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A Case Study of Wetlands in Pakistan with Special Reference to Balloki wetland

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ABSTRACT

This study is mainly focused on investigation of threats responsible for the exploitation of wetlands adjacent to Balloki barrage and provides suggestions for conservation so that they're safe, wise and sustainable use could be ensured. The study showed that management and conservation of wetlands is weak due to lack of awareness both amongst local communities and management authority. Economic benefits are being drawn from Balloki wetlands by local communities and local government at the expense of important resources or values. The water quality of some areas of wetlands is being affected by toxic industrial and municipal wastewater contamination from nearby Ravi River and also as a result of contamination from agricultural runoff from privately owned surrounding land. Water contamination is causing disturbance to waterfowl and aquatic life in the wetlands. Acres of vegetation are harvested annually without paying any regret for ecosystem needs. Use of pastures or surrounding wetland areas as a food source for domestic livestock grazing is posing a threat to site vegetation to some extent. Fishing and hunting of waterfowl are a source of income for local government and local communities. It was suggested to adopt some proposed conservation measures in order to promote the wise and sustainable use of Balloki wetlands.

Key words: Agricultural Runoff, Conservation, Fauna, Flora, Management, Water Quality.

INTRODUCTION

Wetlands are among the most productive and biologically diverse but very fragile ecosystems. They are vulnerable to even small changes in their biotic and abiotic factors. In recent years, there has been concern over the continuous degradation of wetlands due to shortsighted developmental activities [1].

Wetlands form the transitional zone between land and water, where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in and on it[2].

The Ramsar Convention on Wetland in 1971, in Iran [3] characterized wetlands as

'... Areas of marsh, fen, peatland, 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.' [4]

Wetlands provide a wide range of ecological and socioeconomic function, whereas on other hand development poses a serious threat to the wetlands, Pakistan has 225 wetlands, 19 globally significance, which are also recognized as Ramsar sites, in spite of the fact sustainable use of wetland can provide a range of benefits [5]

Wetlands in Pakistan also provide services such as in Rasool barrage (wetlands) and Qadirabad barrage (wetlands), harvesting of reeds and rushes is done for local cottage industries; also fishing is a source of income there. In Balloki wetland, prayer mats are made from the harvesting of vegetation namely Typha. These mats are used in mosques. Various items are also made from the harvesting of vegetation namely saccharine there [6].

Balloki wetlands are natural in origin which is located near Lahore, is not considered as globally significant wetland but holds national significance. Formation resulted from excavations of soil left due to the construction of marginal and spur bunds on Balloki barrage which resulted in depressions in river bank along both sides of the Ravi river. Flood or seepage water got filled up in these depressions which then turned into wetlands. These wetlands developed their own fauna and flora [7].

Bloke barrage were declared as wildlife sanctuary by the Irrigation and Power department Pakistan in 2002 with the purpose of the purpose of management and conservation of wild life and its sustainable development and for the establishment of private game reserves, wetlands associated with. The land surrounding Balloki wetlands is privately owned and is used in agricultural practices [8].

Objectives

This study mainly focuses on the ecological, biological socioeconomic features of the wetland, identifying the threats related to it and ensuring the sustainable use of the wetlands of Balloki for the benefit of local people.

It was observed and analyzed that the local community and local government are making economic benefits from Balloki wetlands by means of resource utilization at the expense of ecosystem needs.

Various threats are confronted to Balloki wetlands causing their exploitation which include:

- Increased population pressure around wetlands due to the desire of gaining economic benefit from resource utilization
- Contamination of Ravi river due to toxic industrial and municipal wastewater inputs and from surrounding land engaged in agricultural development effecting wetland water quality and regime
- Overutilization of wetland resources by means of hunting, fishing, yearly harvesting of vegetation
- Use of surrounding wetland areas or pastures as a food source for domestic livestock grazing
- Invasive alien species such as water hyacinth (Eichhorniacrassipes), and water cabbage (Pistiastratiotes) affecting biodiversity and the ecological characteristics of wetlands.
- Possible threat could also result from global warming and climate change over the coming years

Literature Review

Benefits

The economic valuee of wetlands is due to the products derived from these ecosystems. Products provided by the wetlands can also be taken as the value of wetlands. Fish and rice are important products provided by wetlands. Approximately three billion people feed on an important staple diet that is rice and fishing communities in finding fish as a source of generating income [9]. Andrea Ghermandi (2008) carried out a study on the economic value of wetland conservation and creation. In the study, ecological and economic values of wetlands were recognized and welfare impacts of goods and services provided by wetlands were examined [10].

Exploitation, Degradation and Loss of Wetlands

A study was conducted by RahatJabeen (2004) on major activities resulting in the loss of wetlands such as drainage for agriculture, urbanization, regulation ofthe water systemm. It was figured out that developmental activities such as filling, draining, excavation are a major contributor to the loss of wetlands in the world. Loss in quality and quantity of wetlands has resulted in a decline in migratory birds and wetland productivity, and there is also a decline in the fauna and flora diversity [11].

J.M.Mironga (2004) carried out a study in Kisii district, Kenya regarding the effects of agriculture on wetlands. The study emphasized in the training of farmers so that they have enough knowledge to practice sustainable agriculture on wetlands. Emphasis was also put on the need to build a conservation ethic among the users of wetlands by training and educating them so that they can utilize the resourcess of wetlands in a sustainable way [12].

A study was carried out by Abdul LatifRao (2009) on management and conservation of Pakistan's wetlands. It was studied that despite a large number of wetlands in Pakistan, they are not well managed and are facing a number of threats. The first objective of the study was to provide sustainable conservation of freshwater and marine wetlands, and to create a policy, institutional, technical and financial framework, public awareness and support for wetland conservation. The second objective was to form independent demonstration complexes throughout the country for the purpose of sustainable wetland management [13].

A study was carried out on the conservation and management of Bhoj wetlands, India by Aniruddhe Mukherjee (2009). The study provides a detail regarding the implementation of different conservation programs so that conservation and management of Bhoj wetlands could be done in a best possible way [14].

In developing countries like Pakistan, a number of local communities are dependent on wetland resources for the sake of their livelihoods. Local communities play a major role in the management and conservation of wetlands. Further exploitation and wetland loss could result in case if the communities are excluded from the management and conservation of wetlands. So local government should take into account the practices and attitudes of local communities for effective wetland conservation.

MATERIALS AND METHOD

The research was conducted for the recognition and evaluation of threats to the wetlands, especially Balloki wetland for this purpose primary (Survey technique) as well as secondary data (literature, research papers, field reports, plans & published books) were collected, different materials and analytical methods used in this study to check the water quality of the wetland.

Data regarding physiology, climatic conditions, hydrologic conditions, soil conditions, biodiversity, effects of human disturbance or natural disturbance (threats) on wetlands such as by land use changes, natural resource utilization (vegetation trampling, domestic livestock grazing, hunting, shooting, fishing), deforestation, water pollution, pollution by domestic livestock waste, waste dumping, land tenure, conservation measures taken by management authority, climate change, socioeconomic values, social threats.

Materials

Different materials are used for checking the water quality of the water, which mainly includes the following equipment

Thermometer, PH meter (PH-8414), Dissolved Oxygen (DO) meter (DO-820), Electrical Conductivity (EC) meter (SM-802), Turbidity meter (TN-100), Total Dissolved Solids (TDS) meter (SM-802), Drying oven, Analytical Balance, Chemical oxygen demand (COD) Reactor

Methods

Water quality was analyzed to measure the rate of pollution runoff entering into some of the Balloki wetlands as a result of contamination of the Ravi river receiving toxic industrial effluents (from industries located at Lahore and Sheikhupura districts) and urban or municipal waste discharges through drain and canals and also to measure the pollution rate from surrounding land by means of agricultural runoff which may contain pesticides, fertilizers and herbicides.

Two sites were selected for the sample collection, first wetland was in bad condition free from waterfowl, which was affected by the pollution runoff from river Ravi, and two suitable sampling points were selected for collection in order to make comparisons.

Second wetland was in clear and fresh condition to use compared to that first wetland. A water sample was collected from two suitable sampling points in order to make comparisons. After the collection of samples, analytical methods were applied to check the pollution concentration in the water by following methods

i. Temperature
ii. PH -HACH method 8156
iii. Dissolved Oxygen **(DO)** HACH method 10360
iv. Turbidity - HACH method 8195
v. Electrical Conductivity **(EC)** HACH method 2510-B
vi. Total Suspended Solids **(TSS)** HACH method 8006
vii. Total Dissolved Solids **(TDS)** HACH method 8163
viii. Chemical Oxygen Demand **(COD)** HACH method 8000

RESULT AND DISCUSSION

Balloki is a wetland of national significance. It is situated 3.61 km south east of Balloki barrage and at a distance of 65 km from Lahore at Ravi river near the town of BhaiPheru. Coordinates of Balloki taken by means of GPS are 31.19 (31′11◦ 25N) for latitude and 73.88 (73′ 52◦ 40E) for longitude.

Balloki has an area of 2945 hectares. Out of these183 Acres is under the possession of Punjab wildlife and parks department and 2762 acres is encroached by army and private encroaches.

At 100 square km area around Balloki has an approximate population of 7323982. Balloki has an

average elevation of 190 meters above the sea. This is one of the best fishing and hunting outdoor adventure located in the regions of Asia/Pacific. Balloki consists of 8-9 wetlands of natural origin. All the wetlands were almost separate but near to one another.

Climatology

The climate of the area is sub-tropical monsoonal with cool winters and hot summers. Variation of annual rainfall is from 200-500mm and the relative humidity is ranged from 25-85%. From December to January, minimum temperature is from 5°C-5.5°C, whereas maximum temperature from April to June is from 35°C-40°C.

Hydrology

Water source in wetlands is Ravi River and monsoonal precipitation. Permanent wetlands remain flooded throughout the year. Water level fluctuates in temporary wetlands of Balloki during seasons of the year. Temporary wetlands suffered drought in the absence of monsoonal precipitation.

Soil

The soil is fertile, ranges from coarse to fine, most suitable for irrigated agriculture due to its physical properties.

Bird Species

Sr. #	Common Name	Family	Genera
1.	Barbet bird	Megalaimidae	Megalaimahaemacephala
2.	Coppersmith wolvert	Ardeidae	Lxobrychusflavicollis
3.	Black bittern	Ardeidae	Lxobrychusflavicollis
4.	Yellow bittern	Ardeidae	Lxobrychusflavicollis
5.	Little green bee eater	Meropidae	Meropsorientalis
6.	Red vented bulbul	Pycnonotidae	Pycnonotuscafer
7.	Pied bushchat	Muscicaapidae	Saxicolacaprata
8.	Greater coucal	Cuculidae	Centropussinensis
9.	Jungle crow	Corvidae	Corvusmacrorhynchus
10.	Pied cuckoo	Cuculidae	ClamatorJacobinus
11.	Ring-necked dove	Columbidae	Streptopeliacapicda
12.	Black drongo	Dicruridae	Dicrurusmacrocercus
13.	Cattle egret	Ardeidae	Bulbulcus ibis
14.	Little egret	Ardeidae	Egrettagarzetta
15.	Eagle	Accipitridae	Aquila nipalensis
16.	Step eagle	Accipitridae	Aquila nipalensis
17.	Mallard	Anatidae	Anasplatyrhynchos
18.	Gargany	Anatidae	Anasquerquedula
19.	Marbled teal	Anatidae	Marmaronettaangustirostris
20.	Pintail	Anatidae	Anasacuta
21.	Common teal	Anatidae	Anascrecca
22.	Peregrine falcon	Falconidae	Falco peregrines
23.	Silver bills (finches)	Estrildidae	Euodicemalabarica

24.	Brown fly catcher	Muscicapidae	Muscicapadauurica
25.	Godwit	Scolopacidae	Limosa
26.	Bartailedgodvit	Scolopacidae	Limosalapponica
27.	Marsh harrier	Accipitridae	Circus aeruginosus
28.	Grey herron	Adeidae	Ardeacinerea
29.	Eurasion hobby	Falconidae	Falco subbuteo
30.	Blue jay	Corvidae	Cyanocittacristata
31.	Kestrel	Falconidae	Falco tinnunculus
32.	Black kite	Accipitridae	Milivusmigrans
33.	Koel	Cuculidae	Eudynamisscolopaceus
34.	Red wattled lapwing	Charadriidae	Hoplopterusindicus
35.	House martin	Hirundinidae	Delichonurbicum
36.	Long tailed minivet	Campephagidae	Pericrocotusethologus
37.	Common myna	Sturnidae	Acridotherestristis
38.	Bank myna	Sturnidae	Acridotheresginginianus
39.	Spotted owlet	Strigidae	Athenebrama
40.	Rose ringed parakeet	Psittaculidae	Psittaculakrameri
41.	Grey partridge	Phasianidae	Perdixperdix
42.	Blue rock pilcon	Colmbidae	Columba livia
43.	Little ringed plover	Charadriidae	Charadriusdubius
44.	Wagtail	Motacillidae	Motacilla
45.	Black redstart	Muscicapidae	Phoenicurusochruros
46.	Common sandpiper	Scolopacidae	Actitishypoleucos
47.	Long-tailed shrike	Laniidae	Laniusschach
48.	Crested skylark	Alaudidae	Galeridacristate
49.	Purple sunbird	Nectariniidae	Cinnyrisasiaticus
50.	Common starling	Sturnidae	Sturnus vulgaris
51.	Rosy starling	Sturnidae	Sturnusroseus
52.	Sparrow hawk	Accipiter	Accipiterbadiuscenchroide
53.	Black-winged stilt	Recurvirostridae	Himantopushimantopus
54.	Grey wagtail	Motacillidae	Motacillacinerea
55.	White wagtail	Motacillidae	Motacilla alba
56.	Weaver bird	Ploceidae	Ploceuspelzelni
57.	Bluethroat	Muscicapidae	Luscinia
33.	Koel	Cuculidae	Eudynamisscolopaceus
34.	Red wattled lapwing	Charadriidae	Hoplopterusindicus
35.	House martin	Hirundinidae	Delichonurbicum
36.	Long tailed minivet	Campephagidae	Pericrocotusethologus
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51.	Rosy starling	Sturnidae	Sturnusroseus
52.	Sparrow hawk	Accipiter	Accipiterbadiuscenchroide
53.	Black-winged stilt	Recurvirostridae	Himantopushimantopus
54.	Grey wagtail	Motacillidae	Motacillacinerea
55.	White wagtail	Motacillidae	Motacilla alba

Source: (Sadiairshad and ZahidBaigMirza, 2011)

Fishes

Sr. #	Species Name	Family	Common Name
1.	Channapunctata	Channidae	Spotted snakehead
2.	Puntiussophore	Cyprinidae	Pool barb
3.	Colisafasciata	Osphronemidae	Banded goyrami
4.	Labeorohita	Cyprinidae	Rohu
5.	Cirrhinusmrigala	Cyprinidae	Mrigal
6.	Bariliusvagra	Cyprinidae	Brariliusvagra
7.	Labeogonius	Cyprinidae	Kurialabeo
8.	Chandabaculis	Ambassidae	Baculis
9.	Colisalalia	Osphronemidae	Dwarf gourami
10.	Aspidopariamorar	Cyprinidae	Cyprinusmorar
11.	Puntiustictr	Cyprinidae	Ticto barb
12.	Puntiuschola	Cyprinidae	Swamp barb
13.	Mystusvittatus	Bagridae	Asian striped catfish
14.	Ompokbimaculatus	Siluridae	Butter catfish

Source:(A.M Khan et al, 2011)

Aquatic Vegetation

Sr.#	Common Name	Botanical Name	Family
1.	Water cabbage	Pistiastratiotes	Araceae
2.	Water hyacinth	Eichhorniacrassipes	Pontederiaceae
3.	Reed	Phragmites	Poaceae
4.	Lotus	Nelumbonucifera	Nelumbonaceae
5.	Saccharumrotendus	Nucefera	Poaceae
6.	Typhadomigensis	Bulrush	Typhaceae

Table 1 : Water Analysis Results of Sample # 1 and Sample # 2 taken from Wetlands of Balloki

Water samples from two of the Balloki wetlands were analyzed for water quality;

Parameter	Unit	NEQS	Analysis Results of Sample # 1	Analysis Results of Sample # 2
i. Temperature	**°C**	40	13.0 (winter mean) 28 (summer mean)	13.35 (winter mean) 26.31 (summer mean)
ii. PH	**N/A**	6-9	8.28	8.56
iii. Dissolved Oxygen (DO)	**mg/l**	7-9	6.8	9.7
iv. Turbidity	N**TU**	……	85	70.95
v. Electrical Conductivity (EC)	**ms/cm**	……	0.30	0.54
vi. Total Suspended Solids (TSS)	**mg/l**	200	291	200
vii. Total Dissolved Solids (TDS)	**mg/l**	3500	210	385
viii. Chemical Oxygen Demand (COD)	**mg/l**	150	268.8	295.7

Ranking of Threats to the Wetlands

Evaluation of Risk Aspects Based on their Significance

Risk= (O+D) × M

Where:

O= Chances of occurrences D= Chances of Detection

M= Magnitude of the Hazard H.S= Highly Significant

S= Significant (To Some Extent) NS= Non- Significant

And Cut off point is 30. Cut off point is placed with the reference of national environmental quality standards (NEQS).

Chances of Occurrences (O)		Chances of Detection (D)		Magnitude of Hazard (M)	
Score	**Criteria**	**Score**	**Criteria**	**Score**	**Criteria**
0	None	0	Certain	0	None
1	Very Low	1	Very High	2	Minor
2	Low	2	High	4	Low
3	Moderate	3	Moderate	6	Moderate
4	High	4	Low	8	High
5	Very High	5	Very Low	10	Very High

Risk Aspects	Detailed Aspects	Magnitude ofHazard (M)	Probability of occurrence (O)	Chances of Detection	Risk Ranking	Results	Mitigation Measures
Water Pollution	PH	2	3	2	10	NS	Source of pollution should be controlled and time to time survey is required
	Electrical Conductivity	2	3	2	10	NS	
	Turbidity	6	3	2	30	NS	
	Total Dissolved Solids (TDS)	2	3	2	10	NS	
	Total Suspended Solids (TSS)	8	4	2	48	H.S	
	Chemical Oxygen Demand (COD)	8	4	2	48	H.S	
Vegetation Harvesti	Typha	8	4	2	48	H.S	Use should be sustainable
	Saccharum	8	4	2	48	H.S	

		Ecosystem Disturbance	8	5	1	48	H.S	
Livestock and Excessive Use of Pastures		Over Grazing of pastures	6	4	2	36	s	Grazing should be controlled and management of grazing area or use of alternate area for grazing is required
		Loss of Vegetation	4	4	1	20	NS	
		Land Pollution	6	3	2	30	NS	
		Water Pollution	0	0	2	2	NS	
		Eutrophication	0	0	2	2	NS	
		Land Erosion	4	3	2	20	NS	
Pollution from Surrounding		Agricultural Activities	8	4	2	48	S*	Source of pollution should be managed And controlled
Over Hunting		Loss of Animals	2	4	3	14	NS	Should be controlled
Over Shooting		Loss of Indigenous Birds	6	4	1	30	NS	Should be controlled
		Loss of Migratory Birds	6	4	1	30	NS	
Over Fishing		Loss of Fish	8	4	1	40	S	Legalover-Fishingpractices should be

Deforestatio	Loss of Vegetation	4	4	2	24	NS	Forestation should be improved
	Erosion	4	4	2	24	NS	
Urbanizatio	Population Load Around Wetlands	8	4	2	48	S*	Should be managed and controlle
Un Managed Tourist	Ecosystem Disturbance	4	4	3	28	NS	Awareness should be provided
	Solid Waste Dumping	4	4	3	28	NS	
	Land Pollution	4	4	2	24	NS	
	Water Pollution	4	4	2	24	NS	
Climate Change	……	2	4	1	10	NS	…….

Discussion

The land area surrounded by the wetlands is home of various birds that also includes migratory birds. Study site, serves as a habitat for a number of waterfowl which bare a source of enjoyment for tourists and local people. Piscivorous birds were observed in fresh wetlands, which include: Kingfishers, Cormorants. Healthy wetland ecology was indicated by these birds. Other waterfowl observed and identified in the pond areas include: Common teal, marbled teal, Pintail, gray heron, Mallard, Yellow wagtail, White wagtail [7].

Wetlands serve as important habitat for resident and migratory bird species. Some of them are endangered and threatened with extinction. A large number of migratory birds visit the study site during the autumn and spring seasons of the year for the purpose of feeding. Some of these include: Yellow wagtail, White wagtail, Common teal, Pintail, gray heron, Mallard, Marbled teal, Ducks, Cattle egret, Little egret [7].

Balloki wetlands support fish species. CatlaCatla fish is eliminated from the study area due to industrial and urban sewage water pollution. Fishing in the study area is a source of economic benefit of the government and local communities [15].

Balloki wetlands consist of floating, submerged and rooted vegetation. Aquatic vegetation identified in wetlands is mentioned in the table. Typha (Cattail) was seen growing submerged in most wetlands. Typha is harvested each year there by local people to make the prayer mats or handmade mats from typha leaves. 70% of total typha is harvested each year. Also, various items are made from the harvesting of saccharin. It is a source of income for the government, traders and local communities [15].

Saccharum rotundas were found at the edge of most wetlands and Saccharummunja was found growing on dry land. Local communities, government and traders use “Saccharumbangalense” as a source of income [16].

“Saccharumbangalense” is a rooted plant in the study area. It is trampled each year from the last week of December- February in order to make reed screens. Reed screens are locally called as “sirkee”. Saccharumbangalense” is used as thatching material in villages as well as for fuel purposes in the local communities of Balloki barrage.

In one of the Balloki wetland, invasive alien species such as water hyacinth (Eichhorniacrassipes), water cabbage (Pistiastratiotes) was found to be affected biodiversity and ecological character of wetland.

Some of the wetlands near to Ravi river are being contaminated from toxic industrial effluents (from industries located at Lahore and Sheikhpura districts) and from urban or municipal waste discharges through drain and canals leading to effect its water quality. This toxic industrial and municipal waste is dumped into the river water upstream of Ravi and then as a result of the contribution from link canals is diluted sufficiently. Contamination is also from surrounding land by means of agricultural runoff, which may contain pesticides, fertilizers and herbicides. Contaminated wetland was almost free from any species of waterfowl. Water quality was analyzed to measure the rate of pollution runoff.

Water analysis of two of the Balloki wetlands reveals that results of Sample # 1 are within normal limits except Total Suspended Solids (TSS) and Chemical Oxygen Demand (COD). Results of Sample # 2 are within normal limits except Chemical Oxygen Demand (COD). Elevated levels of Total Suspended Solids (TSS) in Sample # 1 are indicative of high conc. of nutrients, pesticides, metals, industrial wastes and sewage. Elevated levels of Chemical Oxygen Demand (COD) in Sample # 1 and Sample # 2 are indicative of bad water quality.

Analysis of water samples taken from Balloki wetlands reveal that some of Balloki wetlands are being contaminated from toxic industrial and municipal wastewater from Ravi river leading to effect its water quality.

Contamination is posing a threat to fish and aquatic life in effected wetlands, and two species of waterfowl there. Contaminated wetlands were almost free from any species of waterfowl.

Conservation Measures taken by the Management Authority

Wetlands associated with Balloki barrage were declared as a wildlife sanctuary by the Irrigation and power department in 2002. For the purpose of preservation, management and conservation of wildlife and its sustainable development and for the establishment of private game reserves, approval of transfer of management/leasing rights of wetlands was made to Punjab wildlife and parks department on 21st May, 2009.

Suggestions for the Management Strategy of Wetlands near Balloki Headwork’s

On the basis of knowledge drawn from the study, the following recommendations are made.

- In order to minimize impacts to wetland water body, physical buffers should be used along the perimeter of the wetlands. A vegetation band along the perimeter of the wetlands can be taken as a buffer. Width or design of buffer to be applied is dependent on the nature of a resource to be protected. A suitable width or design of buffer should be applied.
- Wetlands act as a buffer for wildlife. A buffer of wider width should be used in the wetland perimeter to provide better conditions for wildlife management.
- Wetlands receiving contamination from industrial, urban and agricultural waste should be protected from such type of inputs by using water quality standards promulgated by the local government. Authority as being engaged in the management of wetlands should strictly adopt those standards.
- Land use activities in the surrounding area such as agricultural activity should incorporate best management practices. Agricultural activity should not incorporate toxic chemicals such as pesticides which are toxic to the aquatic life of wetlands. Instead, use should be made of slow releasing fertilizer formulations based on soil tests.
- Overgrazing should be controlled in the immediate vicinity of wetlands by removing domesticated livestock from grazing, when domesticated animals have grazed 50% of the forage plants of the study area.
- Access of livestock can overcome or prevented by the use of fences, signs, shrub hedges, on the perimeter of the study site.
- Harvesting should be managed in a sustainable way so that negative impacts to the area of wetland could be minimized. Best management practices should be implemented in order to carry out harvesting. Breeding of mosquitoes can be controlled in wetlands by the use of more natural pesticides.
- Pesticides toxic to fish and aquatic life of wetlands should not be used e.g. Organophosphates (melathion). Bacillus thuringensisisraelensis (Bti) is less toxic than melathion. Pesticides should be applied carefully.
- An integrated mosquito control approach can also be used. Predators of mosquitoes such as mosquito fish (Gambusiaaffinis) and killfishes (Fundulus Species) should be introduced as a part of integrated mosquito control program.
- Access of off-vehicles in wetlands near Balloki can be overcome by the use of post and cable barriers.
- In the study site, number, length and width of roads and trails should be minimized.
- Maximization of waterfowl production and animals comes under wildlife management. Inaccurate information, inadequate information, political pressure to modify management techniques can result in the failure of management. Management should be improved.
- Authority for the management of wetlands should incorporate conditions in license or permits regarding any development in the areas surrounding wetlands of Balloki. In thePermit or license, information should be included so that permitee should be aware of the restrictions on their use of wetlands.

- Regeneration of plants and forests can be enhanced by the use of buffers along the perimeter of the wetlands. Plants and forests play a role in providing habitats for wildlife.
- All the protective measures should be implemented by the authority managing the wetlands of Balloki that is wildlife and parks department or by the local government or citizen groups.
- The community should be encouraged to provide support for the protection of study site.
- Use of volunteers should be made in order to implement various protective measures for the study site.
- Volunteers should be taken from different conservation organizations and from different groups of citizens. Volunteers can also be taken from schools as the schools value the opportunity to gain environmental education and awareness.
- To prevent the spread of weed water hyacinth (Eichhorniacrassipes) in some wetlands of Balloki, several control mechanisms can be used which include biological controls, physical controls and chemical controls. The biological control method involves techniques such as water hyacinth eating insect controls.
- Biological control is the most widely used, easy to use and provides sustainable and economic control.
- Protection committees can be formed at the level of local communities.
- Various environmental awareness campaigns should be launched by the local government.
- In the entrance of wetlands near Balloki, display boards and wayside exhibits should be used by the management authority in order to provide awareness to visitors and the local community. Seminars and workshops should be arranged by the management authority or at local level.
- Staff of wildlife and parks department, Punjab should be trained for the conservation of natural resources.
- Adequate funding should be provided to wildlife and parks department so that they carry out their operations in an effective way. Private companies, agencies and organizations should be encouraged to invest.
- There should be strict adherence to laws and regulations regarding the protection of wetlands. Legislation should be improved regarding wetland protection and conservation by the local government. Local government should take legal steps in case of destruction of wetlands.
- Long term mechanism for the management and conservation of wetlands should be established by the management authority.
- Management system regarding wetland should be strengthened and technical innovation should be encouraged. Advanced concepts and techniques should be introduced in the conservation and restoration of wetlands.
- Help can be taken from the media. Publicity should be made and improved regarding the importance of wetlands.

- Protection should be provided by wetlands against any encroachment or alteration.

In the last, for an effective conservation of Balloki wetlands, local communities should appreciate wetland values, wise and sustainable use of wetlands.

A research paper can aid in providing knowledge and awareness among people and communities about the values of Balloki wetlands. The information provided can be utilized for the effective conservation of Balloki wetlands.

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