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Interventions on Watershed Management Programme in Wetalnds of Jaysagar for Fishery Purposes

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Abstract

Assam, India has around 43433.50 ha of swampy area constituting 0.55% of the total geographical wherein watershed management programme can be a boon in augmenting the economic condition of the native people. Jaysagar wet land area covering an area of 237hectares and depth of water varying up to three meter i.e. from 67m to 70 m amsl of Nagaon district in Assam is taken as a site for present study. Only few entrepreneurs or SHGs are engaged in fisheries with one pond. Production ranges from 500 kg to 1200 kg per pond per annum and results in an income of about INR25000 to INR50000. The wetland also has wet rice cultivated area, used for sustenance. This multi faceted study reveals there is a potential to up-scale the success of minor fishery ponds into well developed fishery tanks in this swamp area coupled with agricultural practices. As the seasonally alternating economic activities of fishing and cultivation are the mainstay of the people of the area, understanding of the wetland resources and services will further help in augmenting the economy of the dependent households through aquatic resources management and community based ecological management of this fast encroached Jaysagar.

Key words: *Watershed Management, Pisciculture, Aquatic Resource Management, Wetland Services.*

Introduction

Watershed management envisages in protecting and conserving water and aquatic ecosystems, including their associated riparian area. It has evolved and passed through several developmental stages. To start with it was a subject matter of forestry and forestry-related hydrology and issues related to people was beyond the horizon of study. Besides this it was solely an affair of government forest departments. This directly translates emphasis on study of land use activities and their corresponding effect on a watershed vis-à-vis ground and surface water quality and quantity. During the next stage, watershed management became a concern of land resources management-related issues, including economic activities with an eye on benefits for the user at community level. These beneficiaries gradually over time have been interwoven in to the process of watershed management and termed as "participatory and integrated" watershed management, i.e. with involvement and contribution from local people. Thereby at present 'Watershed Management Plan' look at hydrological aspects, aquatic ecosystems, riparian area, land use issues, economic aspects, resource utilization modalities for a holistic development.

In the context of India schemes like Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) were brought into the watershed mode in 1987, while Integrated Wasteland Development Programme (IWDP) launched in 1989 under the aegis of the National Wasteland Development Board also aimed at the development of wastelands on watershed basis. In 2001 a new set of guidelines for Watershed Development were formulated by the Department of Land Resources, Ministry of Rural Development, Government of India with a the broad objective to of 'promotion of the overall economic development and improvement of the socio-economic conditions of the resource poor sections of people inhabiting the programme areas'. These new guidelines included focused project approach with flexibility in implementation and removal of overlaps, greater role of women and Panchayat Raj Institutions (PRIs), inclusion of SHGs, credit facility and effective use of remote sensing data. All these are seen as innovative approaches and were interwoven in to this revised Watershed Management programme. This document does not contain any reference to wetland, but the statistics however include waterlogged and marshy land as one of the thirteen categories of wasteland.

The gain accrued from watershed management initiatives not only includes maintaining environmental health, but also strengthening livelihood options of people living in countryside. India, during past four decades, has achieved tremendously in the frontier of state of affairs of natural resources and human population. There have been many management practices and intervention strategies that have evolved from long learning process commencing from ancient and medieval India. With the current paradigm of watershed management approaches, watershed programs can become much more efficient and cost effective if the roles and responsibilities of all the partners and stakeholders are clearly defined and followed up for ensuring stricter accountability. In India a sizable amount of about Rs.1600 crores is invested annually in improving the conditions of watersheds (Chowdhary et.al. 2009). Watershed programs can become much more efficient and cost effective if the roles and responsibilities of all the partners and stakeholders are clearly defined and followed up for ensuring stricter accountability.

The whole set of new conceptual thinking for watershed is based on research and project experiences hydrology and ecology, human ecology and environmental economics. The importance impact of land use on the hydrological regime and quality of water downstream varies with the type of land use, the size of the watershed, climate, soil characteristics, topography, geology, etc. (Bosch and Hewlett, 1982; Bruijnzeel, 1990; Calder, 1999). Initially no public or decision-makers fully understood the relative importance of these factors and the need to consider the specific characteristics of each situation. This necessitated rethinking and integration of these system components using remote sensing and GIS technology as a basic input for watershed management. This induced for a change in enabling policies for a better natural resource management and poverty alleviation programme; site-specific micro-interventions within a common institutional, methodological and operational framework; scientific evidence based policies and finally raising awareness among local stake holders and the public (FAO,2006).

Wetland

As defined by Ramsar Convention (Ramsar Convention Secretariat, 2010). Wetland include a variety of land parcels. Wetlands were earlier despised form inhibiting transportation, economic development and responsible for spread of disease (Vileisis 1997. However environmentalists argued for these wetlands due to the high value of ecological functions (Bardecki 1984; Ewe1 1990; Meyer 1994; Mitsch and Gosselink 2000). Over time wetland has acquired a centre stage in environmental conservation programme of various Government and non-government agencies through wetland education conservation and restoration programme and incentives to the local community for their involvement.

Wetlands have various names viz. swamp, marsh, bog, fen, wet meadow, mire and slough (Moss 1980). These names are not synonymous rather categorised on the basis of physical characteristics and have different ecological functions. Thereby wetland management strategies depend upon understanding the wetland diversity (Willard and Darnel1 1982). These wide variety of wetlands provide many important services to human society, but are at the same time ecologically sensitive adaptive systems. Diagnostic survey, evaluation of functions and assessment of various aspects of individual wetland patches will help in better conservation and development programmes than generalisation of all categories into one. Generalizations about wetlands, the benefits they provide and their losses over time serve the useful purpose of beginning to apprehend this complex but important set of ecosystems (Meindl 2007).

One of the key features of understanding wetland for interventions is inventorization of these wetlands. International, National and State agencies all over the world are engaged in identifying and mapping wasteland including wetland with an aim to integrate with environmental management at watershed level and extending benefit to the local community in lieu of maintaining ecological balance.

Objectives

The study envisages in identifying the fishery ponds in a GIS environment to accurately assess the area as the area reported during household survey or information gathered from SHGs are not reliable. Secondly the dependency of people on wetland resources needed to be quantified to assess the magnitude of utilization of wetland services in the watershed area.

Wetland Mapping: Materials & Methodology

The Department of Land Resources has brought out the Wastelands Atlas of India in May 2000 in collaboration with NRSA Hyderabad. Wastelands of India Atlas contained thirteen categories of wasteland and share of waterlogged/marshy land constituted 1.66 million hectares amounting to 0.52% India’s geographical area. The estimates differed from previous estimates by NBSS&LUP in 1994, National Wasteland

Development Board in 1985 due to various technical and scale related differences. The sub group V of the Planning Commission on Natural Resources Management emphasised the importance of standardisation and a consortium of NRSA (now NRSC) and ICAR institutes was formed to resolve these issues and arrive a logical and scientific estimate of land degradation. In 2010 ICAR and National Academy of Agricultural Sciences published 'Degraded and Wastelands of India: Status and Spatial Distribution' with state and district specific data. However its methodology for mapping based on GIS analysis included spatial layers of water erosion (soil loss), salt-affected soils, acid soils; lands affected by wind erosion, dense forested and open forest layers and did not adhere to wasteland categories. Wet land finds no mention in it. In 2011 National Wetland Atlas database was prepared by Ministry of Environment and Forests, published by SAC and ISRO was an outcome of project on National Wetland Inventory and Assessment (NWIA). It contained a updated database and status of wetlands, compiled in an atlas format.

Mapping of wetlands and corresponding statistics worked out by ISRO for India is based on use of IRS P6- LISS III satellite data. There are nineteen classes of wetlands have been identified with six classes under 'Inland: natural wetland'; four classes under 'Inland: man-made wetland'; seven classes under 'Coastal: natural wetland' and two classes under 'Coastal: man-made wetland'. Panigrahi et.al. (2012) explain the details of methodology adopted for the three level classification of wetland that follows Ramsar definition. All wetland having geographic area above 2.25ha are mapped as polygon and small wetlands with less than this are mapped as point in the GIS environment. Wetland parameters like areal extent, pre and post monsoon water spread, aquatic vegetation spread and turbidity of open water have been used in characterising layers of information. Data base is designed at 1: 50000 with standards of National Spatial Framework (NSF) and National Natural Resource Management System (NNRMS) and total estimated area is 15260572ha. The mapping has been done using LISS III data having a spatial resolution of 23.5m that does not provide a microscale or locality level mapping and characterisation of wetland.

Methodology for deriving wetland used by ISRO is based on five indices that enhance various wetland characteristics (McFeetres, 1986; Xu Hanqiu, 2006; Lacaux et al, 2007; Townshend and Justice, 1986; Tucker and Sellers, 1986):

i. Normalised Difference Water Index (NDWI) = (Green-NIR) / (Green + NIR)
ii. Modified Normalised Difference Water Index (MNDWI) = (Green-MIR) / (Green + MIR)
iii. Normalised Difference Vegetation Index (NDVI) = (NIR - Red) / (NIR + Red)
iv. Normalised Difference Pond Index (NDPI) = (MIR – Green / MIR + Green)
v. Normalised Difference Turbidity Index (NDTI) = (Red – Green) / (Red + Green)

One of the easiest methods for mapping wetland is the Image classification using any classifier algorithm (e.g. Parihar 2012). Other method for wetland mapping uses a logit model that provides a binary outcome about presence wetland. It uses ASTER (Advanced Space borne Thermal Emission and Reflection Radiometer) incorporates geographic data base, hydrological data, Digital Elevation Model (DEM), slope, wetness index (Pantaleoni, 2009).

At locality level delineation of wetland will be effective and precise when digitised from high resolution satellite images. In the present context very high resolution image of 30th April 2003 from open source has been used for digitising boundary of watershed, Wetland boundary, fishing pond extension and canals.

Wetland/Swamp area in Assam

Assam located in the north eastern part of India, is the eastern most projection of Indian Plate. The extreme geostatic pressures exerted on the landmass during the creation of the Himalayas have resulted in Assam having large areas of sedimentary deposits. Alluvium, both Recent and Pleistocene is the wide spread formation along the River Brahmaputra. Brahmaputra Valley is about 80 to 100 km wide throughout its course in Assam. The course of Brahmaputra is braided due to high quantum of discharge and sediment flux coupled with very gentle longitudinal and thawleg profile. Reconstruction of planform changes over a period of 90 years in the upper reaches of the Assam valley shows that the 240-km-long channel belt is widening all along its course in the region. From the average width of 9.74 km in 1915, the channel belt has widened to the average width of 14.03 km in 2005 (44% widening), and in certain reaches the average widening is as high as 250% (Lahiri, S.K.et. al. 2012). This widening of braided valley system coupled with abandoned channels, oxbow lakes provide a geomorphologic set up favourable for wetlands.

ISRO's mapping of wetlands in Assam has 5097 number of wetland units at 1:50000 scale. Besides this 6081 small wetlands (<2.25 ha) have been identified. In total, these wetlands cover an area of 764372ha out of the State's geographical area of 78438km2 constituting 9.74%. It is placed at ninth position in terms of state wise wetland area and has 5.01% of total wetlands in India (ISRO, 2011). Out of different types of wetlands in Assam, Rivers and streams constitute 83.63% of total wetlands 637164ha out of total wetland area of 764372ha. Lakes and ponds cover an area of 51257ha. Natural waterlogged units are 2461 in number and cover area of 47141ha i.e. 6.17% of total wetland. There are 139 riverine wetlands (swamp and marsh) in Assam that cover 4258ha and stand fourth after Uttar Pradesh, J&K and West Bengal.

Nagaon district situated in the southern bank of Brahmaputra occupies an area of 3976 km2. Total wetland area in the district is 35659 ha including 233 small wetlands (2.25ha) as per the estimate of SAC 2010. Waterlogged areas cover an area of 12682ha at 410 land parcels and constitute 35.53% of total wetland area. River/Stream based wetlands spread over an area of 12308ha and rank second in terms of geographic area among variety of wetlands. Lakes and ponds estimated to be present in 178 units and cover an area of 8670ha. There are 41 oxbow lakes/cut-off meanders covers an area of 1198ha and constitute 3.36% of total wetland in the district.

Jaysagar Wetland

Jaysagar is located along the southern bank of River Brahmaputra, in the district of Nagaon, Assam (Fig.1). It extends from

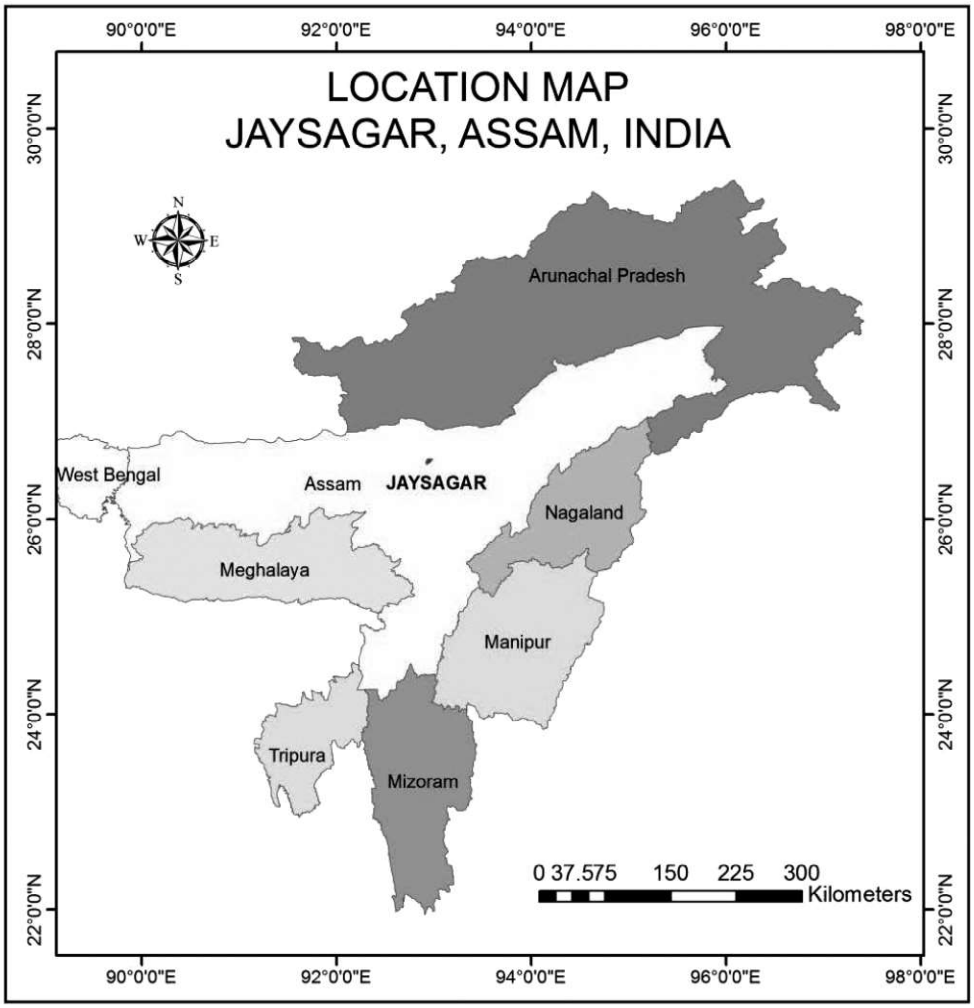

Fig. 1 : Location of Jaysagar Watershed

26°36'56.48"N to 26°33'10.21"N latitude and from 92°55'04.27"E to 92°59'17.56"E longitude. It covers an area of 2580.6745 hectares as mapped from the 30 April 2003 Digital Globe image as available on Google Earth. Landsat ETM image with band 7, 4 and 2 of 17 February 2002 with 15.5 m resolution provides a fair contrasting image of the Jaysagar wetland but boundary delineation is less accurate than from the Google Earth Image due to coarse resolution. Categorisation done by ISRO group using Ramsar Scheme is 1102 i.e. Ox-bow lakes/ Cut-off meanders. However geomorphologically there is no evidence of any ox bow lake or meander in this small parcel of land. The hill forming the northern side of the watershed with an altitude of above 200 m extending for 3.8km is structurally forming this depression and may be categorised as waterlogged wetland. The deepest part of the wetland has an altitude of 69m with 76m to 71m altitude water divides on western, southern and eastern part of the watershed of Jaysagar wetland. Area of Watershed is 2580.6812 ha with a perimeter of 25410m. The waterlogged area as delineated from 2003 image is 236.9144 ha with a perimeter of 8805m. (Fig.2)

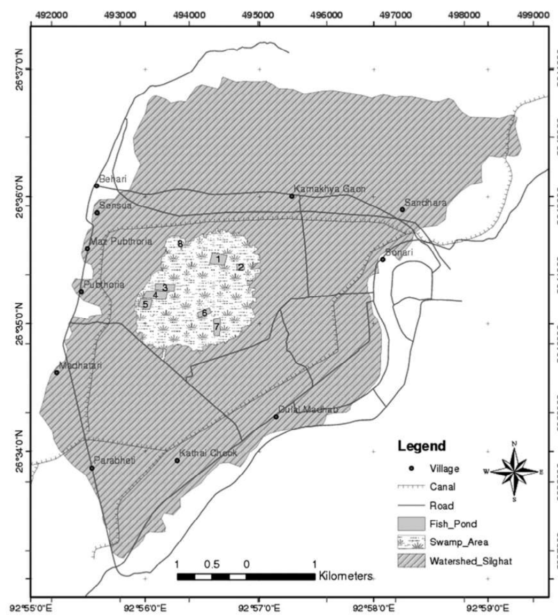

Fig. 2 : Jaysagar Watershed components

Table 1 : Fish pond Area_Jaysagar

Sl. No	Owner of Fish Pond	Perimeter	Area Hectare
1	Dhana Bora	742	3.3095
2	Kamakhya Farmers	386	0.9225
3	Madhatari SHG	757	2.5894
4	Banijik SHG	874	3.6665
5	Hita Kankhi SHG	637	2.3187
7	Montu Bora	534	1.4612
8	Block	678	2.2995
9	Sensua Farm-ers	339	0.4607
		Total	17.028

Wetland Resources and Service

Wetland provides a variety of resources and services that include habitat for fish and pisciculture, wildlife, flood protection, water quality improvement and aesthetic value. Wetland valuation for its resources and services is done using a variety of methods each having its advantages and limitations (Gustavson, et.al. 2010). Valuation is done on the basis of its direct uses for biological wetland functions like agriculture, food production etc. Indirect uses like flow modification, climate regulation, support for biodiversity, carbon sequestration etc. and passive uses. Wetland functions are not limited to the tangible components rather have cascading effect on surroundings. One of the commonly used methods for valuing how environmental quality wetland resources and services affect market price of property is hedonic model. Bin (2005) has utilised this model for assessing the property value of neighbouring area as the services provided by wetland cannot be properly valued or priced and found that 'proximity to open water wetlands has a positive association with property values, while the other types of wetlands have either a negative or insignificant relationship'.

Ramchandra et.al (2003) provided a technical report with valuation procedure, data requirement, appropriate appraisal method along with examples from lakes of Bangalore. Economic valuation of wetland in Kalobaur beel (wetland) of west Bengal was done considering the two management patterns: a) owners operated, i.e., when wetlands owners carry out the fisheries operation; and, b) lease holders operated, i.e., when fisheries operation is leased out to private operators (Mukherjee, 2008).

Jaysagar wetland (Figure. 2) is currently is used a patch of wasteland without much economic use except for limited fish farming (Photo 1). The buffer area of swamps as shown in the figure 1 is used for agriculture. A survey was conducted recently for this paper on production and economic value of fish produce. Fish production is around 500 to 1200 kg per pond in the Jaysagar (Table 2.). Pisciculture is not the primary source of income among the entrepreneurs, still it augments their income. Utilization of wetland resource is limited and underutilized. The recent advances in understanding the wetland services have so far not been utilized too evaluating wetland capabilities.

Table 2. Expenses and Income from pisciculture

Name of owner	Financial assistance received (Rs.)	Area of the pond (bigha)	No. of ponds	Initial investment (Rs.)	Maintenance (Rs.) annually	Production of fish (kg) annually	Income (Rs.) annually
Ranjit mahanta	0	3.00	1	200,000	150,000	1,000	40,000
Hatbor block old	50,000	5.00	1	100,000	75,000	1,000	40,000
Montu Boruah	60,000	4.00	1	75,000	50,000	700	30,000
Hitakankhi SHG	75,000	5.00	1	150,000	100,000	1,200	50,000
Joysagar Banijik SHG	55,000	5.00	1	150,000	100,000	1,000	50,000
Madhotari SHG	60,000	5.50	1	200,000	100,000	1,200	50,000
Sensua farmers	35,000	3.00	1	100,000	50,000	500	25,000
Kamakhya farmers	40,000	3.50	1	75,000	40,000	500	30,000

However, the traditional evaluation of wetland resources has been replaced by a new paradigm for wetland research. The agenda include: hydrology, wetland origins and development and linkages to society (Maltby, 2011). Besides the assessment and valuation benefits and losses accrued from of wetlands, another component that needs attention is its vulnerability. A study of vulnerability of Rupa Lake, Nepal provides an insight how a simple method can be utilised to construct a matrix, similar to Leopold matrix, for combining value or threat scores and use the same to prepare a site management plan (Stratford, 2011).

Interventions on Watershed Management Programme

Managing the wetland resources effectively and sustainably is increasingly challenging and important because wetlands are still being lost through drainage, infilling or inappropriate management, yet it is becoming ever more evident that the services they provide are vital for society (Millennium Ecosystem Assessment, 2005). Wetlands are highly productive ecosystems that provide a number of opportunities for generating income by the native people. Evaluation of wetland using an integrated approach comprising wetland modelling based on water-quality parameters, to understand the dynamics of the ecosystem, followed by the estimation of economic benefits among various stakeholders and the exploration of incentive-based mechanisms and their role in the alleviation of poverty (Verma et.al., 2011) would help in formulating a intervention plan. The vital component of intervention is the inclusion of the stake holders or the native populace. Public participation in environmental management has been increasingly common in all sectors of management including wetland management. The basic premises of such exercise are targeted to enrich the intervention scheme to be improved from public input in the forms of local knowledge and data contributions (Johnson, 2008). However care must be taken at the outset to ensure that public participants appreciate what modelling can and cannot provide so that modelling activities are best able to inform watershed management decisions.

5. Results and Discussions

Jaysagar is one of the riverine wetland in Assam. It covers an area of watershed is 2580ha and the wetland part at the centre of it covers an area of 237 ha. The wetland is surrounded by agricultural field. The wetland is has few stake holders for direct use and management. Few single entrepreneurs and few self help groups (SHG) use the wetland for pisciculture with small fish ponds. The benefits accrued to them are significant in terms of augmenting their income. Fish farming done by the farmers is traditional in nature. Scientific management of fish farms are yet to be taken up by the farmers.

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