A research report on

Baseline Study of Rampur Ghol, Chitwan, Nepal

Submitted to

International Hydrological Programme (IHP, Nepal)/UNESCO

Nepal National Water Week 2010

Submitted by

The Small Earth Nepal (SEN)

March, 2011

Kathmandu, Nepal

Foreword

World Water Day is being celebrated in Nepal as a National Water Week ever since 2009. Water and Energy Commission Secretariat (WECS) of the Government of Nepal has been coordinating the week long activities from the beginning with its Secretary as a Chair of the Organizing Committee. The Nepal National Committee for IHP (International Hydrological Program), UNESCO has been the initiator of the umbrella organizing committee and is actively involved in all activities as a Co-Chair of the National Water-Week Organizing Committee.

The Nepal National Water Week (NNWW) is a joint program of Government of Nepal, INGOs, NGOs, civil societies, professional organizations, business houses, academic institutions and youth organizations to commemorate the World Water Day (March 22) and World Meteorological Day (March 23) with a week long program. The objective of the Nepal National Water Week in general is to focus and make aware and sensitize politicians, policy makers, development planners, bureaucrats, environmentalists, researchers, advocacy groups, teachers, students and the society as a whole on the impact of rapid population growth, industrialization and uncertainties caused by climate change, conflicts and natural disasters on water systems. Nepal National Water Week aims to spotlight and encourage governments, organizations, communities, and individuals to actively engage in addressing the water issues (both qualitative and quantitative), more seriously, and generate a mechanism of rational use of water, protection of degrading water bodies and generate a thrust on proper management and utilization of water.

Nepal National Water Week 2010 was celebrated nationwide with the theme ***Communicating Water Quality, Challenges and Opportunities*** as set by the United Nations. The programs of the week were categorized into four divisions: Research, Capacity Building, Advocacy and Awareness and among them **Baseline Study of Rampur Ghol, Chitwan, Nepal** was under the research program. This research study was a commitment of the Nepal National Committee for IHP, UNESCO. The financial support for the project was received from UNESCO Delhi and the technical support and research coordination was done by The Small Earth Nepal (SEN) and Institute of Agriculture and Animal Sciences (IAAS), Rampur, Chitwan, Nepal. ADAPT-Nepal (Association for the Development of Environment and People in Transition) assisted for the field data collection of the research study.

The Research Study Team consisted of:

Team Leader

Prof. Dr. Dharma Raj Dangol, IAAS

Research Associates

Jeeban Panthi, Piyush Dahal, SEN

Field Data Collection

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Aanta Prakash Subedi, IAAS

To support and facilitate the technical activities following Advisory Committee was formed:

1. Er. Adarsha P. Pokhrel, Chairman, IHP Nepal
2. Dr. Bhanu R. Neupane, Regional Programme Specialist for South Asia, UNESCO
3. Mr. Dhiraj Pradhananga, President, The Small Earth Nepal

This project was jointly launched on May 22, 2010 on the occasion of the International Day for Biological Diversity at IAAS, Rampur by Prof. Dr. Resham Bahadur Thapa, Assistant Dean, Institute of Agriculture and Animal Sciences, Rampur, Chitwan and Er. Adarsha P. Pokhrel, Chairperson, Nepal National Committee for IHP, UNESCO.

Acknowledgements

We are really thankful to IHP-Nepal/UNESCO for providing the financial support. We are indebted to our advisory committee members for encouraging us regularly in the research program and for the feedback during the field visit and research designing process.

We extend our heartfelt acknowledgement to all the faculties who provided the valuable information regarding the current and potential management practices of the Ghol area. We are also indebted to the community people who participated in the household survey and focus group discussion, our key components of the research.

We would like to extend our thanks to the students of IAAS especially Deepak Raj Joshi, Kiran Bhusal, Bhawana Paudel, Smriti Limbu, and Bhawani Pandey for their effort in data collection in the field.

We are thankful to the staff and faculties of Aquaculture Department of IAAS and Nepal Academy of Science and Technology (NAST) for providing laboratory support for analyzing the water quality.

We would also like to thank the participants and the organizers of the Graduates' Workshop on Wetlands organized in Kathmandu for their critical comments and feedbacks.

Research Team

March, 2011

Executive Summary

Wetlands are among the most productive ecosystems on the earth. They are very important in terms of their ecological, economic, cultural and recreational values. These ecosystems support a wide variety of flora and fauna of economic value providing a wide range of goods and services as well as income-generating opportunities to the local people. Rampur Ghol which covers an area of 15 hector is situated in the premises of Institute of Agriculture and Animal Sciences (IAAS) popularly known as Rampur campus. This baseline study of Ghol was conducted to identify the physical, chemical, biological, socioeconomic and management aspect of the area for its future management plan. Vegetation analyses, water quality assessment, socioeconomic survey, Key Informant Interview (KII), Focus Group Discussion (FGD) were used to collect the required data. The study was conducted in December 2010. The study refers that the health condition of the Ghol area is sound and its water quality is not polluted due to any natural factors. Herbs are dominating the area and among them some new species are invasive in recent years. The area is used for fodder, fuelwood, wild vegetable, recreational, religious, grazing, medicinal plants, and irrigation. Darai community is found to be primarily dependent on fishing in the Ghol area.

The Ghol area is very important for scientific study, research and development for enhancing ecosystem services to the communities and could be developed as a wetland laboratory. The area can be a spectacular eco-tourist destination if planned and managed intelligently.

Acronyms and Abbreviations

ADAPT-Nepal	Association for the Development of Environment and People in Transition
DO	Dissolved Oxygen
DOR	Directorate of Research
FGD	Focus Group Discussion
GPS	Global Positioning System
IAAS	Institute of Agriculture and Animal Science
IHP	International Hydrological Programme
INGO	International Non Governmental Organization
IVI	Important Value Index
KII	Key Informant Interview
LPG	Liquefied Petroleum Gas
NARC	Nepal Agriculture Research Council
NAST	Nepal Academy of Science and Technology
NGO	Non Governmental Organizations
NNWW	Nepal National Water Week
NMDP	National Maize Development Programme
NTB	Nepal Tourism Board
SEN	The Small Earth Nepal
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

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I. INTRODUCTION

1.1. Background

Wetlands are often described as transitional ecosystem that represents continua between strictly aquatic and strictly terrestrial ecosystems. It is the areas where water is the primary factor controlling the environment and the associated plants and animals' life. Wetlands are areas of marsh, fen, peat land, 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 meters (Ramsar Convention, 1971). Therefore, rivers, lakes, glaciers, reservoirs, marshy and swampy lands, floodplain, and even paddy field are some of the examples of the wetlands. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water-chemistry, vegetation, and other factors, including human disturbance.

Wetlands are among the most productive ecosystems on the earth. They are very important in terms of their ecological, economic, cultural and recreational values. These ecosystems support a wide variety of plants and animals of economic value, which provide a wide range of goods and services as well as income-generating opportunities. Wetlands are also one of the most threatened habitats because of their vulnerability and attractiveness for development (Hollis *et al.* 1988).

1.2. Wetlands in Nepal

Wetlands denote perennial water bodies that originate from underground sources of water or rains (National Wetland Policy, 2003). It means swampy areas with flowing or stagnant fresh or salt water that are natural or man-made, or permanent or temporary. Wetlands also mean marshy lands, riverine floodplains, lakes, ponds, water storage areas and agricultural lands. Although lakes comprise only 0.7% of the total wetlands of Nepal, their values have been highly commended.

Nepal accessed RAMSAR Wetland Convention in 1988. Currently, nine wetlands and lakes from Nepal are listed in RAMSAR site: Koshi Tappu Wetland in 1987; Beesh Hazar and associated

lakes, Ghodaghodi Lake area, and Jagadishpur Reservoir in 2003; Gokyo and associated lakes, Goshaikunda and associated lakes and Phoksundo lake and Rara lake in 2007 and Mai Pokhari in 2008.

Wetlands in Nepal are rich in biological diversity and are known to regularly support more than 20,000 waterfowl during winter. The systematic study of wetlands in Nepal is very recent. Surveys conducted over the last two decades on the distribution of wetlands in three ecological zones (high mountains, Mid-hills and Terai) have contributed to the wetland literature.

The wetland inventory for Nepal (IUCN-Nepal 1996) indicates that in the Terai, fishing occurs in 94% of wetland sites and animal grazing in 70% and water for irrigation is extracted from 69% of the sites surveyed. These wetlands also serve as habitats for wild relatives of cultivated crops, endangered and threatened flora and some rare birds. Wetlands are essential for the protection of endangered and threatened species. Wetlands in Nepal sustain much bio-diversity. This statement can be verified by the presence of 172 species of fish, and 190 wetland dependent birds (out of 850 species of birds of Nepal). Moreover, the aquatic reptiles and the mammals have also played a vital role in the diversification of the faunal varieties throughout the Nepalese wetlands.

Nepal's wetland is characterized by the floral diversity more than the faunal diversity. Twenty-five percent of the 7,000 species of plants recorded in Nepal are aquatic. Of the 700 species of endemic plants, 27 are rare, seven are threatened, and nine are endangered species of endemic plants. (*www.fern.org.np).*

Land uses around wetland sites include barren land, settlements, commercial establishments, cultivated land, pasture, grassland and open forest.

1.3. Introduction of the Study Area

The Ghol marsh is located inside the campus of the Institute of Agriculture and Animal Science (IAAS), Tribhuvan University, Rampur, Chitwan. It lies at a latitude of 27º38´14.1"N and longitude 84º21´25.2" E

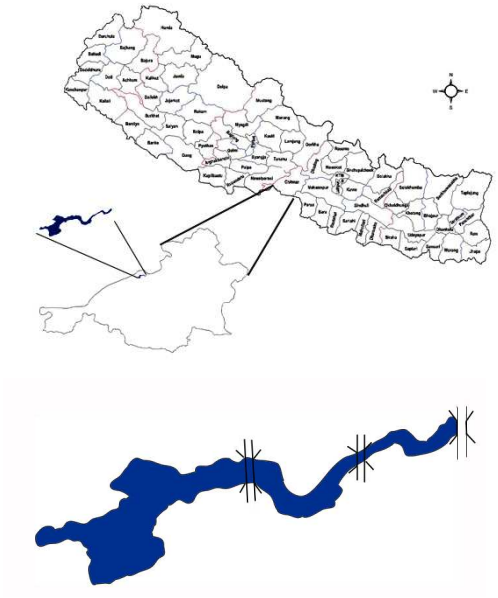


Figure 1: Map showing the study area

and at an altitude of 257 m. It is 9 km south-west from the Narayangarh Bazar and the climate over there is tropical. Ghol wetland area covers an area of 15 ha and the climate is of tropical type. The Ghol area is elongated and the water over there is flowing slowly (Figure 1). There are residential areas of the IAAS and NARC around the Ghol area.

1.4. Research in Rampur Ghol

Some research on vegetation and fish fauna has been carried out by the faculites of the IAAS. The aquatic plant and vegetation have been reported by Dangol et al. (1994), Dangol (1999-2000). Fish fauna and the abiotic factors of the Ghol area was studied by Jha and Shrestha (2000).

1.5. Objectives

The general objective of this research study was to gather the baseline information about the Ghol Wetlands. The specific objectives were to:

- Identify physical, chemical and biological parameters of the wetland area.
- Understand socioeconomic aspects of the Ghol area
- Know the ecological importance of the Ghol
- Identify the impacts of wetland to community and of community to wetland
- Explore the management practices and future potentials for the conservation of the Ghol.

1.6. Significance

Wetlands are the most productive ecosystems in the world. They can save considerable amount of carbon emission into the atmosphere. The Ghol wetland area, in terai region, is potential for bio-diversity conservation and is pride to the reputed IAAS. So, baseline data collection seems very much essential for further planning of management.

II. MATERIALS AND METHODS

2.1. Conceptual Framework

This research was designed to collect primary data from the field and secondary data from the literature. The field data was analyzed into physiochemical, biological and socioeconomic parameters. The detail process of research is shown in Figure 2.

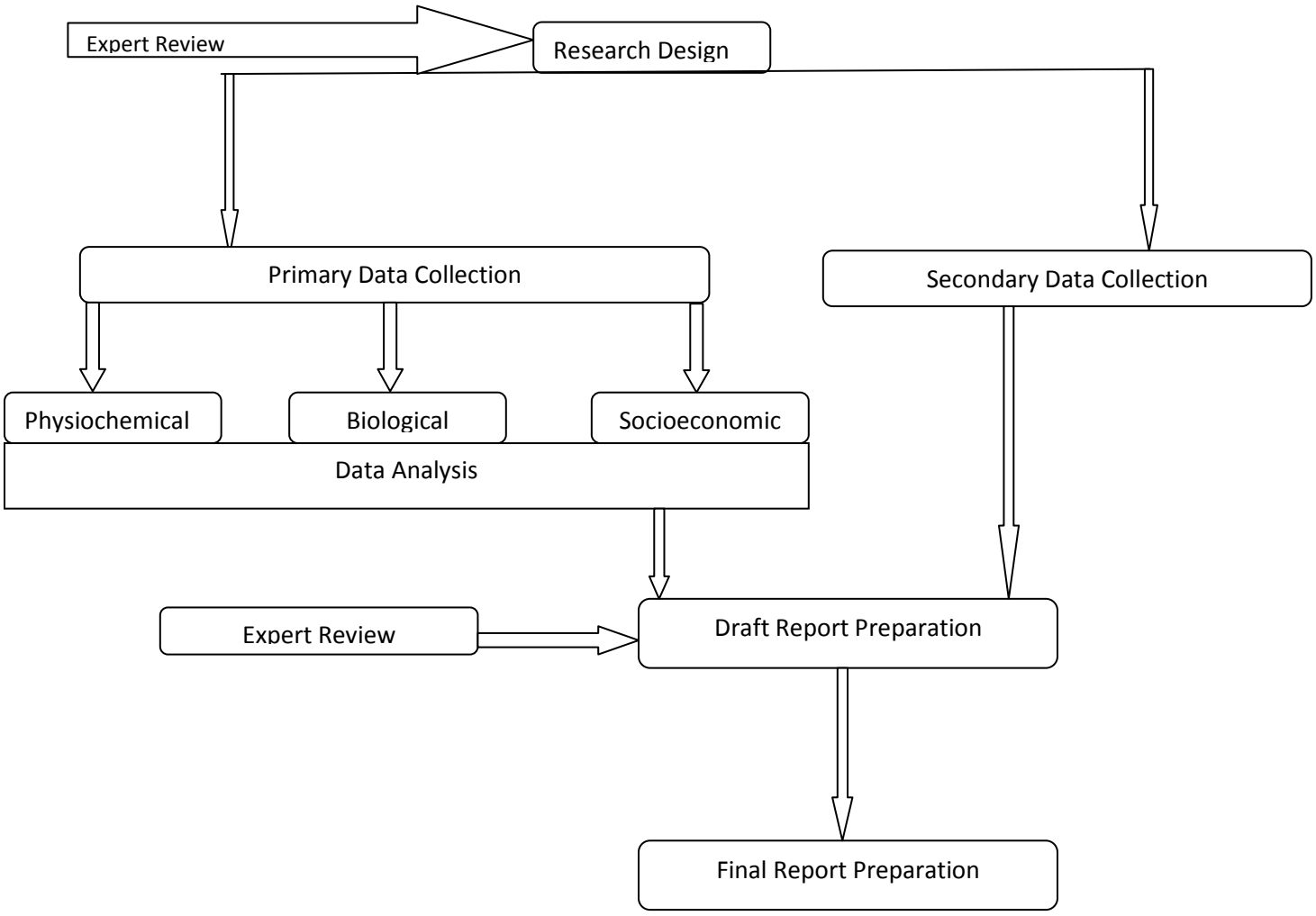


Figure 2: Diagram showing the research methodology

2.2. Study Design

This research is cross-sectional, observational and descriptive. The data were collected once for physio-chemical, biological, socioeconomic and management aspects.

2.3. Sample

The sampling of the the water for physio-chemical parameters was done using the standard guidelines and biological parameter was done using standard sampling manuals.

For socio-economics parts, samples were chosen in random basis and the sampling technique used here was judgment sampling.

2.4. Methods of the Data Collection

Physical parameters

Physical parameters like area, latitude, longitude and altitude were measured by using GPS instrument. Depth of the Ghol area was measured by using a measuring rod. Area velocity method was adopted for measuring the discharge of the water flowing in the Ghol area.

Figure 3: Depth measurement

Physio-chemical parameters

The water sampling points for the analysis were fixed at 6 places from starting point (upstream) to the end point (downstream). The description of the site is as follows:

Site 1: Near the first bridge from where the Ghol water starts flowing

Site 2: Near the second bridge

Site 3: Near Aquaculture Department's bridge

Site 4: Near the culvert in another tributary passing through the fishery farm

Site 5: At the confluence where those two tributaries mix.

Site 6: At the outlet of the Ghol area, at the boundary of the IAAS.

Water quality, physiochemical parameters like temperature, P^H, Conductivity, Dissolved Oxygen (DO), free CO_2, NO_3, PO_4, Chloride, and Hardness were sampled from the Ghol area and laboratory analysis was done at the Aquaculture Laboratory of IAAS and the Environmental

Laboratory of the Nepal Academy of Science and Technology (NAST). Sensitive parameters like temperature, P^H, conductivity were tested instantly in the field.

Biological parameters

Macro-phytes were identified, counted and analyzed to assess the biological status of the Ghol area. Quadrat of size 1 sq. m was taken for the sampling and altogether 23 samples were taken for the vegetation analysis of the Ghol area.

Socioeconomic aspect

Twenty-four households were surveyed among the residents nearby the Ghol area for assessing the economic and livelihood status of the people and their dependency on the Ghol. Two focus group discussions were conducted among the Darai community and the family members of IAAS staffs for understanding the status and their perception on the Ghol area management.

Management practices

Survey among Assistant Deans, Rampur Campus Chief, Director (DOR), Department Head, professors, teachers, NARC/NMDP (coordinator) and local community members was conducted focusing on management practices and future planning.

Figure 4: FGD in the Darai community

2.5. Data Collection Tools

For data collecting, the following tools were used:

- Sampling and laboratory analysis for water quality assessment
- Plant and animal identification toolkit
- Questionnaire for household survey, questionnaire for teachers, researchers and students, FGD moderator's guideline and checklist for socioeconomic analysis
- GPS meter
- Quadrat and measuring rod
- Topographic and socioeconomic maps

2.6. Data Analysis

Data were analyzed using software ArcView 3.2 and MS-Excel.

2.7. Minimization of Error/Reliability and Validity

To minimize the error, research assistants and students were trained to build capacity on data collection, interview techniques, data processing and analysis. The research team had supervised, monitored and evaluated the work of the assistants and students.

III. RESULTS AND DISCUSSION

3.1. Physical, Physio-chemical and Biological Parameters

3.1.1. Physical Parameters

Area

The area of the Ghol area including the adjacent land area is 15 ha. The level of the water increases and overtops in monsoon season.

Depth

The maximum depth of flowing water ranges from 10 cm to 79 cm.

Discharge

The Discharge of the flowing water in the Ghol area was taken in two spots, at the outlet and near aquaculture laboratory. The discharge at the aqua bridge was found to be 0.1071 cu m/secs and 0.4 cu m/secs at the outlet. Since, the data collection time was winter so the discharge is significantly low.

Location

The exact location of the Ghol area through GPS reading was recorded to be at a latitude of 27º38´14.1"N and longitude 84º21´25.2" E and at an altitude of 257 m.

3.1.2. Physiochemical parameters

Temperature

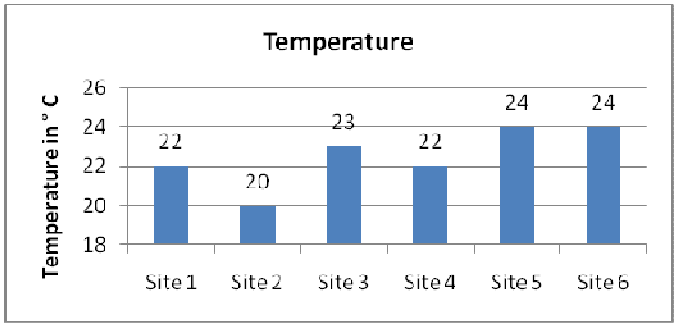


Figure 5. Water temperature at different sites

The temperature of the water at the Ghol area was in the range of 20°C to 24°C (Figure 5). The temperature pattern not subjected to abrupt fluctuations can be attributed to the small and shallow nature of the water basin.

P^H

The P^H of the Ghol water ranges from 7.3 to 7.7 being slightly alkaline (Figure 6). This negligible fluctuation in the P^H and it affinity towards alkaline value may be due to large capacity of carbonate system, supplied through formation from the basin bed.

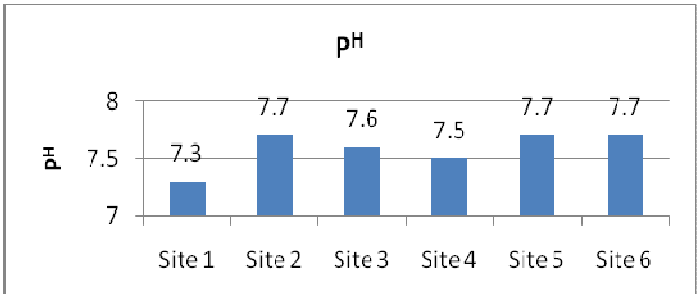
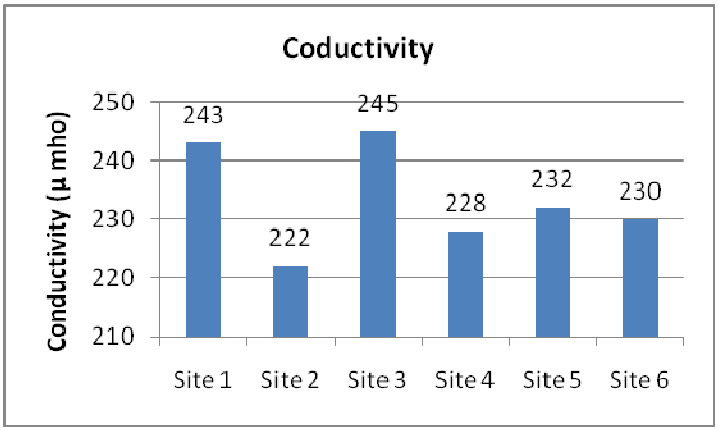


Figure 6. P^H at different sites

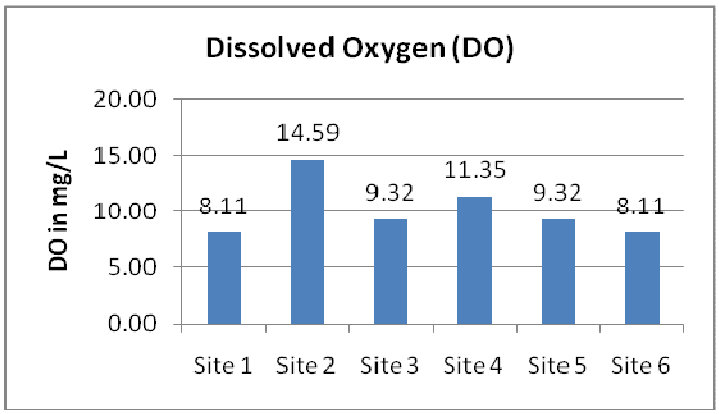
Electrical Conductivity



The EC of the Ghol water ranges from 222 to 245 µ mho (Figure 7). Site 1 and site 2 has relatively high conductivity values this could be due to presence of higher concentration of salt dissolve in water in those sites compared to rest test sites.

Figure 7. Electrical conductivity at different sites

Dissolved Oxygen (DO)



The DO level in the Ghol water is sufficient to support aquatic life thriving on it. The DO level ranges form 8.11 to 14.59 mg/L (Figure 8). At the upstream, the DO level is quite low whereas it rises considerably at couple of site in the

Figure 8. Dissolved oxygen at different sites

middle region of the lake may be due to mixing with air. On contrary due to other organic load from the next tributary flowing through the agricultural land and fishery pond the DO level again drops down to the initial value.

Total Alkalinity

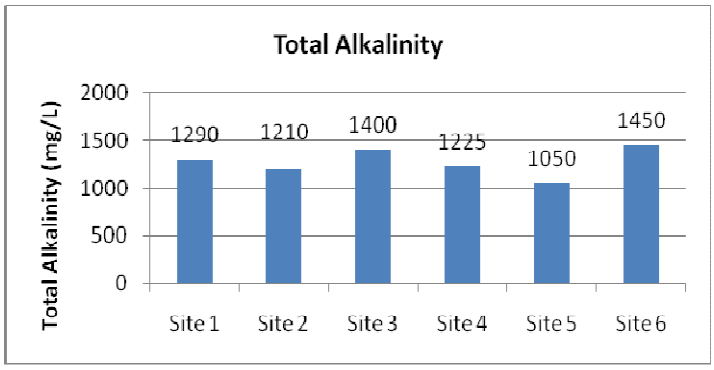


Figure 9. The total alkalinity at different sites

The total alkalinity of the water ranges from 1050 to 1450 (Figure 9). Except Site 5, all the sites had more than 1200 alkalinity.

Total Hardness

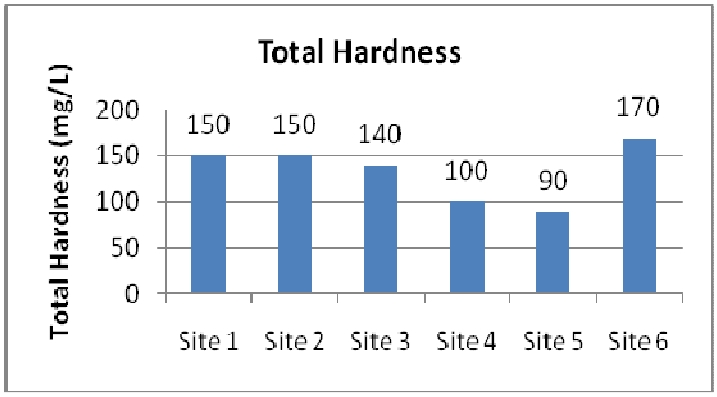


Figure 10. Total hardness at different sites

The total hardness of the Ghol water ranges from 90 mg/L to 170 mg/L (Figure 10). So, the water from the three samples falls under the hard water (150-300 mg/L). Since, the water flows through the soil so it is mixed with geological formations and becomes hard. But, the level of total hardness is far below the standard.

Nitrate

The nitrate level in the Ghol water ranges from 0 to 5 (Figure 11). The nitrate level indicates the agricultural leaching. So, there does not seem any leaching since the value of the nitrate is far below the standard.

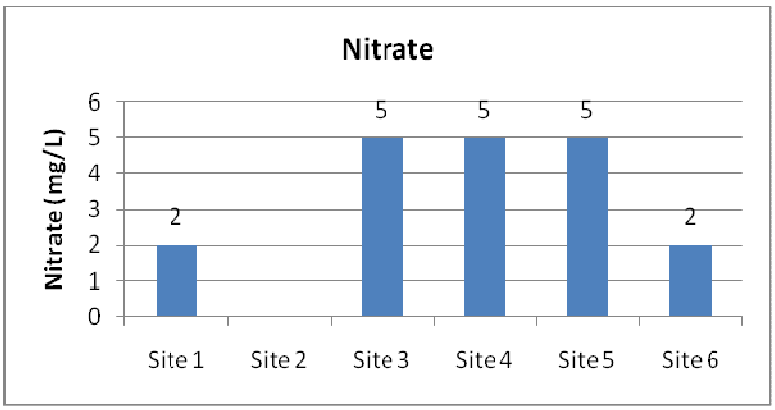


Figure 11: Nitrate level at different sites

Phosphate

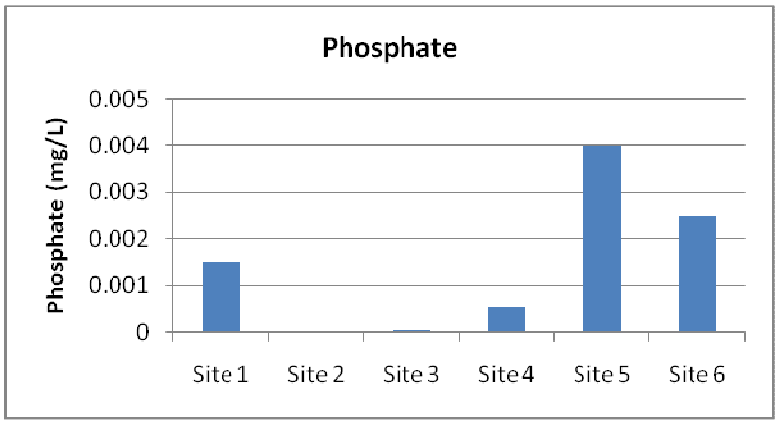


Figure 12. The phosphate at different sites

The Phosphate level in the Ghol water ranges from 0 to 0.004 mg/L (Figure 12). The value of phosphate in the Ghol water is negligible indicating that there is no leaching from the agricultural field since the data were collected in fallow period.

Free Carbon Dioxide

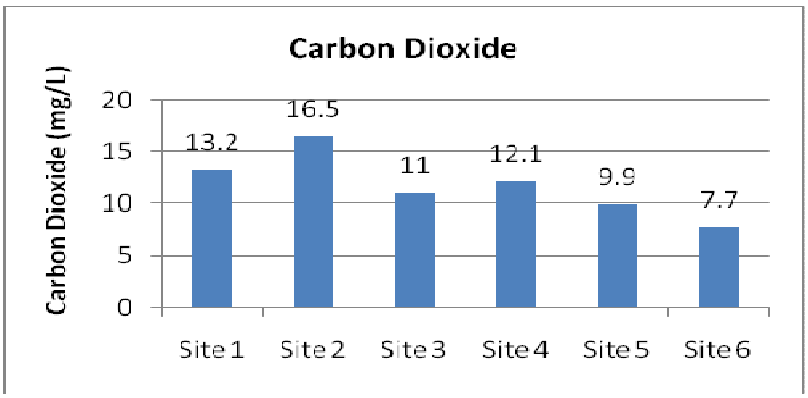


Figure 13. Carbon dioxide at different sites

The amount of free carbon dioxide in the water ranges from 7.7 to 16.5 mg/L (Figure 13). Generally, the free carbon dioxide available in natural water is in the range of 10 mg/L. Biological activities into water determine the amount of the carbon dioxide dissolved into the water.

Chloride

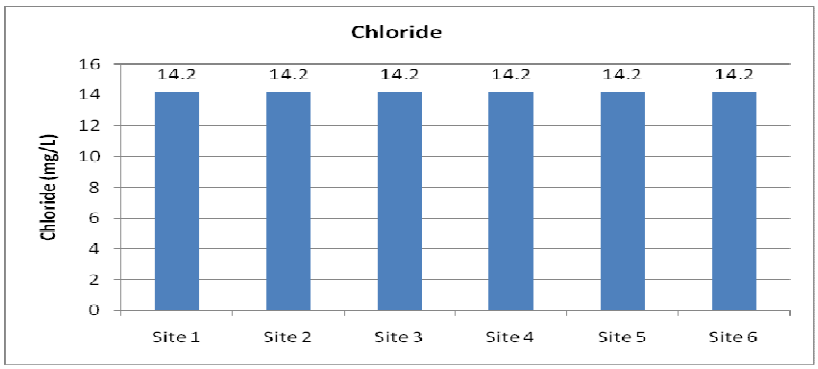


Figure 14. Chloride at different sites

The chloride concentration in the water is 14.4 mg/L throughout the area (Figure 14). The source of chloride in the Ghol water may be from the animal dung and other mini industrial activities. But the level is far below the standard.

3.1.3. Biological aspect

A total of 34 species belonging to 19 families was recorded in 23 quadrats studied in the Ghol of Rampur. The largest family was the Asteraceae (6 species) followed by Poaceae (5 species) and Cyperaceae (3 species). Most of the species at the time of data collection were in vegetative stage.

Density, Abundance, Frequency and IVI values of the herbs around the Ghol Area

The top 5 species of the studied area based on density were *Commelina diffusa* (107.52), *Eragrostis gangetica* (74.83), *Gonostegia pentandra* (24.30), *Pistia stratiotes* (10.52) and *Ageratum houstonianum* (10.26) (Figure 15). Based on abundance, the top species was *Erasgrostis gangetica* (191.22) , followed by *Commelina diffusa* (123.65), *Schoenoplactus juncoides* (86.00), *Pistia stratiotes* (48.40) and *Ammannia densiflora* (39.50) (Figure 16). Based on frequency, *Commelina diffusa* (86.96) was the number one species followed by *Gonostegia pentandra* (78.26), *Ageratum houstonianum* (43.48), *Erasgrostis gangetica* (39.13) and *Persicaria barbata* (39.13) (Figure 17). Based on IVI value, *Commelina diffusa* (66.53), *Eragrostis gangetica* (55.26), *Gonostegia pentandra* (24.64), *Ageratum houstonianum* (13.27) and *Pistia stratiotes* (12.85) (Figure 18).

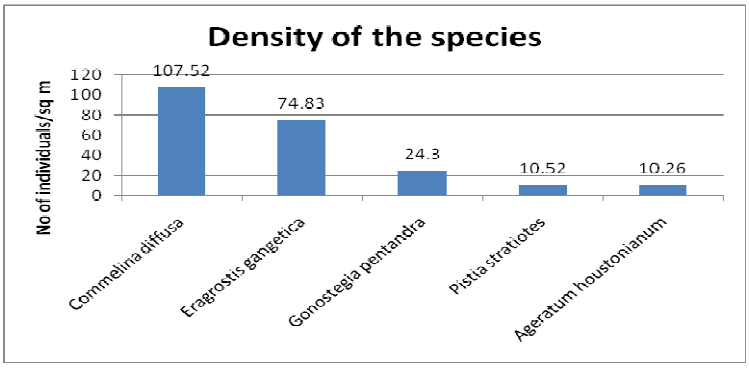


Figure 15: Density of top 5 plant species

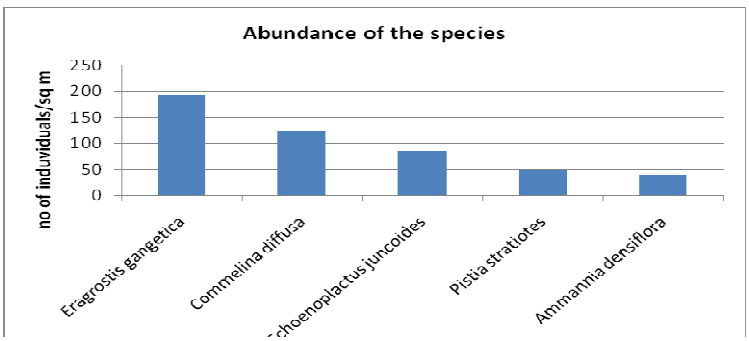


Figure 16: Abundance of top 5 plant species

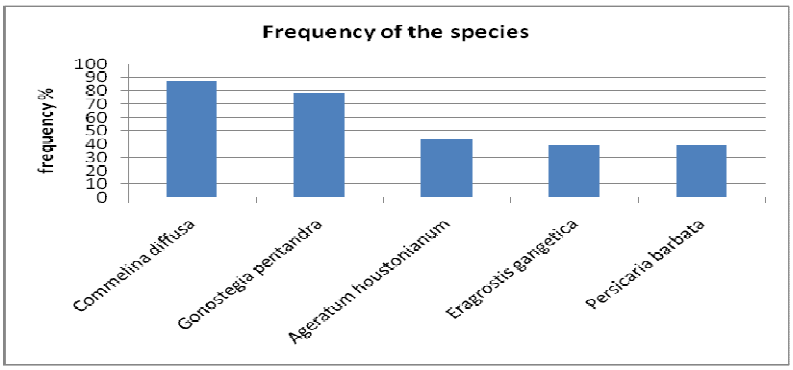


Figure 17: Frequency of top 5 plant species

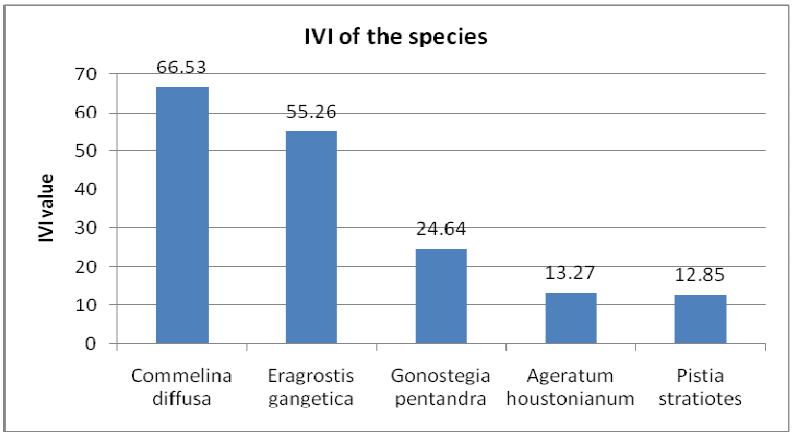


Figure 18: IVI value of top 5 plant species

Alien and Invasive Species

The Ghol area was found invaded by some invasive species like *Mikania micrantha* (Lahare banmara), *Pistia stratiotes* (pani banda) and *Ageratum houstonianum* (Gandhe jhar). Among them, *Pistia* were highly abundant in stagnant water and rice fields of the Ghol. The *Mikania* was seen in the moist places of the Ghol. These invasive plants seem to become a problem to Ghol in near future. The *A. houstonianum* is a poisonous plant to livestock.

Figure 19: *Pistia stratiotes* in Ghol paddy fields

Fishes

Sidra, Bam, Jhinge, Gadaule, Kande are the types of fishes available in the Ghol area. The availability of fish increases in winter than in monsoon season because in monsoon the high discharge sweeps away the fishes. In present trend, local species of fishes are disappearing these days because of domination of modern species from the nearby fishery farms. There is also a problem of injuring of fishes of the Ghol water due to the illegal use of pesticides for fishing purpose.

Birds

Being a wetland area, the Ghol is a major habitat for bird species. The common birds available there are Bakulla, Sarash, Duck, Ghungiphor, Garun, Chakhewa, Lalpharam etc.

3.2. Socioeconomic Aspect

3.2.1. Education Level

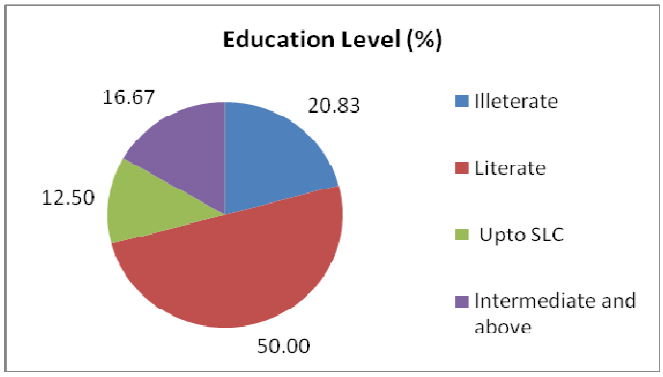


Figure 20: Diagram showing education level of

The respondents around the Ghol area were mostly literate (Figure 20). Since, most of the male member of the household had gone out for their respective job as the survey was conducted in the day time the education level of the housewife was taken in account in most of the households. Children from all surveyed household were admitted to school and it was observed that education among men was significantly high compared to women in respective household.

3.2.2. Occupation

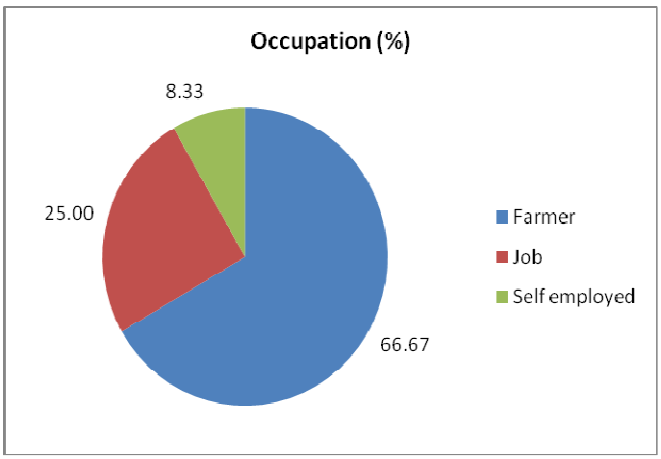


Figure 21: Diagram showing occupation of respondents

Most of the respondents were farmers followed by job holders (Figure 21). Since, the information was taken in day time, so farmers were accessible for the information. Job holders are the employee at the college and some other offices of the area.

3.2.3. Land use of the Ghol area

The land around the Ghol area is used for cultivation. In the rainy seasons, due to high availability of water for irrigation, the premises of the Ghol area is cultivated with paddy. Resident has to pay certain fee to the college administration for using the field. Generally, the area is cultivated by the staffs and families residing at the apartments of the college. In dry season, the area outside the water body remains barren due to unavailability of water for irrigation.

3.2.4. Land for cultivation

The average land for cultivation for the people around the Ghol area is 7.45 Kaththas. For college staff the land ownership is with the college and for local resident around the Ghol the ownership is with themselves. The major crops grown there are rice, maize, potato, mustard, wheat, musuro, beans, millet, oat, peas and other green vegetables. Among all crop, rice seem to be grown by all respondent.

3.2.5. Drinking water

Most of the households do have their own hand pump for groundwater extraction and only few of them have access to piped supply of drinking water. Those households with piped supply of water do also have hand pump for irrigation purpose.

3.2.6. Fuel use

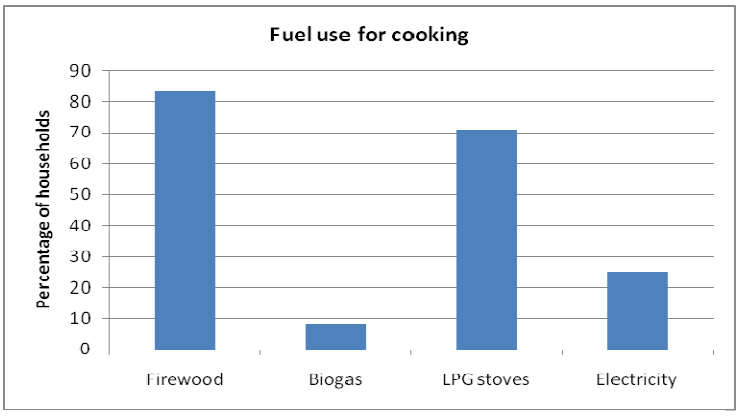


Figure 22: Diagram showing different fuel use

The firewood is used by most of the households followed by LPG stoves (Figure 22). The firewood is collected from the nearby forest and some of them go to Ghol area for firewood collection. Economically higher class people are using LPG stoves for cooking purpose. Electricity is used only for cooking rice in rice cooker; the use of electricity for cooking is high because of no electricity tariff to those staff's family residing staff's quarters. Biogas use is less because those people residing in staff's quarters do

not to have permanent infrastructures thinking that that will not be their own property and those outside the college premises due to lack of financial resources.

3.3. Ecological Importance of the Ghol

The people living there in are taking the following benefits from the Ghol area:

Figure 23: Fodder collection

1. Ghol area is full of plant resources. Fodder is collected by villagers for their livestock.
2. Water is flowing permanently. Farmers are using water for irrigation purpose.
3. Ghol is the habitat for indigenous fishes. Darai community, especially women, come to harvest fish.
4. Villagers also graze their livestock in Ghol area.
5. Local people come to Ghol for collecting wild edible plants and medicinal herbs.
6. People come here for ritual activities
7. People love to come here for scenic beauties.
8. Paddy is cultivated in both sides of Ghol.

3.4. Impacts of the Ghol to the Community People

Flooding

Frequent flooding occurs in the Ghol area which is disrupting the cultivated land around the Ghol. In past, a bridge over the Ghol area had been swept away by a flooding.

Coldness in winter

People have reported that they feel quite cold especially in winter than other place due to their residence being near to Ghol area. The condition becomes mild during summer period.

Foul smell

Organic degradation of the materials swept is creating foul smell which is reported by very few respondents

3.5. Management of the Ghol Area

3.5.1. Current management practices

Currently, paddy cultivation is done in some part of the Ghol area by the staff of IAAS and NARC. There is no special management practices carried out by both organizations.

3.5.2. Management suggested by the community people

- Flood control is necessary.
- The Ghol area should be managed wisely for fishery so that the economic activities of the local people will be enhanced
- A recreation park in the Ghol area should be developed to promote tourism for income generation and wetland education.
- Proper fencing around the Ghol area so that overgrazing can be controlled.
- Fishing by poisoning of the water and electric currents should be stopped.
- Proper irrigation systems should be implemented so that the people will be happy with better agricultural production
- A bridge should be constructed so that it will not be difficult to cross the Ghol area
- Plantation activities should be carried out on the banks of Ghol area.

3.5.3. Management suggested by IAAS Faculties and NARC staff

The Ghol of Rampur supports diverse fish species and other faunal and flora species. Rapid deterioration of natural Ghol may cause loss of fish diversity and other species. This Ghol area is also very important for teaching, research and development. So, it should be improved and well managed wetland for conserving wetland ecosystem and wise use of biodiversity to get maximum environmental services.

- Management plan for Ghol area should be developed incorporating biodiversity conservation and sustainable use through developing recreational sites and agriecotourism business.
- Multidisciplinary mega project should be developed for conserving Ghol area. The project should be leaded by conservation ecologist in partnership with aquaculture specialist, horticulturist, and livestock specialist.
- A dam should be constructed to make a lake where fish farming can be done in large scale.

- Illegal fishing practices such as poisoning and electric currents should be stopped.
- Facilities (such as boats) for recreation should be developed.
- Bamboo plantation need to be done on either side of Ghol area for the beautification of landscape.
- Comprehensive study on Ghol area is necessary for a whole year to explore resources and utilize in teaching, training, research and tourism.
- There is a need to establish a special unit for Ghol development and research
- Consultation meetings, workshops and seminars need to be conducted for enhancing participation of stakeholders in developing and conserving Ghol area.
- The Ghol area should be managed properly in partnership of IAAS and NARC with the support of UNESCO, IUCN, UNDP and other INGOs. The other potential stakeholders identified included District Development Committee, local communities, NTB, NGOs and INGOs.

IV. CONCLUSION

The Ghol area is important for conserving wetland biodiversity and enhancing environmental services and livelihood of the local people. The health condition of the Ghol area is sound and its water quality is not polluted due to any natural factors. Herbs are dominating the Ghol area and among them some new species nowadays are invasive. The area is used for fodder, fuelwood, wild vegetable, recreational, religious, grazing, medicinal plants, and irrigation. Darai community is the most dependent for fishing in the Ghol area. The impacts of Ghol being its existence are frequent flooding and bank cutting in monsoon, foul smell and coldness in winter. The area can be a touristic destination if it is managed wisely. The Ghol area is very important for scientific study, research and development for enhancing ecosystem services to the communities. A detail comprehensive study is required to generate information on ecosystems and biological resources to enhance livelihood. A mega project is required to develop to construct a lake and raise fund for implementation of the project with the support of UNESCO, IUCN, WWF and other interested donor organizations.

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ANNEXES

Annex I. Photographs

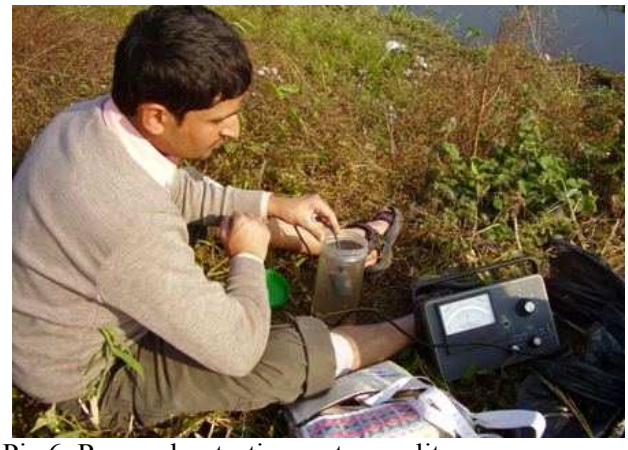
Pic 1: Marshy land around the study area

Pic 2: *Ottelia alismoides* in Ghol area

Pic 3. *Colocasia esculenta* in Ghol area

Pic 4: Research team in the field

Pic 5: Research team heading for observation



Pic 6: Researcher testing water quality

Pic 7: Marcha, for alcohol preparation

Pic 8: Quadrat to measure vegetation

Pic 9: Researcher measuring water discharge

Pic 10: Researcher in Aquaculture laboratory

Pic 12: Clear water in the Ghol area

Pic 12: Sheep grazing around the Ghol area

Annex 2: List of Faculties Participated in Key informant Survey

SN	Name	Designation	Department
1	Dr. Mohan Sharma	Associate Professor	Animal Breeding
2	Dilip Kumar Jha	Associate Professor	Aquaculture
3	Dr. Resham Bahadur Thapa	Professor and Asst. Dean	Entomology
4	Dr. Moha Datta Sharma	Associate Professor	Horticulture
5	Dr. Dil Bahadur Gurung	Coordinator	NMDP
6	Narendra Kumar Chaudhary	Associate Professor and Director	Agronomy
7	Sant Bahadur Gurung	Professor	Environmental Science
8	Madhav Kumar Shrestha	Reader	Aquaculture
9	Dr. Naba Raj Devkota	Associate Professor	Animal Nutrition & Fodder Production
10	Dr. Dainik Bahadur Nepali	Professor and Asst. Dean	Livestock Production
11	Shrawan Kumar Sah	Associate Professor	Agronomy
12	Dr. I. P. Dhakal	Campus Chief	Rampur Campus
13	Dr. S.M. Shakya	Professor	Horticulture
14	Dr. Indira Bhattarai	Associate Professor and Department Head	Environmental Science

Annex 3: Plant species and their ecological parameters

[Density (D), relative density (RD), abundance (A), Relative abundance (RD), frequency (F), relative frequency (RF) and Importance Value Index (IVI)]

SN	Name of the sps	D	RD	A	RA	F	RF	IVI
1	*Adenostemma lavenia*	0.65	0.23	7.50	0.88	8.70	1.37	2.48
2	*Ageratum houstonianum*	10.26	3.66	23.60	2.77	43.48	6.85	13.27
3	*Alternanthera sessilis*	0.48	0.17	3.67	0.43	13.04	2.05	2.66
4	*Ammannia densiflora*	3.43	1.22	39.50	4.63	8.70	1.37	7.23
5	*Bhumea lacera*	0.04	0.02	1.00	0.12	4.35	0.68	0.82
6	*Bidens pilosa*	0.91	0.33	7.00	0.82	13.04	2.05	3.20
7	*Centella asiatica*	0.61	0.22	7.00	0.82	8.70	1.37	2.41
8	*Colocasia escelenta*	2.57	0.91	8.43	0.99	30.43	4.79	6.70
9	*Commelina diffusa*	107.52	38.33	123.65	14.50	86.96	13.70	66.53
10	*Cyperus* spp.	3.04	1.09	11.67	1.37	26.09	4.11	6.56
11	*Digitaria* (Banso)	0.91	0.33	7.00	0.82	13.04	2.05	3.20
12	*Dysophylla auricularia*	0.09	0.03	2.00	0.23	4.35	0.68	0.95
13	*Eragrostis gangetica*	74.83	26.68	191.22	22.42	39.13	6.16	55.26
14	*Isachne globosa*	1.00	0.36	23.00	2.70	4.35	0.68	3.74
15	*Fuireua umbellata*	1.00	0.36	23.00	2.70	4.35	0.68	3.74
16	*Gonostegia pentandra*	24.30	8.67	31.06	3.64	78.26	12.33	24.64
17	*Hydrocotyle rotundifolia*	0.43	0.16	5.00	0.59	8.70	1.37	2.11
18	*Ipomoea aquatica*	0.61	0.22	7.00	0.82	8.70	1.37	2.41
19	*Justicia diffusa*	0.78	0.28	18.00	2.11	4.35	0.68	3.07
20	*Lindernia crustacea*	0.04	0.02	1.00	0.12	4.35	0.68	0.82
21	*Ludwigia hyssopifolia*	0.22	0.08	5.00	0.59	4.35	0.68	1.35
22	*Mikania micrantha*	3.17	1.13	24.33	2.85	13.04	2.05	6.04
23	*Mimosa pudica*	0.96	0.34	7.33	0.86	13.04	2.05	3.26
24	*Monochoria hastata*	2.52	0.90	9.67	1.13	26.09	4.11	6.14
25	Para grass	6.91	2.46	26.50	3.11	26.09	4.11	9.68
26	*Spilanthes ciliata* (Parpare jhar)	1.00	0.36	23.00	2.70	4.35	0.68	3.74
27	*Persicaria barbata*	9.52	3.39	24.33	2.85	39.13	6.16	12.41
28	*Phragmites karka*	3.09	1.10	14.20	1.67	21.74	3.42	6.19
29	*Phyllanthrus urinaria*	0.30	0.11	3.50	0.41	8.70	1.37	1.89
30	*Pistia stratiotes*	10.52	3.75	48.40	5.68	21.74	3.42	12.85
31	*Pteris vittata*	2.17	0.78	16.67	1.95	13.04	2.05	4.78
32	*Rotala rotundifolia*	2.30	0.82	10.60	1.24	21.74	3.42	5.49
33	*Schoenoplactus juncoides*	3.74	1.33	86.00	10.08	4.35	0.68	12.10
34	*Smithia sensitiva*	0.52	0.19	12.00	1.41	4.35	0.68	2.28
	Total	**280.48**	**100.00**	**852.82**	**100.00**	**634.78**	**100.00**	**300.00**

Annex 4: Questionnaire for Household Survey

Namaste! I am……from…….. Today, I am here to take a survey for a research study entitled "**Baseline Study of Ghol Area, Rampur, Chitwan"**. . The survey is carried out by IAAS, UNESCO-IHP Nepal, The Small Earth Nepal and ADAPT Nepal. The information given by you will only be used for research purpose. So, would you mind answering me for a few minutes? It may take about 15 minutes. You can drop at anytime if you wish it to be.

Start ***Date……***

Part A: Socio-economic Status

1 .Name of the respondent……..

2. Age

3. Gender: Male Female

4. Marital Status: Single married

5. Educational status:

Illiterate *Literate* *SLC*

Intermediate *Graduate* *above Graduation*

6. Occupation:

Farmer *Self-employed*

Governmental employee *private Sector*

Others (specify)……..

7. Household size:

Name of the family member	***Age***	***Educational level***	***Occupation***	***Earnings/Income***
1. *2.* *3.* *4.*				

8. What is the source of drinking water in your family?

a. Piped supply *b. Hand-pump* *c. River/irrigation canal* *d. others (specify)*

9. Do you have toilet facility? Yes No

If no, where do you go for defecation?

a. Open/public space b. Riverside c. Private land d. Others (specify)……..

10. What do you use for cooking as fuel?

Electricity Firewood Kerosene

Animal dung LPG stove

Others (specify)……..

11. How much land do you cultivate?

a. Irrigated:……..B. Partially irrigated land……c. Non-irrigated……..

Part B: Benefit from the Ghol Area

SN	***Activities***	***Status***	***Frequency (how often)***	***Remarks***
1	*Drinking water*	*Y N*		
2	*Cloth washing*	*Y N*		
3	*Pot washing*	*Y N*		
4	*Bathing*	*Y N*		
5	*Livestock grazing*	*Y N*		
6	*Fishing*	*Y N*		
7	*Fuelwood collection*	*Y N*		
8	*Fodder collection*	*Y N*		
9	*Medicinal plants*	*Y N*		
10	*Swimming*	*Y N*		
11	*Irrigation*	*Y N*		
12	*Religions purpose ……..*			
13	*Recreational purpose……..*			
14	*Others (specify)……..*			

Part C: Impacts of the Ghol Area

SN	*Activities*	*Status*	*Frequency (how often)*	*Remarks*
1	*Flooding*	*Y* *N*		
2	*Bank cutting/erosion*	*Y* *N*		
3	*Bad/foul smell*	*Y* *N*		
4	*Coldness in winters*	*Y* *N*		
4	*Others (specify)……*			

Part D Management of the Ghol Area

1. *Is the current management practice of the Ghol area good? Y N*

   If not, what should be done for its better management?

   a.

   b.

At last, do you have any comments/feedbacks regarding this survey?

……

Thank you very much for your support and valuable time.

Annex 5: Key Informant Survey Questionnaire

Namaste and a warm welcome! It is our great pleasure to inform you that we are conducting a research study entitled "**Baseline Study of Ghol Area, Rampur, Chitwan"**. The survey is jointly being carried out by IAAS, UNESCO-IHP Nepal, The Small Earth Nepal and ADAPT Nepal. Your participation in this survey is completely voluntary and the information given by you will certainly help for appropriate management of the Ghol area. We request you to support us by answering the following questions:

Date (dd/mm/yyyy) _ _/_ _/_ _ _ _

Name:……Designation:……Department/Institution:…
……

1. How long have you been observing the Ghol area for?

2. What are the current management practices of the Ghol area?

3. Is the current management practice of the Ghol area satisfactory? If not, what are the weaknesses?

Yes	No	What are the weaknesses?	
	1.		3.
	2.		4.

4. What type of Ghol would you like to see in the days to come?

5. In your opinion, what management practices, plans and strategies should be adopted so that the Ghol area will take shape as per your satisfaction?

Practice	**Plan**	**Strategy**

6. Who should take the responsibility for managing the Ghol area and why?

Who	Why

Annex 6: FGD Moderators' Guidelines

Focus Group:

Date: Time: Place:

Moderator: Note taker: Camera person:

Description of the Participants:

S.N.	Name	Age	Education Level	Occupation
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

A. Introduction and greetings (10 minutes)

1. Introduction of the moderator
2. Introduction of the note taker, camera person
3. Introduction of the participants
4. Purpose of the discussion
5. Rules of the discussion

B. Information about the Ghol area (30 minutes)

1. What is the area of the Ghol?
2. Any ancient proverb about the formation of the Ghol?
3. What are the services available from the Ghol area?

   Fisheries, Fodder, grazing land, Firewood, timber, medicinal herbs, irrigation, drinking water, clothing and bathing,

4. What are the negative impacts of the Ghol in the area?

   Flooding, bank cutting, risks to children, coldness in winters

5. Any changes have you found for a long term with the Ghol area?
6. What about the discharge, velocity, depth of the Ghol area?
7. Do you practice plantation activities there?
8. Encroachment? Poaching?
9. Major species of fishes available in the area?
10. What are the major species of plants are in the bank of the Ghol area?
11. What are major birds, mammals, reptiles, invertebrates found in the area?
12. Tourism activities if any?

C. Management of the Ghol (15 minutes)

1. Any existing management plan of the area?
2. How the Ghol area can be managed properly?
3. Whose responsibility seems to manage the Ghol area?
4. Any practices of open defecation in and around the area?
5. At last, how you would like to see the Ghol area,in the days to come in your opinion?

D. Wrap up: (5 minutes)

1. Is there anything else you want to tell us before we finish?

Ghol: Source to Livelihood