestock grazing. Problems also arise due to bans on collection of driftwood, timber, fodder, fuelwood, and thatch and on fishing, hunting, and poaching. Reports also indicate that local communities were dissatisfied with the ban on livestock grazing within the reserve. Limbu (1998) reported that the wild elephant, wild buffalo, and wild boar were the most notorious animals for crop depredation and harassing people. The communities also identified windstorms, water availability for irrigation, livestock disease, floods, hailstorms, and erratic rainfall as major environmental shocks faced in the three districts (Table 22).

Table 22: **Top five environmental shocks and stress factors faced by households near the wetland (in %)**

Saptari		Sunsari		Udaypur	
Type of event	%	Type of event	%	Type of event	%
Windstorm	55.0	Wildlife related shocks	61.8	Wildlife related shocks	60.6
Wildlife related shocks	51.5	Windstorm	60.6	Windstorm	57.6
Livestock disease	36.3	Water crises for irrigation	32.7	Erratic rainfall	48.5
Hail	12.3	Livestock disease	20.6	Water crises for irrigation	39.4
Crop pests	9.9	Flood	13.3	Hailstorms	39.4
Bad seed	9.9	N = 165 hh, 100%; data: LAT 2011		N = 33 hh, 100%; data: LAT 2011	

N = 171 hh, 100%; data: LAT 2011

Perception of non-environmental stress factors

Communities were asked to list and rank non-environmental stress factors during the hazard ranking exercise (Table 23). The factors are lack of irrigation, poor transport service, bad roads, lack of instituted markets, lack of opportunities, and poor quality education.

Bad roads were reported to affect both the transportation of agricultural products as well as household wellbeing. Dirt paths exist on both sides of the KTWR in the buffer zone, which residents of Kamalpur said are impassable in the rainy season due to knee-high mud. Lacking

Table 23: **Hazards ranking of non-environmental factors**

Non-environmental stress factors	Hazard ranking
Education	→
Market	→
Irrigation	→
Bad road	↑
Transport service	↓
Opportunity	↑

0-2 = ↓, 2-4 = →, and >4=↑

local transportation services, vegetables must be carried manually. The amounts sold are further limited by the poor quality of roads. Markets are not easily accessible and residents are forced to travel far away from the villages to sell their goods. The lack of instituted markets also affects households' selling capacity. Pricing information for crops and dairy products are unavailable and households have to ask the buyers (storekeepers) for prices, according to East Pipra residents. Agricultural inputs also have to be purchased and transported, at the expense of valuable time and money. The low returns and hard labour involved in agriculture push families to encourage young members to study and find employment through incomes unassociated with agriculture. Unfortunately, the quality of education is also low in the KTWRBZ, affecting future opportunities and prospects for livelihood generation. Some households cannot afford to educate their children; one respondent said 40–50% of the children in Bairwa do not attend school and instead work for daily wages to support their families. Opportunities for educated individuals are also limited, forcing educated job-seekers to search for employment in nearby towns or cities. Despite the difficulties associated with finding employment, whether through migration (domestic and international), or lack of opportunities and qualifications, communities expressed preference for non-agricultural employment due to the unpredictability of yields and arduous labour involved in agriculture.

Coping and adaptation strategies

According to the MSLVI framework, coping strategies are represented by indicators such as livelihoods diversification, reduced investments, time to recover from shocks, and adaptation strategies. Of the surveyed households, only 9.2% did not adopt any of the 12 types of strategies. On average, households were found to adopt up to three types of coping strategies (60.4%). The most common strategy is borrowing money – from relatives (43.9%), cooperatives and village fund (27.9%), friends (25.2), bank (21.4), or other financial service provider (17.6%). It was also common for households to rely on less preferred or less expensive food (35.8%), and purchase food on credit (29.3%) (Table 24).

In addition to the household survey, coping strategies were identified through focus group discussions. Through these discussions, it was reported that agriculture constantly adapted in response to environmental and other changes. The seasonal agricultural calendar is based on expected weather events; when certain events occur, such as delayed rainfall, shifting the agricultural calendar is a basic coping strategy. Coping and adaptive strategies have been adopted in the past and building on these will assist in assessing capabilities and planning for the future. Figure 25 illustrates the number of strategies practised in Nepal, divided into short-term coping mechanisms and long-term adaptive responses. The diversity

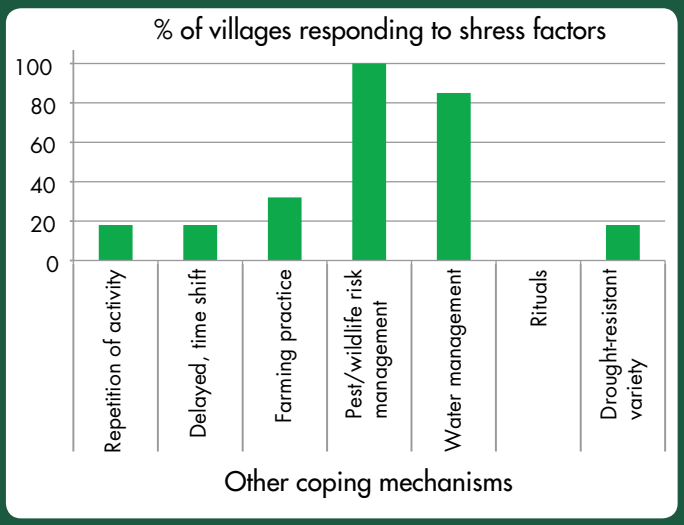
Table 24: **Overall distribution of coping strategies used (%)**

Coping strategies used	Used
Borrowed money from relatives	43.9
Relied on less preferred/less expensive food	35.8
Bought food on credit	29.3
Borrowed money from cooperative/village fund	27.9
Borrowed money from friends	25.2
Borrowed money from bank	21.4
Borrowed money from other financial service provider	17.6
Reduced spending on clothes	14.1
Sold agricultural assets (tools, seeds, livestock)	9.8
Non-working HH member started to work	6.5
Spent savings on food	6
Sold HH assets (small animals, jewelery)	5.7
Reduced spending on education	4.6
Consumed seed stock held for next season	4.6
Reduced proportion/ number of meals	4.3
HH member sought shelter in other communities (displaced)	4.1
Sold farmland	3.5
Sent children to work outside the HH	3.5
HH member sought work within the country	3.5
Leased farmland	2.7
Collected and sold fuelwood/non-timber forest products	2.4
Reduced spending on health	2.2
Moved children to a less expensive school	1.9
Begged for money and food	1.9
Restricted consumption by adults	1.4
HH member sought shelter in the same community	1.1
HH member sought shelter elsewhere (migration)	1.1
Took children out of school to work	0.8
Collected food from the wild	0.8
Skipped eating for a day	0.5
Sent children to school to benefit from incentive	0.3

N=369 hh, 100%; data: LAT 2011.

of crops in Nepal causes communities to apply a variety of strategies to deal with the changing weather conditions. In East Pipra, if the first batch of paddy dries due to late rains, it is replanted if possible. This creates substantial costs to these households, with some families stopping the plantation of paddy completely. Similarly, transplantation is delayed to coincide with the rains. Aware of the reduction in harvests with this delay in activity, communities irrigate with water from wells as much as possible. Dhule, a local variety of paddy seed that can be planted in dry beds, is also used if there is insufficient precipitation. Stalks of plants are tied together in Madhuban to protect against damage from storms. The use of pesticides and chemical fertilizers have been increasing every year.

Figure 25: **Coping and adaptive strategies**



While the first option is coping with stresses, fundamental to adaptation to any changes – climatic or non-environmental – is the availability of resources. The low returns from agriculture, sufficient only for six months a year, have forced households to search for other sources of income. Livestock rearing, practised in the Koshi Tappu with ample grazing in the wetlands, is a natural complement to agricultural incomes. The KTWR is crucial for income generation for local communities living in the buffer zone. It provides non-timber forest products, fuelwood, and timber for household consumption and sale, although the latter is illegal. Once a year, the reserve authorities allow 'khad-kadai' during which communities are able to enter the premises and cut long grasses (saccharum, typha) for thatch and mat-weaving. The reserve also serves as grazing land for livestock. Few benefits from tourism are available as few lodges exist. A portion of the revenue of the KTWR – entrance fees paid by tourists – is given to each user committee to spend on community development. With low tourist numbers, however, these funds do not amount to much when spread across the entire buffer zone. Off-farm income dependency is higher in the KTWRBZ with wage labour and remittances accounting for at least four months of income on average.

Since half of the households engaged in farming depend on rainfall for cultivation, precipitation patterns are a key factor considered by agricultural households. The most common response of the households to changes in precipitation and temperature patterns is to change the type of crops cultivated. Almost 67.8% of surveyed households reported giving up planting certain crops, and 62.6% reported introducing new crop varieties in response to these changes. In terms of livestock, 42.8% of households had given up rearing certain animals, while 31.2% had introduced new types of livestock. Additionally, 29.8% reported taking new off-farm activity, 18.7% had given up off-farm activity, 16% had stopped migrating for work, and 5% had migrated for work (Table 25).

Conservation and management approaches and practices

Since the establishment of the KTWR, several approaches have been undertaken for sustainable management and conservation of the reserve and its resources. Listing all the approaches individually is not possible; however, some of the approaches have been grouped under the following sub-headings:

- Conventional approaches
- Protected area focused practices
- Participatory approaches
- Research-based practices
- Multi-stakeholder forum practices

Table 25: **Household responses to observed changes (in %)**

Response	%
Gave up planting certain crops	67.8
Introduced new crop varieties	62.6
Gave up rearing certain types of livestock	42.6
Introduced new types of livestock	31.2
Gave up off-farm activities	18.7
Took a new off-farm activity (wages)	29.8
Stopped migrating for work	16.0
Migrated for work	5.4
Others	0.8

N=369 hh, 100%; data: LAT 2011.

- **Conventional approaches:** The Koshi Tappu drew national attention in 1969 when it was designated as one of the six royal hunting reserves in the Terai (DNPWC 2009). Conservation efforts had been undertaken in the reserve to maintain wildlife populations for hunting purposes. With dense riverine forests and tall grasses, the KTWR housed many species including the royal Bengal tiger (*Panthera tigris*), spotted leopard (*Panthera pardus*), Asiatic wild elephant (*Elephus maximus*), wild water buffalo, nilgai (*Boselaphus tragocamelus*), Gangetic dolphin, and swamp partridge. Growing human activities such as the construction of an embankment, the Koshi barrage, an access road and a railway line, as well as natural calamities, led to the clearing of the forest and eventual destruction of the habitat of large mammals (Bhandari 1994; DNPWC 2009). A large percentage of mammals were lost due to habitat conversion, destruction, human activities, and changes in the course of the Koshi River. The mandate of the hunting reserve was to protect animals and their habitats, manage the hunting activities of the royals and their guests, and protect the area from poachers and illegal hunters.
- **Protected area approach:** The conservation movement was launched in 1970 when King Mahendra approved in principle the establishment of Royal Chitwan National Park and Langtang National Park. Accordingly, the Wildlife Conservation Office was established in 1972 (DNPWC 2009). The conservation initiative gained momentum with the passage of the National Parks and Wildlife Conservation Act, 2029 v.s. in 1971. This act was a monumental document for Nepal's conservation movement. Based on the act, three categories of protected areas, national parks, reserves, and conservation areas were established in various regions of the country, representing the diverse ecological zones, climate, and ecosystems in Nepal (GoN 1988). The act also allows the government to declare buffer zones around protected areas without making any impact on land ownership. The rich faunal and floral diversity prompted the Government of Nepal to establish a protected area on the land already acquired by the Koshi Embankment Project. In 1976 the *Nepal Gazette* declared the area as Koshi Tappu Wildlife Reserve under the Act of 2029 v.s. (1971). To support the reserve administration, a unit of the Royal Nepal Army was deployed in 1977 for strict enforcement of wildlife reserve rules (DNPWC 2009).
- **Participatory approach:** The history of a participatory approach to conservation began with the enactment of the Buffer Zone Management Regulations, 2052 v.s. (1995) in accordance with Clause 33 of the National Parks and Wildlife Conservation Act, 2029 v.s. (1971) and the Buffer Zone Management Guidelines, 2056 v.s. (1996). According to DNPWC (2009), after the enactment of the aforementioned regulations and guidelines,

a conservation strategy and integrated management plan of the KTWR and its vicinity was formulated in 1998 (DNPWC 1998). The buffer zone of the KTWR was declared in August 2004, incorporating 16 VDCs with 108 wards and 215 settlements. The population of the area was 77,950 with 10,693 households (DNPWC 2009).

- **Research-based practices:** Various studies have been conducted in the KTWR in order to incorporate scientific data and information into the decision-making system of the reserve administration. Numerous studies were conducted on the individual flora and fauna, issues and concerns related to conservation, and the wise use and sustainable development of the area. There has also been regular census work on the wild water buffalo since 1976; the total population at the time of the study was 219 (DNPWC 2009; Khatri et al. 2010).
- **Multi-stakeholder forum practices:** The wetland is an interdisciplinary area and its wise use and conservation require the engagement and support of a wide range of stakeholders. Their collabouration is essential for promoting sustainable use. A multi-stakeholder forum was created to promote the idea of cross-sectoral coordination and cooperation for collabourative management of wetlands. The forum is headed by the Chairperson of the District Forest Coordination Committee; the District Forest Officer serves as member-secretary.

Socioeconomic development perspective

The population in the surrounding areas is estimated to be 77,950, representing 10,693 households. Approximately 120 households still reside inside the reserve (DNPWC 2009). The majority of households are engaged in agriculture and livestock rearing, while a few are dependent on fishing. The people living adjacent to the reserve are engaged in various activities that put high pressure on the reserve, such as fuelwood collection, wildlife poaching, and livestock grazing (Sah 1993; Shrestha 1994). Different organizations are working to both encourage local people towards conservation and improve their livelihoods. Some of them are briefly described below.

Conservation and Sustainable Use of Wetlands in Nepal (CSUWN): CSUWN is a joint undertaking of the Ministry of Forests and Soil Conservation of Nepal, Global Environment Facility, and the UNDP. The project promotes the sustainable management and conservation of Nepal's wetlands that are of national and global importance. Its main focus is on building partnerships to integrate wetland biodiversity conservation values into the national policy and planning framework, strengthening the capacity of government and community institutions for the conservation and sustainable use of wetlands, and promoting the collabourative management of wetland resources. CSUWN is currently working in the Koshi Tappu and its buffer zone areas to improve livelihoods and manage biodiversity.

Bird Conservation Nepal (BCN): At the KTWR, BCN assists local communities in managing buffer zone wetlands for sustainable livelihoods, while enhancing wetland biodiversity. They provide personnel training and build the capacity of local organizations and community groups, develop guidelines for wetland management for sustainable livelihoods, develop plans for sustainable fisheries management and community learning, and have established a visitor centre. Their programmes in Koshi are mostly funded by a Darwin Initiative Grant received from the British government with the Wildfowl and Wetlands Trust as the lead partner. BCN has played a lead role in various bird conservation activities within the KTWR and has been a major sponsor of a bird festival for the last three years.

Koshi Development Foundation-Nepal (KODEF-Nepal): KODEF-Nepal, a non-governmental, non-political, and non-profit organization, has been working in the area to enhance biodiversity conservation and alleviate poverty through meaningful participation of stakeholders. It was established and run by people living on the outskirts of the KTWR in 2008.

Union for Culture, Human and Environment Protection (UNCEP): UNCEP has been working on literacy, livelihoods, income generation, health and environmental awareness, rights-based programming, and volunteer mobilization by coordinating with different INGOs and NGOs in the region. UNCEP has been working in three districts of Nepal: Sunsari, Saptari, and Udaypur (buffer zone areas of the KTWR) in coordination with Development Nepal, Care Nepal, community development organizations and local governments, community-based organizations, and community user groups.

Community Animal Health Centre: This centre provides both disease prevention services and curative treatment to domestic animals in the district of Sunsari in the KTWRBZ. Additionally, people from all around the reserve have access to community animal health workers trained by the project, who work closely with the centre. The centre was established with support from IUCN Nepal.

Himalayan Nature (Himalayan Conservation and Research Institute): Himalayan Nature is mainly focused on the following programmes.

- **Conservation of the fishing cat (*Felis viverrina*) in eastern Nepal**: The fishing cat is a medium-sized wild cat in the wetlands of South and Southeast Asia. It is listed as an endangered species in the IUCN Red List of Threatened Species and in Appendix II of CITES. To date, no scientific study has examined its status, distribution, or conservation in Nepal. This field research in Nepal aims to shed light on the current population and distribution of the fishing cat in the KTWR using camera traps, sign surveys, and questionnaire surveys. This information will be helpful in conserving the species.
- **Bat Conservation Programme**: Himalayan Nature is working closely with KODEF-Nepal to protect Koshi Tappu's biodiversity, including bats. KODEF-Nepal promotes houses and roost areas for the insect-eating greater Asiatic yellow bat (*Scotophilus kuhli*). A recent flock count yielded more than 100 bats. Himalayan Nature has initiated its own bat conservation project in Lumbini and Koshi Tappu. They are closely working with KODEF to protect Koshi Tappu's biodiversity including bats such as Indian flying fox (*Pteropus giganteus*) whereas the KODEF promotes houses and helps conserve roosting areas for Greater Asiatic Yellow Bat (*Scotophilus kuhli*). A recent flock count yielded more than 100 of these bats.
- **Vulture Conservation Programme**: To maintain a stable population of white-rumped vultures (*Gyps bengalensis*), Himalayan Nature initiated the Vulture Conservation Programme in the KTWR in 2009. The main objective is to establish a site support group for long-term monitoring activities, establish a vulture 'restaurant', and promote income generation activities and awareness campaigns.

Koshi Victims Society (KVS): KVS is a non-governmental, non-profit social organization established in May 2003. It is registered with the District Administration Office, Saptari and is affiliated with the Social Welfare Council, Kathmandu. Its vision is creation of empowered, self-reliant, and equitable communities. It carries out activities for the sustainable development of the country, and specifically the district, advocates for the rights of people affected by the climate change process, increases awareness of environmental problems, disaster preparedness and ownership over land and water resources. KVS targets people and communities living in the river basin and affected by flooding, and focuses on women, children, the disabled, the elderly, and other marginalized or deprived sections of the community.

Koshi Early Recovery Project (KERP): Based in Itahari, KERP worked with the area's flood victims by engaging in plantation, resettlement of the area's landless people, and supporting local livelihoods. A UNDP-funded project, the KERP was phased out in the middle of 2011.

Association for Protection of Environment and Culture (APEC): APEC is a Koshi Tappu based non-governmental organization that works in collabouration with the reserve and buffer zone institutions. Its general objectives are to support the protection of biological diversity such as wildlife, wetland species, and forest resources, and to mobilize individuals and experts in the conservation of natural resources and sustainable use. It is engaged in the protection of wetlands, wildlife, and avifauna, empowering and educating local people, and implementing community-based management programmes in and around Koshi Tappu.

IUCN Nepal: IUCN Nepal is also involved in the conservation and sustainable development of Koshi Tappu. In collabouration with the DNPWC and the Mountain Institute (formerly Woodlands Institute) IUCN Nepal conducted studies on biodiversity, socioeconomic issues, and wetland-dependent people in the area. It also worked on sustainable financing of the reserve and the health of the domestic animals grazing in the area.

World Wildlife Fund (WWF) Nepal: WWF Nepal also works in the upper catchment areas of the Indrawati and Dudhkoshi rivers of the Koshi River sub-basin. It conducts and collabourates with other partner organizations in the conservation and sustainable use of wetlands and related resources in the area.

Majhi-Malaha Shanjal: Majhi-Malaha is a network of wetland-dependent Majhi (migrated from the hills) and Malaha (fisherpeople from the Terai) people. The network is engaged in mobilizing the local fishing population to improve their livelihoods and access to resources so that they can easily use resources, from both inside the reserve and the buffer zone areas. The network is formed under the auspices of the CSUWN, reserve, and buffer zone institutions.

Conservation and Development Challenges

As a wetland of international importance, the KTWR has been supporting and protecting natural systems and processes in the area that directly and indirectly support and benefit human livelihoods. The reserve offers a wide range of services such as fuelwood, fodder, food, irrigation, water storage, carbon sequestration, and pollution control to the substantial population living in the buffer zone, contributing to their subsistence and the local economy, and helping to reduce poverty (Shrestha and Alavalapati 2006; CSUWN 2009; Rayamajhi 2009). However, in recent years, a number of conservation and development challenges have been observed in the KTWR. Some of the challenges are listed below:

- Local people are extremely dependent on the KTWR, particularly on provisioning and cultural services (CSUWN 2009). As land cover changed significantly over the 34-year period (1976-2010), the KTWR's provisioning services were notably impacted. Swamps/marshes, forests, and rivers/streams, which have low coverage but a high production capacity and high level of dependency by local people, decreased drastically over the 34-year period. This change meant a great loss in provisioning, regulating, and supporting services and had serious negative impacts, not only on local people, but also on the reserve's globally threatened species, which use these ecosystems as their key habitats.
- In addition to the ecosystem changes endured by wetlands in general, the KTWR faces additional challenges from the dynamics of river course change, a serious management challenge for the authorities of the protected area. A trend of decreasing original habitats for species such as the wild water buffalo, Asiatic elephant, Indian bison, and spotted leopard, and isolation from nearby populations from the protected areas pose a serious threat for long-term conservation.
- Climate trends and projections also indicate future temperature rises and changes in precipitation patterns. These changes could have serious consequences for the productivity of the land in the buffer zone, including more frequent floods due to erratic rainfall and further changes in species' habitats.
- In recent years, the remaining forested areas have been highly infected by various invasive species, including bitter vine (*Mikania micrantha*). Thus, managing the KTWR as a protected area in isolation is becoming difficult.
- Poverty still plays an important role in the dependence of local people on the resources of the KTWR.

Recommended Adaptation Strategies

The KTWR is one of the most important protected areas for the conservation of wetland ecosystems in Nepal. The KTWR's key element is its significant biodiversity, especially the wetland migratory birds and the number of globally significant species including the wild water buffalo. This analytical research revealed that this globally significant wetland ecosystem is facing a number of conservation and development challenges. The observed climate data revealed an increasing trend in temperature and erratic rainfall. The land use and cover change analysis showed visible changes in different ecosystems, including a decrease in forested areas and river course change. Similarly, there has been demographic change over the period with increasing human pressure on the resources of the reserve. Considering these drivers of change, both biodiversity and local livelihoods in the KTWR are at risk. The livelihood vulnerability index reflected a higher frequency of natural shocks, higher sensitivity, and higher adaptive capacity. Some of the species are losing their key habitats at an alarming rate. Based on these assessments, some strategies have been suggested as a way forward to help maintain the ecosystem integrity of the area and build socioeconomic resilience of the local people.

- **Take cognizance of climate uncertainty and monitor changes continuously:** There is some uncertainty about the future direction and magnitude of change in the eastern Himalayan region. Climate change scenarios in the KTWR show a trend of increasing temperature and higher precipitation in the area; this will have significant impacts on the ecosystems, their services, and the livelihoods of local people. Local people have also perceived changes in the climate and its impact on different ecosystems, including agriculture. The changes in the state of ecosystems, climate, and livelihood patterns should be regularly monitored and assessed.
- **Understand the dynamics and linkages with an integrated system approach:** The KTWR has witnessed significant changes in its ecosystems over the last 30 years. To understand the reasons for such changes, studies should be strengthened on the linkages between land use and cover change, ecosystem goods and services,

and livelihoods of the people. Since the ecosystem of the KTWR is dependent on the hydrological cycle of the Koshi River, it is essential to look at the strategic level for better planning, research and management, covering both upstream and downstream areas, as well as conservation at transboundary and river basin levels, with an integrated approach.

- **Improved social protection services:** Communities in the KTWRBZ generally lacked access to social protection services (such as access to subsidised food and amenities, micro-credit, and insurance). Even where services were present, they were often not responsive to the increasingly erratic weather patterns affecting communities in the study area. The quality of these social protection services should be improved and coverage and access increased, with a special focus on disadvantaged groups, such as lower caste people and women, and those living in remote places.
- **Diversify livelihood options in the buffer zone to reduce poverty and social inequality:** The reserve is vulnerable at several levels: regional, ecosystem, and species level. These vulnerabilities are further exacerbated by socio-cultural issues; vulnerability is particularly high where poverty intersects with gender-, caste-, or ethnicity-based inequalities. Therefore, interventions to reduce poverty and social inequality are very important in addressing vulnerability in the KTWRBZ. Such interventions could include pro-poor ecotourism strategies such as understanding the value chain, diversification and up-scaling of tourism products; promoting community-based homestays, the use of renewable energy, and other enterprises related to local livelihoods; and better management of wetlands.
- **Support implementation of policies and institutions:** The KTWRBZ Management Plan 2009–2013, national wetland policy, national forest act, and other related policies and plans can be made more effective with stronger collabouration with local people. Multi-stakeholder approaches should be promoted to further increase the level of engagement by local people regarding the use of resources through buffer zone institutions, community institutions, and community-based organizations, among others. Future interventions should focus primarily on addressing the underlying causes of vulnerability and enhanced adaptive capacity of communities, particularly the marginalized and disadvantage groups including their high dependence on natural resources, persistent poverty and inaccessibility to markets and outreach services, and inadequate education and employment opportunities.
- **Moving from coping to adaptation and resilience:** Many of the observed household responses in the study areas were short-term coping strategies. Examples include dependence on borrowing, reduction of living expenditure, and buying food on credit. Such strategies not only deplete the household's livelihood asset base, but may actually render it more vulnerable to future shocks and stress. Adaptation planning should focus on 'no-regret' strategies, which aim to increase robustness to uncertainty, enhance flexibility, ensure efficiency, and guarantee equity. Studies on impacts of climate change on wetlands, biodiversity, and human society should be conducted and actions for ecological as well as socioeconomic resilience should be implemented.
- **Building the capacity of community institutions:** Local community institutions are pivotal for the success of long-term conservation and development actions. The KTWRBZ communities have been playing an important role in the conservation and management of the KTWR. The institutional capacity of the buffer zone institutions for participatory planning, management, and implementation of such conservation and development actions must be strengthened.
- **Raising awareness:** Raising awareness at regional, national, and local levels is imperative to motivate people towards conservation as well as prepare them to cope with uncertainty. It is crucial to raise awareness about the significance of ecosystems and their linkages with livelihoods. In the KTWR, most strategies observed in the study area were retrospective in nature. As adaptive capacity is partly determined by knowledge and the awareness of risks, it will be crucial to raise communities' awareness of potential risks as well as appropriate mechanisms to address such risks.

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Annex I: **Mountain Specific Livelihoods Vulnerability Index (MSLVI) Framework**

Main dimensions	Sub-dimensions	Indicators
Adaptive capacity	Socio-demographic profile (.8)	■ Dependency ratio (1) ■ Female headed households (y/n) (.5) ■ Educational attainment of HH head (1)
	Access to resources (.5)	■ Agricultural land per head (1) ■ Livestock per head (1)
	Livelihood strategies (1)	■ Secondary and tertiary sector livelihood diversification index (1) ■ Primary sector livelihood diversification index (.75) ■ Total amount of annual remittances per head (.75) ■ Cash crop diversity index (.75)
	Social networks (.7)	■ No. of institutions assisting HH in time of stress)/total No. of networks (1) ■ Household has difficulties to borrow money (y/n) (.5)
	Accessibility (.8)	■ Accessibility factor (time in minutes) to next hospital, bus stop, paved road, market centre, agricultural centre, bank, post office (1)
	Coping strategies (1)	■ No. of livelihood diversification strategies (.5) ■ No. of decreased investments as coping strategies (-.5) ■ Average time to recover from shocks (months)/combined severity (-1) ■ No. of adaptation strategies implemented (.5)
Sensitivity	Wellbeing (-1)	■ Extent of indebtedness (-.5) ■ Durable goods factor (No. of TVs, dish antenna, radios, mobiles, motor vehicles) (.75) ■ Total per head consumption (1)
	Health/sanitation (-1)	■ Frequency of serious illnesses (1) ■ Access to improved sanitation (.5) ■ Access to improved source of drinking water (.5) ■ Perceived quality of drinking water (.75)
	Food security (-1)	■ Household is food self-sufficient (1) ■ No. of months HH has sufficient food (1) ■ Food crop diversity index (.3) ■ Average no. of months food stocks feed all household members (.5)
	Water security (-1)	■ Time to water resource (min) (.8) ■ No. of months with water sufficiency for household needs (1) ■ Severity of water conflicts (within community and between communities) (.75) ■ No. of months of water sufficiency for crops and livestock (1)
	Environmental stability (-1)	■ Household with sloping terrain (y/n) (-.5) ■ Household with irrigated land (y/n) (1) ■ Degree to which house can withstand strong winds, severe rain, snow, or hail without significant damage (.5) ■ Quality of wall material of dwelling (.5)
Exposure	Natural shocks (1) Economic shocks (1)	■ No. of natural shocks during the past 12 months (.5) ■ Combined damage caused by natural shocks (1) ■ No. of economic shocks during the past 12 months (.5) ■ Combined damage caused by economic shocks (1)
	Perception of climate variability (.5)	■ Household experienced changes in frequency of certain climatic events (y/n) (1) ■ Household experienced changes in severity of certain climatic events (y/n) (1) ■ Household experienced new climatic or environmental conditions over the past 10 years (y/n) (.5) ■ Household reported changes in temperature over the past 10 years (y/n) (.5) ■ Household reported changes in precipitation over the past 10 years (y/n) (.5)

Annex II: **Preliminary checklist of plant species in the KTWR (taxonomic order)**

S.N.	Family	Scientific Name	Common Name	Status		
	Pteridophytes					
1	Polypodiaceae	*Adiantum philippense*	Raljari			
		Drynaia quercifolia				
2	Athyriaceae	*Diplazium esculenlum*	Lamtusia. Niuro			
3	Ophioglossaceae	*Ophioglossum reticulatum*	Jibhiya Sag. Jibre Sag	LC		
		Helminthostachys zeylanica	Kurkure. Ankhe Jhar			
4	Marsileaceae	*Marsilea minuta*	Charpate	LC		
5	SALVINIACEAE	*Azolla imbricata*	Pani Unyu (Water fern)	LC		
6	Eouisetaceae	*Equisetum debile*	Kurkure. Ankhe Jhar			
7	Pteridaceae	*Pteris vittata*				
		Pteris wallichiana				
		Ceratopteris thalictroides	Pani dhaniya			
8	Lygodiaceae	*Lygodium flexuosum*				
	Angiosperm- monocots					
1	Typhaceae	*Typha elephantina*	Pater	LC		
2	Alismataceae	*Sagittaria guayanensis*				
		Sagittaria trifolia		LC		
3	Hydrocharitaceae	*Hydilla verticillata*				
		Hydrocharis dubia		LC		
		Ottelia alismoides		LC		
		Vallisneria spiralis		LC		
4	Poaceae (gramineae)	*Apluda mutica*	Dakle Khar			
		Arundo donax	Khar			
		Axonopus compressus				
		Bothriochloa bladhii				
		Brachiaria distachya	Likhe banso			
		Brachiaria ramosa		LC		
		Brachiaria reptans				
		Chrysopogon aciculatus	Kuro			
		Coix lachryma-jobi	Bhirkaulo. Jare			
		Cymbopogon jwarancusa				
		Cymbopogon martinii				
		Cymbopogon pendulus	Khar			
		Cynodon arcuatus	Dubo			
		Cynodon dactylon	Dubo			
		Cyrtococcum accrescens				
		Dactyloctenium aegypticum				
		Desmostachya bipinnata	Kush			
		Dichanthium annulatum				
		Digitaria albudens	Banso			
		Digitaria ciliaris	Banso			
		Digitaria setigera	Banso			
		Digitaria violescens	Banso			
		Echinochloa colona	Sama			
		Echinochloa crus-galli	Sama			
		Echinochloa cruspavonis				
		Eleusine indica	Kodejhar	LC		
		Elytrophorus spicatus		LC		
		Eragrostis atrovirens	Banso			
		Eragrostis gangetica	Banso			
		Eragrostis coarctata	Banso			
		Eragrostis japonica	Banso	LC		
		Eragrostis tenella	Banso			
		Eragrostis unioloides	Banso	LC		
		Eriochloa procera		LC		
		Eulaliopsis binata	Sabo, Babiyo			

S.N.	Family	Scientific Name	Common Name	Status		
		Erianthus ravennae				
		Hemarthria compressa		LC		
		Hygorhyza aristata	Ghans			
		Hymenachne pseudointerrupta				
		Imperata cylindrica	Siroo			
		Isachne globosa				
		Ischaemum rugosum				
		Leersia hexandra	Navo dhan			
		Leptochloa chinensis				
		Oplismenus burmannii				
		Oplismenus compositus	Jangali dhan			
		Oryza rufipogon	Urila	LC		
		Panicum paludosum				
		Paspalidium flavidum				
		Paspalidium punctatum		LC		
		Paspalum distichum				
		Paspalum conjugatum		LC		
		Paspalum scrobiculatum				
		Phalaris minor				
		Phragmites karka	Narkat			
		Pogonatherum crinitum				
		Pogonatherum monspliensis				
		Saccharum spontaneum	Kans			
		Sacciolepis indica				
		Setaria glauca	Kanike kaguno			
		Setaria pumila	Ghode-banso			
		Setaria tomentosa	Khude grass			
		Sporobolus indicus				
		Thysanolaena maxima	Amriso, Kucho			
		Vetiveria zizanioides	Khus Khus			
5	Arecaceae (palmae)	*Phoenix sylvestris*	Khajur			
6	Cyperaceae	*Bulbostylis barbata*				
		Carex microglochin				
		Cyperus compactus		LC		
		Cyperus compressus	Motha			
		Cyperus corymbosus	Motha			
		Cyperus difformis	Motha	LC		
		Cyperus diffusus	Motha	LC		
		Cyperus digitatus	Motha	LC		
		Cyperus distans	Motha	LC		
		Cyperus esculentus	Motha	LC		
		Cyperus exaltatus	Motha			
		Cyperus halpan	Motha			
		Cyperus iria	Motha	LC		
		Cyperus platystylis	Motha			
		Cyperus procerus	Motha	LC		
		Cyperus rotundus	Motha	LC		
		Elaeocharis dulcis	Motha			
		Eleocharis acutangula	Motha			
		Eleocharis atropurpurea				
		Fimbristylis dichotoma	Motha	LC		
		Fimbristylis aestivalis				
		Fimbristylis littoralis		LC		
		Fimbristylis miliacea	Motha			
		Fimbristylis schoenoides	Motha	LC		
		Kyllinga brevifolia		LC		
		Kyllinga nemoralis		LC		
		Pycreus flavidus	Motha			
		Pycreus pumilus				

S.N.	Family	Scientific Name	Common Name	Status		
		Pycreus sanguinolentus		LC		
		Schoenoplectus articulatus				
		Schoenoplectus juncoides				
		Schoenoplectus grossus	Kaysoor			
		Schoenoplectus lateiflorus				
		Schoenoplectus mucronatus				
7	Araceae	*Acorus calamus*	Bojho	LC		
		Alocasia macrorrhiza	Ghyamphe tarul			
		Amorphophallus bulbifer	Oal			
		Arisaema tortuosum	Sarpa ko Makai			
		Colocasia esculenta	Arikonch. Karkalo	LC		
		Lassia spinosa				
		Pistia stratiotes	Jal Kobhi			
8	Eriocaulaceae	*Eriocaulon cinereum*				
9	Pontederiaceae	*Eichhornia crassipes*	Jalkumhi			
		Monochoria hastata				
		Monochoria vaginalis				
10	Juncaceae	*Juncus bufonius*		LC		
11	Liliaceae	*Asparagus racemosus*	Santawar. Kurilo			
		Chlorophytum arundinaceum				
		Wolfia globosa				
12	Dioscoreaceae	*Dioscorea bulbifera*	Gittha. Panglung			
		Dioscorea pentaphylla	Gittha			
13	Orchidaceae	*Spiranthes sinensis*	Tutiya		II	
		Zeuxine strateumatica		LC	II	
14	Hypoxidaceae	*Curculigo orchioides*	Musali			
15	Potamogetonaceae	*Potamogeton crispus*		LC		
		Potamogeton lucens		LC		
		Potamogeton nodosus		LC		
		Potamogeton pectinatus		LC		
16	Aponogetonaceae	*Aponogeton natans*		LC		
	Butomaceae	*Butomopsis latifolia*	Kunth			
	Commelinaceae	*Commelina benghalensis*		LC		
		Commelina paludosa	Kane saag			
		Cyanotis cristata				
		Floscopa scandens		LC		
		Murdannia nudiflora	Simkane Ghans			
		Tonningia axillaris				
	Angiosperm- dicots					
1	Piperaceae	*Peperomia pellucida*	Piplajhar			
		Piper longum	Pipla			
2	Salicaceae	*Salix tetrasperma*	Bains			
3	Utricaceae	*Boehmeria platyphylla*	Gargalo			
		Gonostegia oppositifolia				
		Pauzolzia pentandra				
		Pauzolzia zeylanica	Maaslahare			
4	Loranthaceae	*Dendrophthoe falcata*	Banjhi, Ajeru			
5	Polygonaceae	*Polygonum barbatum*	Pire			
		Polygonum hydropiper		LC		
		Polygonum kawagoeanum				
		Polygonum glabrum				
		Polygonum lapathifolium	Mirmiriya			
		Polygonum plebeium		LC		
		Rumex dentatus				
6	Chenopodiaceae	*Chenopodium album*	Bathuwa			
		Chenopodium ambrosioides	Guhuana Khar			
7	Nyctaginaceae	*Boerhavia diffusa*	Punarnawa			
8	Aizoaceae	*Mollugo lotoides*				
9	Basellaceae	*Basella alba*	Poye ke Saag			

S.N.	Family	Scientific Name	Common Name	Status		
10	Caryophyllaceae	*Drymaria cordata*	Abijalo			
		Stellaria media				
11	Portulacaceae	*Portulacca oleracea*	Nuniya ke Saag			
12	Ceratophyllaceae	*Ceratophyllum demersum*	Sewar	LC		
13	Nymphaeaceae	*Nelumbo nucifera*	Rato Kamal			
		Nymphaea nouchali	Seto Kamal	LC		
14	Ranunculaceae	*Ranunculus sceleratus*				
		Ranunculus aquitalis				
		Ranunculus diffusus				
15	Menispermaceae	*Cissampelos pariera*	Gudarganu			
		Stephania japonica				
		Tinospora sinensis	Gurjo			
		Tiliacora acuminata	Rukh kane			
16	Lauraceae	*Litsea monopetala*	Kutmiro			
17	Papaveraceae	*Argemone mexicana*	Kataiya. Thakal			
18	Fumariaceae	*Fumaria indica*				
19	Capparaceae	*Capparis spinosa*	Kabara			
		Cleome gynandra				
		Cleome speciosa				
		Cleome viscosa	Hurhur			
20	Crassulaceae	*Kalanchoe spathulata*				
		Sedum multicaule				
21	Oxalidaceae	*Biophytum sensitivum*	Lajbali			
		Oxalis corniculata	Amta. Chari amilo			
22	Rutaceae	*Aegle marmelos*	Bel			
		Murraya koenigii	Gandhel Patta			
		Murraya paniculata	Kamini			
23	Meliaceae	*Azadirachta indica*	Neem			
		Cipadessa baccifera	Dhamina			
		Melia azedarach	Bakenu			
24	Polygalaceae	*Polygala arvensis*	Bisnar. Pire			
25	Euphorbiaceae	*Bridelia scandens*	Gayo			
		Bridelia squamosa	Kajhi. Banangur			
		Croton bonplandianum	Mirchaira, Ban Tulsi			
		Euphorbia heterophylla				
		Euphorbia hirta	Dudhiya			
		Euphorbia prostrata	Dudhiya			
		Euphorbia thymifolia				
		Jatropha gossypifolia	Lal Bangrera			
		Jatropha curcas	Saruva. Sajiyon			
		Kirganelia reticulatus				
		Macaranga pustulata	Malato			
		Mallotus philippensis	Roena. Sindure			
		Phyllanthus virgatus				
		Phyllanthus emblica	Aura. Amla			
		Phyllanthus urinaria				
		Ricinus communis	Ledi. Arari			
		Trewia nudiflora	Bhilor			
26	Anacardiaceae	*Mangifera indica*	Aap			
		Chaerospondias axillaris	Labsi			
27	Celastraceae	*Celastrus paniculatus*	Pilaphal			
28	Sapindaceae	*Cardiospermum halicacabum*	Jyotismati. Tilbor			
29	Rhamnaceae	*Zizyphus mauritiana*	Bayar			
30	Vitaceae	*Ampelocissus latifolia*	Panlati. Karauja			
		Cayratia javanica				
		Tetrastigma serrulatum	Panilahara			
31	Tiliaceae	*Corchorus aestuans*	Jangati Patuwajhar			
		Grewia disperma	Phorsa. Siyal phurse			
		Grewia oppositifolia				

S.N.	Family	Scientific Name	Common Name	Status		
		Grewia optiva				
		Triumfetta rhomboides				
32	Malvaceae	*Abelmoschus manihot*	Simal tarul			
		Abutilon indicum				
		Gossypium hirsutum	Kapas			
		Melochia corchorifolia	Patuwajhar	LC		
		Sida acuta	Bariyar			
		Sida cordata	Bariyar			
		Sida glutinosa				
		Sida rhombifolia	Bariyar			
		Thespesia lampus				
		Urena lobata	Lapta. Thulo Ballu. Nalu Kuro			
33	Tamaricaceae	*Tamarix dioica*	Jhauwa			
34	Hypericaceae	*Hypericum japonicum*				
35	Elatinaceae	*Bergia ammannioides*				
36	Lythraceae	*Amnannia baccifera*	Ambar			
		Lagerstroemia parviflora	Sidh. Bot Dahngreo			
		Rotala densiflora		LC		
		Rotala indica		LC		
		Rotala rotundifolia	Simijhar	LC		
		Woodfordia fruticosa	Burghairo. Bhuidnayero	LC		
37	Myrtaceae	*Syzygium cumini*	Jamun			
38	Melastomataceae	*Osbeckia nepalensis*	Seto Chulesi			
39	Onagraceae	*Fissendocarpa linifolia*	Loyange Jhar			
		Ludwigia adescendens				
		Ludwigia octovalvis				
		Ludwigia perennis		LC		
40	Plumbaginaceae	*Plumbago zeylanica*				
41	Sapotaceae	*Madhuca longifolia*	Mahuwa			
42	Oleaceae	*Nyctanthes arbor-tristis*	Harshingar. Parilat			
43	Gentianaceae	*Centaurium centaurioides*				
44	Apocynaceae	*Alstonia scholaris*	Chhatoun	LC		
		Cascabela thevetica				
		Holarrhena pubescens	Dudhkhoria. Madishe khirro	LC		
		Ichnocarpus frutescens	Gahumani			
		Thevetia peruviana				
		Asclepias curassavica	Khurahe Phool			
		Calotropis gigantea	Akon. Ank			
		Calotropis procera	Akon. Ank			
		Cryptolepis buchanani				
		Cynanchum callialatum				
		Oxystelma esculentum	Arna single laharo	LC		
		Pergularia daemia				
		Tylophora tenerrima				
45	Cuscutaceae	*Cuscuta reflexa*	Akashlati. Paheli Lahara			
46	Convolvulaceae	*Argyreia argentea*				
		Argyreia hookeri				
		Evolvulus nummularius				
		Ipomoea aquatica	Karmi ko Saag			
		Ipomoea carica				
		Ipomoea carnea	Behaya			
	.	*Ipomoea hederifolia.*				
		Ipomoea nil				
		Ipomoea quamoclit				
		Ipomoea turbinata	Gidhawar			
		Merremia hederacea				
		Operculina turpethum	Nisodha			

S.N.	Family	Scientific Name	Common Name	Status		
		Porana paniculata	Akashveli			
47	Hydrophyllaceae	*Hydrolea zeylanica*		LC		
48	Verbenaceae	*Callicarpa arborea*	Guyalo			
		Callicarpa macrophylla	Budhiyadai Ke Lawa			
		Clerodendrum indicum	Banhnaithi			
		Clerodendrum viscosum	Bhat			
		Duranta repens	Nilkanda			
		Gmelina arborea	Khamar			
		Lantana camara	Phulajhar			
		Phyla nodiflora	Kurkura jhar	LC		
		Vitex negundo	Semiwar. Simali			
49	Lamiaceae (labiatae)	*Anisomeles indica*	Ratochrapate			
		Colebrookia oppositifolia	Dhurselo. Goithiya Khar			
		Hyptis suaveolens	Ban tulsi			
		Leonotis nepetaefolia	Udusmara			
		Leonurus japonicus	Dulphe jhar			
		Leucas indica	Guma			
		Leucas cephalotes				
		Leucas mollissima				
		Mentha spicata	Pudina			
		Ocimum ameicana				
		Ocimum tenuiflorum	Tulsi			
		Pogostemon benghalensis	Bokwa. Utjar. Rijilo			
		Salvia plebeia				
50	Solanaceae	*Datura metel*				
		Physalis peruviana	Dhatur			
		Physalis minima	Jangali mewa			
		Solanum aculeatissimum	Jangali mewa			
		Solanum anguivi	Kantakari			
		Solanum nigrum	Bhatkaiya. Bihi			
		Solanum surattense	Rengani. Kantaka			
		Solanum torvum	Banbhanta. Kachera			
51	Scrophulariaceae	*Bacopa monnieri*		LC		
		Dopatrium junceum		LC		
		Limnophila indica		LC		
		Lindenbergia indica		LC		
		Lindernia anagallis		LC		
		Lindernia antipoda		LC		
		Lindernia ciliata		LC		
		Lindernia crustacea		LC		
		Lindernia procumbens		LC		
		Lindernia pusilla		LC		
		Lindernia viscosa		LC		
		Mazus pumilus				
		Mecardonia procumbens				
		Scoparia dulcis	Mithuwa Khar			
		Torenia indica				
		Veronica anagallis-aquatica				
52	Lentibulariaceae	*Utricularia aurea*	Bladderwort	LC		
		Utricularia exoleta	Bladderwort			
53	Orobanchaceae	*Orobanche aegytica*	Thokara			
54	Bignoniaceae	*Oroxylum indicum*	Patsan. Tatelo			
55	Acanthaceae	*Dicliptera bupleuroides*				
		Echinacanthus attenuatus				
		Eranthemum pulchellum				
		Eranthemum splendens				
		Hemigraphis hirta				
		Hygrophila auriculata	Gokhula-k-kaant			
		Hygrophila polysperma	Asuro			
		Justicia adhatoda				

S.N.	Family	Scientific Name	Common Name	Status		
		Justicia procumbens				
		Lepidagathis incurua				
		Nelsonia canescens				
		Peristrophe bicalyculata				
		Ruellia tuberosa				
		Rungia parviflora				
		Thunbergia fragrans				
		Thunbergia grandiflora	Kag Chuchche			
56	Plantaginaceae	*Plantago erosa*	Isapgol			
57	Rubiaceae	*Anthocephalus chinensis*	Kadam			
		Borreria alata				
		Borreria articularis				
		Catunaregam uliginosa	Pirar			
		Dentella repens		LC		
		Dentella serpyllifolia				
		Hedyotis corymbosa				
		Hedyotis diffusa		LC		
		Paederia foetida L.				
		Meyna pubeseens				
58	Cucurbitaceae	*Citrullus lanatus*	Tarbujo			
		Cicumis melo	Ghurmi			
		Coccinea grandis	Tilkor			
		Diplocyclos palmatus				
		Gymnopetalum cochichinense				
		Momordica charantia	Tite Karela			
		Mukia maderaspatana				
		Solena amplexicaulis				
59	Campanulaceae	*Lobelia alsinoides*		LC		
60	Amaranthaceae	*Achyranthes aspera*	Chirchiri. Apamarg Datiuan			
		Achyranthes bidentata				
		Altemanthera paronychioides				
		Altemanthera philoxeroides				
		Altemanthera sessilis	Saranchi. Bhiringi Jhar			
		Amaranthus spinosus	Kataiya. Kande Lude			
		Amaranthus tricolor	Lude			
		Amaranthus viridis	Lude			
		Celosia argentea				
		Deeringa amaranthoides				
		Gomphrena celosoides				
61	Umbelliferae	*Centella asiatica*	Ghodtapre	LC		
		Hydrocotyle sibthorpioides	Sano Ghodtapre	LC		
		Oenanthe javanica				
62	Asteraceae	*Ageratum conyzoides*	Rawune. Ilame. Gandhe			
		Ageratum houstonianum	Nilo Gandhe			
		Artemisia dubia	Titepati			
		Bidens biternata				
		Bidens pilosa				
		Bidens sulphurea	Thakal			
	.	*Breea arvensis*				
		Blumea lacera				
		Blumea membrenacea				
		Blumea mollis				
		Blumea oxyodonta				
		Caesulia axillaris	Thukaha	LC		
		Centipeda minima		LC		
		Chromolaena odorata	Banmara			
		Conyza bonaiensis				
		Conyza canadensis				

S.N.	Family	Scientific Name	Common Name	Status		
		Conyza japonica				
		Cotula hemispherica				
		Crassocephalum crepidioides				
		Cyathocline purpurea	Purple bane	LC		
		Eclipta prostrata	Vangrila			
		Emilia sonchifolia				
		Elephantopus scaber	Sabsoria. Mulapatey			
		Eupatorium adenophorum	Banmara			
		Gnaphalium polycaulon				
		Grangea maderaspatana		LC		
		Gynura nepalensis				
		Ixeris polycephala				
		Launaea aspleniifolia				
		Mikania micrantha	Kunth			
		Parthenium hysterophorus				
		Pseudognaphalium luteo-album ssp.	Kairo jhar			
		Siegesbeckla orientalis	Titiya			
		Sonchus asper				
		Sonchus wightiana				
		Sphaeranthus indicus	Latoghans	LC		
		Synedrella nodiflora	Pirpire			
		Spilanthes acmella	Pirpire			
		Spilanthes calva		LC		
		Spilanthes paniculata				
		Tridax procumbens				
		Vernonia cinerea	Mirchiya			
		Youngia japonica				
		Xanthiun strumariun	Lapetuwa. Bhede Kuro			
63	Bombacaceae	*Bombax ceiba*	Simal, Simar			Protected
64	Boraginaceae	*Bothriospermum tenellum*				
		Cynoglossum lanceolatum	Kanike Kuro			
		Heliotropium indicum	Heathi-sur			
		H. strigosum	Lapta			
65	Brassicaceae	*Rorippa nasturtium-aquaticum*				
		Rorippa indica				
		Draba elata				
66	Buddlejaceae	*Buddleja asiatica*	Bhimsenpatee			
67	Burseraceae	*Garuga pinnata*	Dabdabe			
68	Cannabaceae	*Cannabis sativa*	Bhangai. Ganja			
69	Fabaceae	*Abrus precatorius*	Lalgedi. Sakhine			
		Acacia catechu	Khair. Katha			Protected
		Acacia nilotica .	Babul			
		Aeschynomene indica		LC		
		Aeschynomene aspera	Dhondiya	LC		
		Albizia lebbeck	Kalo Siris			
		Albizia chinensis				
		Alysicarpus vaginalis				
		Atylosia scarabaeoides		LC		
		Bauhinia purpurea	Koiralo			
		Bauhinia vahlii	Malhan. Bhorla			
		Butea monosperma	Palas			
		Caesalpinia bonduc	Tairi. Gainde Kosda			
		Cassia fistula	Rajbriksha. Amaltash			
		Cassia occidentalis	Chakor. Tapre			
		Cassia sophera				
		Cassia tora	Chakor. Tapre			
		Crotalaria alata	Jhunjhuna			
		Crotalaria albida		LC		
		Crotalaria pallida				

S.N.	Family	Scientific Name	Common Name	Status		
		Crotalaria prostrata	Jhunjhuna			
		Crotalaria quinquefolia		LC		
		Crotalaria spectabilis				
		Dalbergia latifolia	Satishal	VU	I	Protected
		Dalbergia sissoo	Sisso			
		Desmodium gangeticum				
		Desmodium heterocarpon				
		Desmodium laxiflorum	Kuro			
		Desmodium triflorum		LC		
		Dunbaria rotundifolia				
		Erythrina suberosa				
		Flemengia macrophylla				
		Indigofera linifolia		LC		
		Latyrus aphaca	Jangali Kerau			
		Medicago lupulina				
		Melilotus alba				
		Mimosa pudica	Lajaunia Jhar	LC		
		M. rubicaulis	Arar. Boksi Kanda			
		Mucuna pruriens	Kabachhua. Kauso			
		Pithecellobium dulce	Julebi			
		Phyllodium pulchellum	Kanani	LC		
		Sesbania bispinosa		LC		
		Smithia sensitiva		LC		
		Tamarindus indica	Imli			
		Uraria lagapodioides				
		Uraria picta		LC		
		Vicia angustifolia				
		Vicia hirsuta	Akta Misia			
		Vicia tetraspema				
70	Hippocrateaceae	*Reissantia arborea*	Chatpatia			
71	Menyanthaceae	*Nymphoides hydrophyllum*				
		Nymphoides indicum				
72	Moraceae	*Artocarpus lacucha*	Badhar			
		Ficus benghalensis	Bargaj. Bar			
		Ficus hispida	Kothedumar			
		Ficus hirta				
		Ficus ovata				
		Ficus racemosa	Gular. Dumri			
		Ficus religiosa	Pipal			
		Ficus semicordata	Khnayo			
		Ficus vireens	Khurhur. Pakar			
		Streblus asper	Sihora			
73	Moringaceae	*Moringa oleifera*	Sahinjan			
74	Primulaceae	*Anagallis arvensis*	Armale			
		Primula umbellata				
75	Campanulaceae	*Sphenoclea zeylanica*	Panimarich	LC		
76	Lythraceae	*Trapa bispinosa*	Singara			
77	Cannabaceae	*Trema orientalis*	Khari. Kuyel			
78	Annonaceae	*Miliusa velutina*				

Source: IUCN (1998); and DNPWC (2009)

Annex III: **Preliminary checklist of mammals of KTWR (taxonomic order)**

S.N.	Family	Scientific Name	Common Name	Status		
				GoN	IUCN	CITES
1.	Elephantidae	*Elephas maximus*	Asiatic Elephant	P	E	I
2.	Cercopithecidae	*Macaca mulata*	Rhesus Macaque		VU	II
3.		*Semnopithecus entellus*	Hanuman Langur		LC	I
4.	Leporidae	*Lepus nigricollis*	Indian Hare		LC	
5.	Sciuridae	*Ratufa bicolor*	Black Giant Squirrel		NT	II
6.		*Funambulus palmarum*	Three Striped Squirrel		LC	II
7.	Suidae	*Sus scrofa*	Wild boar		LC	
8.	Platanistiade	*Platanista gangetica*	Gangetic Dolphin	P	EN	I
9.	Cervidae	*Axis axis*	Spotted Deer		LC	I
10.		*Axis porcinus*	Hog Deer		EN	I
11.		*Muntiacus muntjak*	Barking Deer		LC	I
12.		*Bubalus arnee*	Wild Water Buffalo	P	EN	III
13.	Pteropodidae	*Pteropus giganteus*	Indian Flying Fox		LC	II
14.	Felidae	*Felis chaus*	Jungle Cat		LC	II
15.		*Prionailurus viverrinus*	Fishing Cat		EN	II
16.		*Panthera pardus*	Common Leopard		NT	
17.	Viverridae	*Viverra zibetha*	Large Indian Civet		NT	III
18.	Canidae	*Canis aureus*	Golden Jackle		LC	III
19.		*Vulpes benghalensis*	Bengal Fox		LC	III
20.	Herpestedae	*Herpestes edwardsii*	Indian Grey Mongoose		LC	III
21.		*Lutra lutra*	Common Otter		NT	I
22.		*Lutrogale perspicillata*	Smooth Coated Otter		VU	II

Sources: IUCN, 1998; TMI and IUCN/Nepal. (1994; IUCN 1998).

Annex IV: **Preliminary checklist of herpetofauna of KTWR (alphabetical order)**

S.No.	Family	Scientific Name	Common Name	Status		
				GoN	IUCN	CITES
1.	Agamidae	*Calotes versicolor*	Garden lizard		LC	
2.	Bataguridae	*Kachuga kachuga*	Painted roofed turtle		CR	II
3.		*Kachuga smithii pallidipes*	Brown roofed turtle		NT	II
4.		*Kachuga tecta*	Indian roofed turtle			
5.		*Hardella thurjii*	Crowned river turtle		LC	II
6.		*Melanochelys trijuga*	Indian black turtle		NT	
7.	Boidae	*Python molurus bivittatus*	Burmese rock python	P	NT	II
8.	Bufonide	*Bufo melanosticus*	Black spined toad		LC	
9.		*Bufo stomatictus*	Marbled toad		LC	
10.	Colubridae	*Ahaetulla nasuta*	Short nosed vine snake		NT	
11.		*Amphiesma stolata*	Buf striped keelback		LC	
12.		*Boiga trigonata*	Common cat snake		LC	
13.		*Enhydris enhydris*	Smooth water snake		LC	
14.		*Ptyas mucosus*	Asian rat snake		LC	
15.		*Xenocrophis piscator*	Checkered keelback		LC	III
16.		*Xenochrophis sanctijohannis*			LC	
17.	Crocodylidae	*Crocodylus palustris*	Marsh mugger		V	I
18.	Elapidae	*Bungarus caeruleus*	Common krait		LC	
19.		*Bungarus fasciatus*	Banded krait		LC	
20.		*Ophiophagus hannah*	King cobra		V	
21.		*Naja kaouthia*	Monocellate cobra		LC	II
22.		*Naja naja*	Bonocellate cobra		LC	
23.	Gavialidae	*Gavialis gangeticus*	Gharial	P	E	I
24.	Gekkonidae	*Hemidactylus flaviviridis*	Saffron-bellied wall gecko		LC	
25.		*Hemidactylus frenatus*	Bridled house gecko		LC	
26.	Ranidae	*Amolops afghanus*	Meghalaya stream frog		LC	
27.		*Hoplobatrachus crassus*	Jerelon's bull frog		LC	
28.		*Euphlyctis cyanophylictis*	Skittering frog			
29.		*Rana humeralis*	Burmese frog		LC	
30.		*Limnonectes limnocharis*	Cricket frog			
31.		*Rana nigrovittata*	Black spotted frog		LC	
32.		*Hoplobatrachus tigerinus*	Indian bull frog		LC	
33.		*Tomopterna breviceps*	Short-headed burrowing frog		LC	II
34.	Rhacophoridae	*Polypedates taeniatus*	Six lined tree frog		LC	
35.	Scincidae	*Riopa punctata*	Dotted garden skink		LC	
36.	Testudinidae	*Indotestudo elongata*	Elongated tortoise		VU	II
37.	Trionychidae	*Chitra indica*	Chitra turtle		EN	II
38.		*Lissemys punctata anderson*	Indian flap-shell turtle		LC	I
39.		*Aspederetes gangeticus*	Ganges soft-shell turtle		VU	I
40.		*Aspideretes hurum*	Peacock soft-shell turtle		VU	I
41.		*Aspideretes leithi*	Leith's soft-shell turtle		VU	I
42.	Typhlopidae	*Rhamphotyphlops braminus*	Blind snake			
43.	Varanidae	*Varanus flavescens*	Yellow monitor		LC	I
44.		*Varanus begalensis*	Bengal monitor		LC	I
45.	Viperidae	*Trimeresurus albolabris*	White-lipped tree viper		LC	

Source IUCN 1998, DNPWC 2009

Annex V: **Preliminary checklist of fish of KTWR (alphabetical order)**

S.N	Family	Scientific Name	Local and Common Name	Status	
				IUCN	CITES
1	Amblycipidae	*Amblyceps mangois*	Pichhi	LC	
2	Amphinoidae	*Amphipnous cuchia*	Bamn Gangetic mudeel	LC	
3	Anabantidae	*Anabanus tesdineus*	Kabai, Climbing perch	LC	
4	Anguilidae	*Anguilla bengalensis*	Rajbam, Long freshwater eel	LC	
5	Bagridae	*Mystus aor*	Kanti, Long whiskered catfish	LC	
6		*Mystus bleekeri*	Tengra, Day's Mystus	LC	
7		*Mystus cavasius*	Tengra, Gangetic Mystus	LC	
8		*Mystus seenghala*	Tengra, Giant river catfish		
9		*Mystus tengara*	Tengra, Mystus	LC	
10		*Mystus vittatus*	Tengra, Striped dwarf mystus	LC	
11		*Rita rita*	Rita, Chona	VU	
12	Belonidae	*Xenentodon cancila*	Kauwa, Chuchebam, Freshwater Gar fish	LC	
13	Belontidae	*Colisa fasciatus*	Katara, Striped Gourami		
14		*Colisa latius*	Dwarf gaurami		
15		*Colisa sota*	Gourami		
16	Chacide	*Chaca chaca*	Pauna, Pauwa	LC	
17	Channadae	*Channa gachua*	Bhoti, Hile, Asiatic murrel	LC	
18		*Channa marulius*	Saul, Saura, Giant Murrel	LC	
19		*Channa punctatus*	Garahi, Spotted Murrel		
20		*Channa stewartii*	Hile, Assamese Murrel	LC	
21		*Channa stratus*	Saura, Striped Murrel		
22	Chandidae	*Chanda nama*	Nata Elongated glass perchlet	LC	
23		*Chanda ranga*	Chanari Glassy fish	LC	
24	Claridae	*Clarias batrachus*	Mungri, Mugar	LC	
25	Cobitidae	*Botia histrionic*	Baghi		
26		*Botia lohochata*	Loach		
27		*Lepidocephalichthys guntea*	Lata, Nakata, Goira, Guntea loach	LC	
28		*Somileptes gongota*	Latai, Gongata loach		
29		*Noemacheilus botia*	Natawa, Bhoti, Pate gadela		
30		*Nemacheilus devdevi*	Gadera, Gorolla	LC	
31	Clupeidae	*Gudusia chapra*	Suiya, River Shad	LC	
32		*Gudisia godana hiae*	Suhiya Burmese River Shad		
33		*Setipunna phasa*	Phasi, Gankabai Gangetic Hairfin Anchovy		
34	Cyprinidae	*Acrossochelius hexagonolepsis*	Katle	VU	
35		*Catla catla*	Catla, Bhakur		
36		*Changunius chagunio*	Rewa, Chaguni		
37		*Cirhinus mrigala*	Naini, Mirgal		
38		*Cirrhinus reba*	Rewa	LC	
39		*Labeo angra*	Thed, Angra Labeo		
40		*Labeo bata*	Rohu, Bata Labeo	LC	

S.N	Family	Scientific Name	Local and Common Name	Status	
				IUCN	CITES
41		*Labeo boga*	Boga	LC	
42		*Labeo calbasu*	Kalbasu, Black Rohu		
43		*Labeo caeruleus*	Roi, Sind Labeo		
44		*Labeo dero*	Gerdi kalabans	LC	
45		*Labeo dyochelius*	Kalanch, Brahmaputra Labeo		
46		*Labeo gonius*	Kursa, Gurdi	LC	
47		*Labeo pangusia*	Termassa	NT	
48		*Labeo rohita*	Rohu, Bata Labeo	LC	
49		*Labeo sindensis*	Roru		
50		*Osteobrama cotio*	Gurda	LC	
51		*Puntius apogon*	Sidre		
52		*Puntius chillinoides*	Kanrange		
53		*Puntius chola*	Sidre, Pothia Swamp Barb	LC	
54		*Puntius clavatus*	Bada Pothia Stedman Barb	NT	
55		*Puntius conchonius*	Sidre Rosy Barb	LC	
56		*Puntius gelices*	Golden Barb		
57		*Puntius sarana*	Kande, Bhitti Olive Barb	LC	
58		*Puntius sophore*	Pothi (Spot fin swamp Barb)	LC	
59		*Puntius ticto*	Sidre, Fire Fin Barb	LC	
60		*Tor putitora*	Mahaseer	EN	
61		*Tor tor*	Sahara	NT	
62		*Amblypharyngodon mola*	Mada, Dhawani, Pale Carplet	LC	
63		*Aspidopariay jaya mara*	Mara		
64		*Aspidoapria morar*	Harda, Bhenga		
65		*Barilius barila*	Chachale, Fakete Hamilton's Baril	LC	
66		*Barilius barna*	Faketa Barna Baril	LC	
67		*Barilius jalkapoori*	Jalkapoor, Burmese trout		
68		*Barilius bendelisis*	Gudasi, Fakate Hamilton's Baril	LC	
69		*Barilius bola*	Goha, Boha Trout	VU	
70		*Barilius tileo*	Faketa tileo Baril	LC	
71		*Barilius vagra*	Vagra Baril	LC	
72		*Danio aequipinnatus*	Bhitti Giant Danio		
73		*Danio dangila*	Nepti	LC	
74		*Danio devario*	Chitahari, Pothi		
75		*Danio rerio*	Zebra machha, Zebra fish	LC	
76		*Esomus danricus*	Dhadawa, Darai flying Barb		
77		*Rasbora daniconius*	Dedua, Dhera Blackline Rasbora		
78		*Chela cachius*	Silver Hatchet Chela		
79		*Chela laubuca*	Deduwa, Chalwa Glass Barb		
80		*Oxygaster argentea*	Namsehara Razor belly Minnow		
81		*Oxygaster bacaila*	Darai Large Razor Belly	LC	
82		*Oxygaster gora*	Chalwa	LC	
83		*Oxygaster phulo*	Finescale Razor Belly Minnow		
84		*Chrossochilus latius*	Dhurla, Gangetic Latius		

S.N	Family	Scientific Name	Local and Common Name	Status	
				IUCN	CITES
85		*Garra annandelei*	Buduna lohari		
86		*Garra lamta*	Buduna	LC	
87	Gobiidae	*Glossoglobius*	Bulla, Tank Goby		
88	Mastacembelidae	*Macrognathus aculeatus*	Gainchi		
89		*Macrognathus aral*	Gainchi	LC	
90		*Mastacembelus armatus*	Chsi Bam, Spiny Eel	LC	
91		*Mastacembelus pancalus*	Kath Gainchi		
92	Nandidae	*Badis badis*	Pasari, Dwarf Chameleon fish	LC	
93		*Nandus nandus*	Dhala Mottled Nandus	LC	
94	Notopteridae	*Notopterus chitala*	Mohi, Chital, Humped Featherback	LC	
95		*Notopterus notopterus*	Golhi, Patara Grey Featherback	LC	
96	Sacchobranchidae	*Heteropneustes fossilis*	Singhi, Stinging Catfish	LC	
97	Schilbeidae	*Alia coila*	Patasi, Patangu, Gangetic Aila		
98		*Clupisoma garua*	Jalkapoor, Gaura Bachhwa	LC	
99		*Clupisoma monata*	Jalkapoor, Kocha Garua		
100		*Eutropiichthys vacha*	Bachora, Bachawa, Goonwaree Vaccha	LC	
101		*Psedeutropius atherinoides*	Jalkapoor, Patasi Potasi		
102	Sciaenidae	*Sciaena coitor*	Bhola, Two-bearded Croaker	LC	
103	Siluridae	*Ompok bimaculatus*	Pabata, Butter Catfish	NT	
104		*Ompok pabo*	Pabata, Butter Catfish	NT	
105		*Wallago attu*	Buhari, Padani	NT	
106	Sisoridae	*Bagarius bagarius*	Gounch Gangetic Counch	NT	
107		*Gagata cenia*	Tikthi Gogta Gagata	LC	
108		*Gatata nangra*	Gogta		
109		*Glyptothorax annadalei*	Kapre		
110		*Glyptothorax cavai*	Capree		
111		*Glyptothorax horai*	Kabre	LC	
112		*Glyptothorax telchitta*	Kotel, Telchitta, Telcapre	LC	
113		*Hara jerdoni*	Sylhet	LC	
114		*Nangra viridescens*	Huddha Nangra		
115		*Pseudecheneis sulcatus*	Kabri Sulcatus Catfish		
116		*Sisor rhabdophorus*	Bistuiyaa Sisor Catfish		
117	Tetrodontidae	*Tetradon cutcutia*	Pokcha, Ocellated Pufferfish	VU	
Source: DNPWC (2009)					

Annex VI: **Preliminary checklist of birds of KTWR**

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
	GALLIFORMES					
1.	**Phasianidae**	Black Francolin	*Francolinus francolinus*	LC		
2.		Grey Francolin	*Francolinus pondicerianus*	LC		
3.		Swamp Francolin	*Francolinus gularis*	VU		
4.		Common Quail	*Coturnix coturnix*	LC		
5.		Blue-breasted Quail	*Coturnix chinensis*	LC		
6.		Red Junglefowl	*Gallus gallus*	LC		
7.		Indian Peafowl	*Pavo cristatus*	LC		
	ANSERIFORMES					
8.	**Dendrocygnidae**	Fulvous Whistling Duck	*Dendrocygna bicolor*	LC		
9.		Lesser Whistling Duck	*Dendrocygna javanica*	LC		
	Anatidae					
10.		Greater White-fronted Goose	*Anser albifrons*	LC		
11.		Greylag Goose	*Anser anser*	LC		
12.		Bar-headed Goose	*Anser indicus*	LC		
13.		Ruddy Shelduck	*Tadorna ferruginea*	LC		
14.		Common Shelduck	*Tadorna tadorna*	LC		
15.		Comb Duck	*Sarkidiornis melanotos*	LC	II	
16.		Cotton Pygmy-goose	*Nettapus coromandelianus*	LC		
17.		Gadwall	*Anas strepera*	LC		
18.		Falcated Duck	*Anas falcata*	NT		
19.		Eurasian Wigeon	*Anas penelope*	LC		
20.		Mallard	*Anas platyrhynchos*	LC		
21.		Spot-billed Duck	*Anas poecilorhyncha*	LC		
22.		Northern Shoveler	*Anas clypeata*	LC		
23.		Northern Pintail	*Anas acuta*	LC		
24.		Garganey	*Anas querquedula*	LC		
25.		Baikal Teal	*Anas formosa*	LC	II	
26.		Common Teal	*Anas crecca*	LC		
27.		Red-crested Pochard	*Rhodonessa rufina*			
28.		Common Pochard	*Aythya ferina*	LC		
29.		Ferruginous Pochard	*Aythya nyroca*	NT		
30.		Baer's Pochard	*Aythya baeri*	CR		
31.		Tufted Duck	*Aythya fuligula*	LC		
32.		Greater Scaup	*Aythya marila*	LC		
33.		Long-tailed Duck	*Clangula hyemalis*	VU		
34.		Common Goldeneye	*Bucephala clangula*	LC		
35.		Smew	*Mergellus albellus*	LC		
36.		Red-breasted Merganser	*Mergus serrator*	LC		
37.		Common Merganser	*Mergus merganser*	LC		
	TURNICIFORMES					
38.	**Turnicidae**	Yellow-legged Buttonquail	*Turnix tanki*	LC		
39.		Barred Buttonquail	*Turnix suscitator*	LC		
	PICIFORMES					
40.	**Picidae**	Eurasian Wryneck	*Jynx torquilla*	LC		
41.		Brown-capped Pygmy Woodpecker	*Dendrocopos nanus*	LC		

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
42.		Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	LC		
43.		Fulvous-breasted Woodpecker	*Dendrocopos macei*	LC		
44.		Rufous Woodpecker	*Celeus brachyurus*	LC		
45.		Streak-throated Woodpecker	*Picus xanthopygaeus*	LC		
46.		Grey-headed Woodpecker	*Picus canus*	LC		
47.		Black-rumped Flameback	*Dinopium benghalense*	LC		
48	**Megalaimidae**	Lineated Barbet	*Megalaima lineata*	LC		
49		Blue-throated Barbet	*Megalaima asiatica*	LC		
50.		Coppersmith Barbet	*Megalaima haemacephala*	LC		
	BUCEROTIFORMES					
51.	**Bucerotidae**	Indian Grey-Hornbill	*Ocyceros birostris*	LC		
52.		Oriental Pied-Hornbill	*Anthracoceros albirostris*	LC	II	
	UPUPIFORMES					
53.	**Upupidae**	Common Hoopoe	*Upupa epops*	LC		
	CORACIIFORMES					
54.	**Coraciidae**	Indian Roller	*Coracias benghalensis*	LC		
55.		Dollarbird	*Eurystomus orientalis*	LC		
56.	**Alcedinidae**	Common Kingfisher	*Alcedo atthis*	LC		
57.	**Dacelonidae**	Stork-billed Kingfisher	*Pelargopsis capensis*	LC		
58.		White-throated Kingfisher	*Halcyon smyrnensis*	LC		
59.		Black-capped Kingfisher	*Halcyon pileata*	LC		
60.	**Cerylidae**	Pied Kingfisher	*Ceryle rudis*	LC		
61.	**Meropidae**	Blue-bearded Bee-eater	*Nyctyornis athertoni*	LC		
62.		Green Bee-eater	*Merops orientalis*	LC		
63.		Blue-tailed Bee-eater	*Merops philippinus*	LC		
64.		Chestnut-headed Bee-eater	*Merops leschenaulti*	LC		
	CUCULIFORMES					
65.	**Cuculidae**	Pied Cuckoo	*Clamator jacobinus*	LC		
66.		Chestnut-winged Cuckoo	*Clamator coromandus*	LC		
67.		Common Hawk Cuckoo	*Hierococcyx varius*			
68.		Hodgson's Hawk Cuckoo	*Hierococcyx fugax*			
69.		Indian Cuckoo	*Cuculus micropterus*	LC		
70.		Eursian Cuckoo	*Cuculus canorus*	LC		
71.		Oriental Cuckoo	*Cuculus saturatus*	LC		
72.		Grey-bellied Cuckoo	*Cacomantis passerinus*	LC		
73.		Plaintive Cuckoo	*Cacomantis merulinus*	LC		
74.		Drongo Cuckoo	*Surniculus lugubris*	LC		
75.		Asian Koel	*Eudynamys scolopacea*	LC		
76.		Green-billed Malkoha	*Phaenicophaeus tristis*	LC		
77.		Sirkeer Malkoha	*Phaenicophaeus leschenaultii*	LC		
78.	**Centropodidae**	Greater Coucal	*Centropus sinensis*	LC		
79.		Lesser Coucal	*Centropus bengalensis*	LC		
	PSITTACIFORMES					
80.	**Psittacidae**	Alexandrine Parakeet	*Psittacula eupatria*	NT	II	
81.		Rose-ringed Parakeet	*Psittacula krameri*	LC		
82.		Slaty-headed Parakeet	*Psittacula himalayana*	LC	II	
83.		Plum-headed Parakeet	*Psittacula cyanocephala*	LC	II	
84.		Blossom-headed Parakeet	*Psittacula roseata*	NT	II	
85.		Red-breasted Parakeet	*Psittacula alexandri*	NT	II	

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
	APODIFORMES					
86.	**Apodidae**	Himalayan Swiftlet	*Collocalia brevirostris*	LC		
87.		Asian Palm-Swift	*Cypsiurus balasiensis*	LC		
88.		Alpine Swift	*Tachymarptis melba*	LC		
89.		Fork-tailed Swift	*Apus pacificus*	LC		
90.		House Swift	*Apus affinis*	LC		
91.	**Hemiprocnidae**	Crested Treeswift	*Hemiprocne coronata*	LC		
	STRIGIFORMES					
92.	**Tytonidae**	Grass Owl	*Tyto capensis*	LC	II	
93.	**Strigidae**	Collared Scops Owl	*Otus bakkamoena*	LC	II	
94.		Dusky Eagle Owl	*Bubo coromandus*	LC	II	
95.		Brown Fish Owl	*Ketupa zeylonensis*	LC	II	
96.		Jungle Owlet	*Glaucidium radiatum*	LC	II	
97.		Spotted Owlet	*Athene brama*	LC	II	
98.		Brown Hawk-Owl	*Ninox scutulata*	LC	II	
99.		Short-eared Owl	*Asio flammeus*	LC	II	
100.	**Caprimulgidae**	Skyes's Nightjar	*Caprimulgus mahrattensis*	LC	II	
101.		Large-tailed Nightjar	*Caprimulgus macrurus*	LC	II	
102.		Indian Nightjar	*Caprimulgus asiaticus*	LC	II	
103.		Savanna Nightjar	*Caprimulgus affinis*	LC	II	
	COLUMBIFORMES					
104.	**Columbidae**	Rock Pigeon	*Columba livia*	LC		
105.		Common Wood Pigeon	*Columba palumbus*	LC		
106.		Oriental Turtle Dove	*Streptopelia orientalis*	LC		
107.		Laughing dove	*Streptopelia senegalensis*			
108.		Spotted Dove	*Streptopelia chinensis*			
109.		Red Collared Dove	*Streptopelia tranquebarica*	LC		
110.		Eurasian Collared Dove	*Streptopelia decaocto*	LC		
111.		Emerald Dove	*Chalcophaps indica*	LC		
112.		Orange-breasted Green Pigeon	*Treron bicincta*			
113.		Pompadour Green Pigeon	*Treron pompadora*	LC		
114.		Thick-billed Green Pigeon	*Treron curvirostra*	LC		
115.		Yellow-footed Green Pigeon	*Treron phoenicoptera*	LC		
116.		Wedge-tailed Green Pigeon	*Treron sphenura*			
	GRUIFORMES					
117.	**Otididae**	Bengal Florican	*Houbaropsis bengalensis*	CR	I	√
118.		Lesser Florican	*Sypheotides indica*	EN	II	
119.	**Gruidae**	Demoiselle Crane	*Grus virgo*		II	
120.		Common Crane	*Grus grus*	LC	II	
121.	**Rallidae**	Water Rail	*Rallus aquaticus*	LC		
122.		Brown Crake	*Amaurornis akool*	LC		
123.		White-breasted Waterhen	*Amaurornis phoenicurus*	LC		
124.		Baillon's Crake	*Porzana pusilla*	LC		
125.		Spotted Crake	*Porzana porzana*	LC		
126.		Ruddy-breasted Crake	*Porzana fusca*	LC		
127.		Watercock	*Gallicrex cinerea*	LC		
128.		Purple Swamphen	*Porphyrio porphyrio*	LC		
129.		Common Moorhen	*Gallinula chloropus*	LC		
130.		Common Coot	*Fulica atra*	LC		

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
	CICONIIFORMES					
131.	**Scolopacidae**	Pintail Snipe	*Gallinago stenura*	LC		
132.		Common Snipe	*Gallinago gallinago*	LC		
133.		Black-tailed Godwit	*Limosa limosa*	NT		
134.		Whimbrel	*Numenius phaeopus*	LC		
135.		Eurasian Curlew	*Numenius arquata*	NT		
136.		Spotted Redshank	*Tringa erythropus*	LC		
137.		Common Redshank	*Tringa totanus*	LC		
138.		Marsh Sandpiper	*Tringa stagnatilis*	LC		
139.		Common Greenshank	*Tringa nebularia*	LC		
140.		Green Sandpiper	*Tringa ochropus*	LC		
141.		Wood Sandpiper	*Tringa glareola*	LC		
142.		Terek Sandpiper	*Xenus cinereus*	LC		
143.		Common Sandpiper	*Actitis hypoleucos*	LC		
144.		Red Knot	*Calidris canutus*	LC		
145.		Sanderling	*Calidris alba*	LC		
146.		Little Stint	*Calidris minuta*	LC		
147.		Temminck's Stint	*Calidris temminckii*	LC		
148.		Dunlin	*Calidris alpina*	LC		
149.		Curlew Sandpiper	*Calidris ferruginea*	LC		
150.		Ruff	*Philomachus pugnax*	LC		
151.	**Rostratulidae**	Greater Painted-snipe	*Rostratula benghalensis*	LC		
152.	**Jacanidae**	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	LC		
153.		Bronze-winged Jacana	*Metopidius indicus*	LC		
154.	**Burhinidae**	Eurasian Thick-knee	*Burhinus oedicnemus*	LC		
155.		Great Thick-knee	*Burhinus recurvirostris*	NT		
156.	**Charadriidae**	Black-winged Stilt	*Himantopus himantopus*	LC		
157.		Pied Avocet	*Recurvirostra avosetta*	LC		
158.		Pacific Golden Plover	*Pluvialis fulva*	LC		
159.		Grey Plover	*Pluvialis squatarola*	LC		
160.		Little Ringed Plover	*Charadrius dubius*	LC		
161.		Kentish Plover	*Charadrius alexandrinus*	LC		
162.		Lesser Sand Plover	*Charadrius mongolus*	LC		
163.		Greater Sand Plover	*Charadrius leschenaultii*	LC		
164.		Northern Lapwing	*Vanellus vanellus*	LC		
165.		Yellow-wattled Lapwing	*Vanellus malarbaricus*	LC		
166.		River Lapwing	*Vanellus duvaucelii*	NT		
167.		Grey-headed Lapwing	*Vanellus cinereus*	LC		
168.		Red-wattled Lapwing	*Vanellus indicus*	LC		
169.	**Glareolidae**	Indian Courser	*Cursorius coromandelicus*	LC		
170.		Oriental Pratincole	*Glareola maldivarum*	LC		
171.		Small Pratincole	*Glareola lactea*	LC		
172.	**Laridae**	Indian Skimmer	*Rynchops albicollis*	VU		
173.		Mew Gull	*Larus canus*	LC		
174.		Heuglin's Gull	*Larus heuglini*			
175.		Yellow-legged Gull	*Larus cachinnans*	LC		
176.		Pallas's Gull	*Larus ichthyaetus*	LC		
177.		Brown-headed Gull	*Larus brunnicephalus*	LC		
178.		Black-headed Gull	*Larus ridibundus*	LC		
179.		Slender-billed Gull	*Larus genei*	LC		

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
180.		Gull-billed Tern	*Gelochelidon nilotica*			
181.		Caspian Tern	*Sterna caspia*	LC		
182.		River Tern	*Sterna aurantia*	NT		
183.		Common Tern	*Sterna hirundo*	LC		
184.		Little Tern	*Sterna albifrons*	LC		
185.		Black-bellied Tern	*Sterna acuticauda*	EN		
186.		Whiskered Tern	*Chlidonias hybridus*			
187.		White-winged Tern	*Chlidonias leucopterus*	LC		
188.	**Accipitridae**	Osprey	*Pandion haliaetus*	LC	II	
189.		Black Baza	*Aviceda leuphotes*	LC	II	
190.		Oriental Honey-buzzard	*Pernis ptilorhyncus*	LC	II	
191.		Black-shouldered Kite	*Elanus caeruleus*	LC	II	
192.		Black Kite	*Milvus migrans*	LC	II	
193.		Brahminy Kite	*Haliastur indus*	LC	II	
194.		Pallas's Fish Eagle	*Haliaeetus leucoryphus*	VU		
195.		White-tailed Eagle	*Haliaeetus albicilla*	LC	I	
196.		Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	NT		
197.		Egyptian Vulture	*Neophron percnopterus*	EN		
198.		White-rumped Vulture	*Gyps bengalensis*	CR	II	
199.		Slender billed Vulture	*Gyps tenuirostris*	CR	II	
200.		Himalayan Griffon	*Gyps himalayensis*	LC	II	
201.		Eurasian Griffon	*Gyps fulvus*	LC	II	
202.		Cinereous Vulture	*Aegypius monachus*	NT	II	
203.		Red-headed Vulture	*Sarcogyps calvus*	CR	II	
204.		Short-toed Snake Eagle	*Circaetus gallicus*	LC	II	
205.		Crested Serpent Eagle	*Spilornis cheela*	LC	II	
206.		Eurasian Marsh Harrier	*Circus aeruginosus*	LC	II	
207.		Hen Harrier	*Circus cyaneus*	LC	II	
208.		Pallid Harrier	*Circus macrourus*	NT	II	
209.		Pied Harrier	*Circus melanoleucos*	LC	II	
210.		Montagu's Harrier	*Circus pygargus*	LC	II	
211.		Crested Goshawk	*Accipiter trivirgatus*	LC	II	
212.		Shikra	*Accipiter badius*	LC	II	
213.		Besra	*Accipiter virgatus*	LC	II	
214.		Eurasian Sparrowhawk	*Accipiter nisus*	LC	II	
215.		Northern Goshawk	*Accipiter gentilis*	LC	II	
216.		White-eyed Buzzard	*Butastur teesa*	LC	II	
217.		Common Buzzard	*Buteo buteo*	LC	II	
218.		Long-legged Buzzard	*Buteo rufinus*	LC	II	
219.		Black Eagle	*Ictinaetus malayensis*	LC	II	
220.		Greater Spotted Eagle	*Aquila clanga*	VU	II	
221.		Tawny Eagle	*Aquila rapax*	LC	II	
222.		Steppe Eagle	*Aquila nipalensis*	LC	II	
223.		Imperial Eagle	*Aquila heliaca*	VU	I	
224.		Golden Eagle	*Aquila chrysaetos*	LC	II	
225.		Indian Spotted Eagle	*Aquila hastata*	VU	II	
226.		Booted Eagle	*Hieraaetus pennatus*	LC	II	
227.		Rufous-bellied Eagle	*Hieraaetus kienerii*		II	
228.		Changeable Hawk Eagle	*Spizaetus cirrhatus*		II	
229.		Mountain Hawk Eagle	*Spizaetus nipalensis*		II	

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
230.	**Falconidae**	Collared Falconet	*Microhierax caerulescens*	LC	II	
231.		Lesser Kestrel	*Falco naumanni*	LC	II	
232.		Common Kestrel	*Falco tinnunculus*	LC	II	
233.		Red-necked Falcon	*Falco chicquera*	LC	II	
234.		Amur Falcon	*Falco amurensis*	LC	II	
235.		Merlin	*Falco columbarius*	LC	II	
236.		Eurasian Hobby	*Falco subbuteo*	LC	II	
237.		Oriental Hobby	*Falco severus*	LC	II	
238.		Laggar Falcon	*Falco jugger*	NT	I	
239.		Peregrine Falcon	*Falco peregrinus*	LC	I	
240.	**Podicipedidae**	Little Grebe	*Tachybaptus ruficollis*	LC		
241.		Great Crested Grebe	*Podiceps cristatus*	LC		
242.		Black-necked Grebe	*Podiceps nigricollis*	LC		
243.	**Anhingidae**	Oriental Darter	*Anhinga melanogaster*	NT		
244.	**Phalacrocoracidae**	Little Cormorant	*Phalacrocorax niger*	LC		
245.		Indian Cormorant	*Phalacrocorax fuscicollis*	LC		
246.		Great Cormorant	*Phalacrocorax carbo*	LC		
247.	**Ardeidae**	Little Egret	*Egretta garzetta*	LC		
248.		Grey Heron	*Ardea cinerea*	LC		
249.		Purple Heron	*Ardea purpurea*	LC		
250.		Great Egret	*Casmerodius albus*	LC		
251.		Intermediate Egret	*Mesophoyx intermedia*	LC		
252.		Cattle Egret	*Bubulcus ibis*	LC		
253.		Indian Pond Heron	*Ardeola grayii*	LC		
254.		Little Heron	*Butorides striatus*			
255.		Black-crowned Night Heron	*Nycticorax nycticorax*	LC		
256.		Yellow Bittern	*Ixobrychus sinensis*	LC		
257.		Cinnamon Bittern	*Ixobrychus cinnamomeus*	LC		
258.		Black Bittern	*Dupetor flavicollis*			
259.		Great Bittern	*Botaurus stellaris*	LC		
260.	**Phoenicopteridae**	Greater Flamingo	*Phoenicopterus ruber*	LC	II	
261.	**Threskiornithidae**	Glossy Ibis	*Plegadis falcinellus*	LC		
262.		Black-headed Ibis	*Threskiornis melanocephalus*	NT		
263.		Black Ibis	*Pseudibis papillosa*	LC		
264.		Eurasian Spoonbill	*Platalea leucorodia*	LC	II	
265.	**Pelecanidae**	Great White Pelican	*Pelecanus onocrotalus*	LC		
266.		Spot-billed Pelican	*Pelecanus philippensis*	NT		
267.	**Ciconiidae**	Painted Stork	*Mycteria leucocephala*	NT		
268.		Asian Openbill	*Anastomus oscitans*	LC		
269.		Black Stork	*Ciconia nigra*	LC	II	√
270.		Woolly-necked Stork	*Ciconia episcopus*	LC		
271.		White Stork	*Ciconia ciconia*	LC		√
272.		Black-necked Stork	*Ephippiorhynchus asiaticus*	NT		
273.		Lesser Adjutant	*Leptoptilos javanicus*	VU		
274.		Greater Adjutant	*Leptoptilos dubius*	EN		
275.	**Gaviidae**	Red-throated Loon	*Gavia stellata*	LC		
	PASSERIFORMES					
276.	**Pittidae**	Hooded Pitta	*Pitta sordida*	LC		
277.		Indian Pitta	*Pitta brachyura*	LC		
278.	**Irenidae**	Golden-fronted Leafbird	*Chloropsis aurifrons*	LC		

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
279.	**Laniidae**	Rufous-tailed Shrike	*Lanius isabellinus*	LC		
280.		Brown Shrike	*Lanius cristatus*	LC		
281.		Bay-backed Shrike	*Lanius vittatus*	LC		
282.		Long-tailed Shrike	*Lanius schach*	LC		
283.		Grey-backed Shrike	*Lanius tephronotus*	LC		
284.		Southern Grey Shrike	*Lanius meridionalis*			
285.	**Corvidae**	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	LC		
286.		Rufous Treepie	*Dendrocitta vagabunda*	LC		
287.		Grey Treepie	*Dendrocitta formosae*	LC		
288.		House Crow	*Corvus splendens*	LC		
289.		Large-billed Crow	*Corvus macrorhynchos*	LC		
290.		Ashy Woodswallow	*Artamus fuscus*	LC		
291.		Eurasian Golden Oriole	*Oriolus oriolus*	LC		
292.		Black-naped Oriole	*Oriolus chinensis*	LC		
293.		Slender-billed Oriole	*Oriolus tenuirostris*	LC		
294.		Black-hooded Oriole	*Oriolus xanthornus*	LC		
295.		Maroon Oriole	*Oriolus traillii*	LC		
296.		Large Cuckooshrike	*Coracina macei*	LC		
297.		Black-winged Cuckooshrike	*Coracina melaschistos*	LC		
298.		Black-headed Cuckooshrike	*Coracina melanoptera*	LC		
299.		Rosy Minivet	*Pericrocotus roseus*	LC		
300.		Ashy Minivet	*Pericrocotus divaricatus*	LC		
301.		Small Minivet	*Pericrocotus cinnamomeus*	LC		
302.		Scarlet Minivet	*Pericrocotus flammeus*	LC		
303.		Bar-winged Flycatcher-shrike	*Hemipus picatus*	LC		
304.		White-throated Fantail	*Rhipidura albicollis*	LC		
305.		White-browed Fantail	*Rhipidura aureola*	LC		
306.		Black Drongo	*Dicrurus macrocercus*	LC		
307.		Ashy Drongo	*Dicrurus leucophaeus*	LC		
308.		White-bellied Drongo	*Dicrurus caerulescens*	LC		
309.		Crow-billed Drongo	*Dicrurus annectans*	LC		
310.		Bronzed Drongo	*Dicrurus aeneus*	LC		
311.		Spangled Drongo	*Dicrurus hottentottus*	LC		
312.		Greater Racket-tailed Drongo	*Dicrurus paradiseus*	LC		
313.		Black-naped Monarch	*Hypothymis azurea*	LC		
314.		Asian Paradise-flycatcher	*Terpsiphone paradisi*	LC		
315.		Common Iora	*Aegithina tiphia*	LC		
316.		Common Woodshrike	*Tephrodornis pondicerianus*	LC		
317.	**Muscicapidae**	Blue-capped Rock Thrush	*Monticola cinclorhynchus*	LC		
318.		Blue Rock Thrush	*Monticola solitarius*	LC		
319.		Blue Whistling Thrush	*Myophonus caeruleus*	LC		
320.		Orange-headed Thrush	*Zoothera citrina*	LC		
321.		Scaly Thrush	*Zoothera dauma*	LC		
322.		Dark-sided Thrush	*Zoothera marginata*	LC		
323.		Tickell's Thrush	*Turdus unicolor*	LC		
324.		White-collared Blackbird	*Turdus albocinctus*	LC		
325.		Grey-winged Blackbird	*Turdus boulboul*	LC		
326.		Eurasian Blackbird	*Turdus merula*	LC		
327.		Dark-throated Thrush	*Turdus ruficollis*	LC		
328.		Dusky Thrush	*Turdus naumanni*	LC		

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329.		Dark-sided Flycatcher	*Muscicapa sibirica*	LC		
330.		Asian Brown Flycatcher	*Muscicapa dauurica*	LC		
331.		Rusty-tailed Flycatcher	*Muscicapa ruficauda*	LC		
332.		Slaty-backed Flycatcher	*Ficedula hodgsonii*	LC		
333.		Red-breasted Flycatcher	*Ficedula (parva) parva*	LC		
334.		Red-throated Flycatcher	*Ficedula parva*	LC		
335.		Kashmir Flycatcher	**Ficedula subrubra*	VU		
336.		White-gorgeted Flycatcher	*Ficedula monileger*	LC		
337.		Little Pied Flycatcher	*Ficedula westermanni*	LC		
338.		Ultramarine Flycatcher	*Ficedula superciliaris*	LC		
339.		Verditer Flycatcher	*Eumyias thalassina*			
340.		Small Niltava	*Niltava macgrigoriae*	LC		
341.		Rufous-bellied Niltava	*Niltava sundara*	LC		
342.		Pale-chinned Flycatcher	*Cyornis poliogenys*	LC		
343.		Blue-throated Flycatcher	*Cyornis rubeculoides*	LC		
344.		Pygmy Blue Flycatcher	*Muscicapella hodgsoni*	LC		
345.		Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	LC		
346.		Siberian Rubythroat	*Luscinia calliope*	LC		
347.		White-tailed Rubythroat	*Luscinia pectoralis*	LC		
348.		Indian Blue Robin	*Luscinia brunnea*	LC		
349.		White-browed Bush Robin	*Tarsiger indicus*	LC		
350.		Blue-throated Flycatcher	*Cyornis rubeculoides*	LC		
351.		Oriental Magpie Robin	*Copsychus saularis*	LC		
352.		White-rumped Shama	*Copsychus malabaricus*	LC		
353.		Indian Robin	*Saxicoloides fulicata*			
354.		Black Redstart	*Phoenicurus ochruros*	LC		
355.		Durian Redstart	*Phoenicurus auroreus*	LC		
356.		White-capped Water Redstart	*Chaimarrornis leucocephalus*	LC		
357.		Hodgson's Bushchat	*Saxicola insignis*	VU		
358.		Common Stonechat	*Saxicola torquata*			
359.		White-tailed Stonechat	*Saxicola leucura*			
360.		Pied Bushchat	*Saxicola caprata*	LC		
361.		Jerdon's Bushchat	*Saxicola jerdoni*	LC		
362.		Grey Bushchat	*Saxicola ferrea*			
363.		Desert Wheatear	*Oenanthe deserti*	LC		
364.		Brown Rock Chat	*Cercomela fusca*	LC		
365.	**Sturnidae**	Asian Glossy Starling	*Aplonis panayensis*	LC		
366.		Spot-winged Starling	*Saroglossa spiloptera*	LC		
367.		Chestnut-tailed Starling	*Sturnus malabaricus*	LC		
368.		Brahminy Starling	*Sturnus pagodarum*	LC		
369.		Purple-backed Starling	*Sturnus sturninus*	LC		
370.		White-shouldered Starling	*Sturnus sinensis*	LC		
371.		Rosy Starling	*Sturnus roseus*	LC		
372.		Common Starling	*Sturnus vulgaris*	LC		
373.		Asian Pied Starling	*Sturnus contra*	LC		
374.		Common Myna	*Acridotheres tristis*	LC		
375.		Bank Myna	*Acridotheres ginginianus*	LC		
376.		Jungle Myna	*Acridotheres fuscus*	LC		
377.		Great Myna	*Acridotheres grandis*	LC		
378.		Hill Myna	*Gracula religiosa*	LC	II	

S.No.	Order/Family	English name	Scientific name	IUCN status	CITES category	GoN
379.	**Sittidae**	Chestnut-bellied Nuthatch	*Sitta castanea*	LC		
380.	**Paridae**	Great Tit	*Parus major*	LC		
381.	**Hirundinidae**	Sand Martin	*Riparia riparia*	LC		
382.		Plain Martin	*Riparia paludicola*	LC		
383.		Barn Swallow	*Hirundo rustica*	LC		
384.		Wire-tailed Swallow	*Hirundo smithii*	LC		
385.		Red-rumped Swallow	*Hirundo daurica*	LC		
386.		Streak-throated Swallow	*Hirundo fluvicola*	LC		
387.		Asian House Martin	*Delichon dasypus*	LC		
388.	**Regulidae**	Goldcrest	*Regulus regulus*	LC		
389.	**Pycnonotidae**	Black-crested Bulbul	*Pycnonotus melanicterus*	LC		
390.		Red-whiskered Bulbul	*Pycnonotus jocosus*	LC		
391.		Himalayan Bulbul	*Pycnonotus leucogenys*	LC		
392.		Red-vented Bulbul	*Pycnonotus cafer*	LC		
393.		Black Bulbul	*Hypsipetes leucocephalus*	LC		
394.	**Cisticolidae**	Zitting Cisticola	*Cisticola juncidis*	LC		
395.		Bright-capped Cisticola	*Cisticola exilis*	LC		
396.		Rufous-vented Prinia	*Prinia burnesii*	NT		
397.		Striated Prinia	*Prinia criniger*	LC		
398.		Grey-crowned Prinia	*Prinia cinereocapilla*	VU		
399.		Grey-breasted Prinia	*Prinia hodgsonii*	LC		
400.		Graceful Prinia	*Prinia gracilis*	LC		
401.		Yellow-bellied Prinia	*Prinia flaviventris*	LC		
402.		Ashy Prinia	*Prinia socialis*	LC		
403.		Plain Prinia	*Prinia inornata*	LC		
404.	**Zosteropidae**	Oriental White-eye	*Zosterops palpebrosus*	LC		
405.	**Sylviidae**	Grey-bellied Tesia	*Tesia cyaniventer*	LC		
406.		Pale-footed Bush Warbler	*Cettia pallidipes*	LC		
407.		Chestnut-crowned Bush Warbler	*Cettia major*	LC		
408.		Aberrant Bush Warbler	*Cettia flavolivacea*	LC		
409.		Grey-sided Bush Warbler	*Cettia brunnifrons*	LC		
410.		Spotted Bush Warbler	*Bradypterus thoracicus*	LC		
411.		Chinese Bush Warbler	*Bradypterus taczanowskius*			
412.		Lanceolated Warbler	*Locustella lanceolata*	LC		
413.		Grasshopper Warbler	*Locustella naevia*	LC		
414.		Rusty-rumped Warbler	*Locustella certhiola*	LC		
415.		Black-browed Reed Warbler	*Acrocephalus bistrigiceps*	LC		
416.		Paddyfield Warbler	*Acrocephalus agricola*	LC		
417.		Blunt-winged Warbler	*Acrocephalus concinens*	LC		
418.		Blyth's Reed Warbler	*Acrocephalus dumetorum*	LC		
419.		Clamorous Reed Warbler	*Acrocephalus stentoreus*	LC		
420.		Thick-billed Warbler	*Acrocephalus aedon*	LC		
421.		Booted Warbler	*Hippolais caligata*	LC		
422.		Common Tailorbird	*Orthotomus sutorius*	LC		
423.		Common Chiffchaff	*Phylloscopus collybita*	LC		
424.		Dusky Warbler	*Phylloscopus fuscatus*	LC		
425.		Smoky Warbler	*Phylloscopus fuligiventer*	LC		
426.		Tickell's Leaf Warbler	*Phylloscopus affinis*	LC		
427.		Sulphur-bellied Warbler	*Phylloscopus griseolus*	LC		
428.		Yellow-browed Warbler	*Phylloscopus inornatus*	LC		

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429.		Hume's Warbler	*Phylloscopus humei*	LC		
430.		Greenish Warbler	*Phylloscopus trochiloides*	LC		
431.		Large-billed Leaf Warbler	*Phylloscopus magnirostris*	LC		
432.		Western Crowned Warbler	*Phylloscopus occipitalis*	LC		
433.		Blyth's Leaf Warbler	*Phylloscopus reguloides*	LC		
434.		Yellow-vented Warbler	*Phylloscopus cantator*	LC		
435.		Golden-spectacled Warbler	*Seicercus burkii*	LC		
436.		Striated Grassbird	*Megalurus palustris*	LC		
437.		Bristled Grassbird	*Chaetornis striatus*			
438.		Abbott's Babbler	*Malacocincla abbotti*	LC		
439.		Striped Tit Babbler	*Macronous gularis*	LC		
440.		Yellow-eyed Babbler	*Chrysomma sinense*	LC		
441.		Striated Babbler	*Turdoides earlei*	LC		
442.		Jungle Babbler	*Turdoides striatus*			
443.		Lesser Whitethroat	*Sylvia curruca*	LC		
444.		Orphean Warbler	*Sylvia hortensis*	LC		
445.	**Alaudidae**	Rufous-winged Lark	*Mirafra assamica*	LC		
446.		Ashy-crowned Sparrow Lark	*Eremopterix grisea*			
447.		Greater Short-toed Lark	*Calandrella brachydactyla*	LC		
448.		Hume's Short-toed Lark	*Calandrella acutirostris*	LC		
449.		Sand Lark	*Calandrella raytal*	LC		
450.		Crested Lark	*Galerida cristata*	LC		
451.		Oriental Skylark	*Alauda gulgula*	LC		
452.	**Nectariniidae**	Thick-billed Flowerpecker	*Dicaeum agile*	LC		
453.		Pale-billed Flowerpecker	*Dicaeum erythrorynchos*			
454.		Purple Sunbird	*Aethopyga gouldiae*	LC		
455.	**Passeridae**	House Sparrow	*Passer domesticus*	LC		
456.		Spanish Sparrow	*Passer hispaniolensis*	LC		
457.		Russet Sparrow	*Passer rutilans*	LC		
458.		Eurasian Tree Sparrow	*Passer montanus*	LC		
459.		Chestnut-shouldered Petronia	*Petronia xanthocollis*	LC		
460.		Forest Wagtail	*Dendronanthus indicus*	LC		
461.		White Wagtail	*Motacilla alba*	LC		
462.		White-browed Wagtail	*Motacilla maderaspatensis*			
463.		Citrine Wagtail	*Motacilla citreola*	LC		
464.		Yellow Wagtail	*Motacilla flava*	LC		
465.		Grey Wagtail	*Motacilla cinerea*	LC		
466.		Richard's Pipit	*Anthus richardi*	LC		
467.		Paddyfield Pipit	*Anthus rufulus*	LC		
468.		Tawny Pipit	*Anthus campestris*	LC		
469.		Blyth's Pipit	*Anthus godlewskii*	LC		
470.		Long-billed Pipit	*Anthus similis*	LC		
471.		Tree Pipit	*Anthus trivialis*	LC		
472.		Olive-backed Pipit	*Anthus hodgsoni*	LC		
473.		Red-throated Pipit	*Anthus cervinus*	LC		
474.		Rosy Pipit	*Anthus roseatus*	LC		
475.		Water Pipit	*Anthus spinoletta*	LC		
476.		Buff-bellied Pipit	*Anthus rubescens*	LC		
477.		Black-breasted Weaver	*Ploceus benghalensis*	LC		
478.		Streaked Weaver	*Ploceus manyar*	LC		

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479.		Baya Weaver	*Ploceus philippinus*	LC		
480.		Finn's Weaver	*Ploceus megarhynchus*	VU		
481.		Red Avadavat	*Amandava amandava*	LC		
482.		Indian Silverbill	*Lonchura malabarica*	LC		
483.		White-rumped Munia	*Lonchura striata*	LC		
484.		Scaly-breasted Munia	*Lonchura punctulata*	LC		
485.		Black-headed Munia	*Lonchura malacca*	LC		
486.	**Fringillidae**	Common Rosefinch	*Carpodacus erythrinus*	LC		
487.		Crested Bunting	*Melophus lathami*	LC		
488.		Chestnut-eared Bunting	*Emberiza fucata*	LC		
489.		Little Bunting	*Emberiza pusilla*	LC		
490.		Yellow-breasted Bunting	*Emberiza aureola*	EN		
491.		Black-headed Bunting	*Emberiza melanocephala*	LC		
492.		Red-headed Bunting	*Emberiza bruniceps*	LC		
493.		Black-faced Bunting	*Emberiza spodocephala*	LC		
494.		Pallas's Bunting	*Emberiza pallasi*	LC		

Source: Bird Conservation Nepal (2013)

About ICIMOD

The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.

This publication made possible through the financial support received from the MacArthur Foundation, Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

ICIMOD gratefully acknowledges the support of its core donors: the Governments of Afghanistan, Australia, Austria, Bangladesh, Bhutan, China, India, Myanmar, Nepal, Norway, Pakistan, Switzerland, and the United Kingdom.

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ISBN 978 92 9115 317 6