

ECONOMIC VALUATION OF WETLANDS

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ECONOMIC VALUATION OF WETLANDS

SUMMARY

Aquatic ecosystems sustain life on earth, regardless of mankind's understanding of the biology, chemistry, and geology involved. Population increase coupled with intense anthropogenic activities and unplanned developmental activities have impaired the ecosystems' functions and are resulting in the extinction of these fragile ecosystems. The consequence may be long term and possibly irreversible changes. Such changes reduce the value of the ecosystem, even affecting the economy. Understanding of functions and values of the ecosystem is crucial for appropriate decision making. The decisions with the holistic ecosystem approach ensure the sustainability of the ecosystems. This paper with case studies discusses the valuation of ecosystems considering the direct, indirect and existence benefits. The economic valuation of wetlands helps to understand the constituents' functions and benefits and this exercise could act as a catalyst for wetland conservation. The services provided by these wetlands are innumerable and these values are often lost through inappropriate development or used inefficiently due to lack of knowledge about the vital functions performed by them. Linkages between use values and ecosystem functions are to be highlighted to raise awareness among the users. The role of the stakeholders especially public and private sectors in managing the ecosystems in a sustainable manner has been outlined while evolving the management strategies.

1.0 INTRODUCTION

Wetlands inhabit a transitional zone between terrestrial and aquatic habitats, and are influenced to varying degrees by both. They differ widely in character due to regional and local differences in climate, soils, topography, hydrology, water chemistry, vegetation, and other factors. Depth and duration of inundation, a key defining force, can differ greatly between types of wetlands and also can vary from year to year within a single wetland type. As per the definition adopted at Ramsar Convention (Iran in 1971), "Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing; fresh, brackish, or salty, including areas of marine water the depth of which at low tide does not exceed six meters."

Wetlands are categorised as inland (also known as non-tidal, freshwater wetlands) and coastal (also known as tidal, salt water or estuarine wetlands) (Barbier et al, 1997). In addition to these, man-made wetlands have also been included under wetland classes. Inland wetlands receive water from precipitation, snowmelt, ground water, and runoff. Coastal and

estuarine wetlands receive water from precipitation, surface water, tides and ground water discharge.

Wetlands due to their biological, ecological, social, cultural and economic values form an important component of the environment. They provide habitats and support diverse range of biodiversity (e.g., in one square meter of coral reef there can be up to 3000 species <http://www.kenya-wildlife-service.org/wetlands.htm>). Wetlands undertake important biological and ecological processes including life support systems i.e. water and carbon cycles. Hence, they are important for hydrological functions, and economic, social, spiritual and cultural development.

2.0 VALUATION OF WETLANDS

Economic valuation is a powerful tool to aid and improve wise use and management of global wetland resources by providing a means for measuring and comparing the various benefits of wetlands (Edward B Barbier et al, 1997). The following are some of the terms used while quantifying the wetland benefits.

Wetland Processes: The fundamental hydrological, chemical and physical activities that occur in a wetland that are linked to its biological productivity. For example, the role of wetlands in the global carbon cycling.

- **Functions:** The results of the interaction of the wetland's ecological processes. Functions are the physical, chemical, and biological processes occurring in and making up an ecosystem. Processes include the movement of water through the wetland into streams or the ocean; the decay of organic matter; the release of nitrogen, sulphur, and carbon into the atmosphere; the removal of nutrients, sediment and organic matter from water moving into the wetland; and the growth and development of all the organisms that require wetlands for life.
- **Benefits:** The goods and services made possible by a wetland's functions. For example, by reducing wave energy and stabilising shorelines, the wetland reduces the chances of property damage. This reduced risk is a benefit to society.
- **Value:** The economic worth of goods or services, generally measured in terms of what individuals are willing to pay for (e.g., the wetland has value because it supports commercial fishery).

The value of the benefit is determined by its price, i.e., the amount of money for which it will be exchanged. The value of a benefit is the price of that product in the open market and

the worth of that benefit to a potential buyer. This is measured in economic terms as willingness to pay. In other words, the economic value of the wetland services/commodity is measured by people's *willingness to pay* (WTP) for those benefits. The economic valuation is essentially quantification of the environmental goods and services, and the values of human beings for the environment.

2.1 Quantification of economic values of wetlands

The economic value of environmental goods and services/commodity is measured by the summation of many individuals' willingness-to-pay for it. In turn, this willingness-to-pay (WTP) reflects individuals' choice for the goods in question. Therefore, economic valuation in the environment context is about measuring the preferences/choices' of people for an environmental benefit or against environmental degradation. Valuation is therefore in relation to preferences held by people. Moreover, the use of economic values permits the comparison that is required between environmental' and 'developmental' values. The latter is expressed in fiscal/monetary terms, either in rupees or as economic rate of return [<http://www.wes.army.mil/el/vrtc/wrp/tnotes/wgev2-1.pdf>]. Using other units to measure environmental values would not permit the comparison with development values. The economic value of wetlands includes both use and non-use values. Typically, use values involve some human 'interaction' with the resource whereas non-use values do not. Wetland use values are associated with a diverse and complex array of direct and indirect uses. Wetland "values" may be derived from outputs that can be consumed directly, such as food, water supply, recreation, or timber; indirect uses which arise from the functions occurring within the ecosystem, such as water quality, and flood control; possible future direct or indirect uses such as biodiversity or conserved habitats; and the knowledge that such habitats or species exist (known as existence value) (Serageldin, 1993)

Values are "an estimate, usually subjective, of worth, merit, quality, or importance". Direct uses of wetlands could involve both commercial (marketed value) and non-commercial activities whereas indirect use values are unmarketed, go financially unrewarded and are only indirectly connected to economic activities. A special category of value is *option value*, which arises because an individual may be uncertain about his or her future demand for a resource and/or its availability in the wetland in the future. If an individual is uncertain about the future value of a wetland, but believes it may be high or that current exploitation and conversion may be irreversible, then there may be *quasi-option value* derived from delaying the development activities. The *quasi-option value* is the value that society would place on wetlands, if all knew the complex functions of wetlands. Uncertainty is acceptable in non-economic valuations, but must be accounted somehow in economic valuations. *Quasi-option value* is a concept allowing expert scientists to define wetland value. In contrast, *non-use values*, often referred as intrinsic or existence values are difficult to

measure, as they involve subjective valuations by individuals unrelated to either their own or others' use, whether current or future. An important subset of non-use or preservation values is *bequest value*, which results from individuals placing a high value on the conservation of tropical wetlands for future generations to use. Bequest values may be particularly high among the local populations currently using a wetland, in that they would like to see the wetland and their way of life that has evolved in conjunction with it passed on to their heirs and future generations in general. Table 1 lists various use and non-use values of wetlands.

Table 1: Classification of total economic value for wetlands

Use Value/Benefits			Non-Use Value/Benefits
Direct Use Benefits	Indirect Use Benefits	Option and Quasi-Option Benefits	Existence Benefits
recreation - boating - fauna (birds, etc) - wildlife - viewing - walking - fishing commercial harvest - fish - fuelwood - transport - nuts - berries - grains - peat/energy - forestry -Wildlife harvesting - agriculture	-nutrient retention -flood control -storm protection -groundwater recharge -external ecosystem support -micro-climatic stabilisation -shoreline stabilisation, etc -water filtration -erosion control	-potential future uses (as per direct and indirect uses) -future value of information, e.g , pharmaceuticals, education	-biodiversity -culture -heritage -bequest

Source: Adopted and modified from Barbier et al 1997.

In general, the direct use of marketed products of ecosystems is easier to measure since marketed products exist and their prices may be adjusted for distortions. In contrast, ecological functions, such as groundwater recharge or discharge, may have indirect use values, which are reflected in the economic activities these functions support. Usually, changes in the well being or *social welfare* are used to define and quantify economic value. Therefore, valuing a good or service requires one to study the change in a person's welfare due to a change in the availability of the resource. The purpose of economic valuation is to reveal the true costs of using scarce environmental resources.

2.2 Need for Economic valuation of wetlands

Specific major reasons for economic valuation of environmental goods and services are:

- (i) The need for economic valuation of environmental impacts and assets arises for pursuing efficient policies and investing in efficient projects and programmes. At the most general level of intergenerational concern, valuation is still required. If transfers of resources are to be made between generations -- with the current generation sacrificing for the future, or future benefits being lost for the sake of present gain -- then it is essential to know what is being sacrificed and how much it is that is being surrendered.

[<http://www.unep.org/unep/products/eeu/ecoserie/ecos14/ecos141.htm>].

Macroeconomic management records monetary flows and transactions within the economy. The national accounts are widely used to indicate well-being and rates of change, and national aggregates such as Gross Net Production (GNP) are widely construed as measures of 'development'. Whether the accounts are designed to record economic activity or measure well-being, or both, they are deficient with respect to their treatment of the environment. Economic activity involves the use of materials and energy, and, once transformed into products, the same resources become, sooner or later, waste products. Any measure of economic activity, which ignores these materials and energy flows, will fail to record important activities that affect the sustainability of the economic activity. For these reasons, there is a need for widespread consensus so that the national accounts are modified and environmental 'stocks' and 'flows' are recorded. Depreciation in the stocks of natural resources requires proper valuation to ensure sustainability.

[<http://www.unep.org/unep/products/eeu/ecoserie/ecos14/ecos141.htm>].

- (iii) Information on the economic values of policy changes (with regard to the environment) can greatly assist the in identifying the policy and sectoral priorities. Economic valuation incorporating environmental aspects helps in evaluating developmental projects, programmes and policies.

2.3 Market price and wetland benefits

Individual's Willingness to pay Vs Market price: In the environmental context, it is required to quantify ecosystem benefits in terms of priced goods (i.e. the private goods, which have market value, e.g., fish) and unpriced goods (i.e. the public goods, which have no market value, e.g., clean air, water). The market price is a measure of the minimum that some people are willing to pay for a benefit - they will buy goods/commodity, for example,

if their willingness to pay is equal to or more than the market price. There are also many other forms of value beyond market economic terms including subjective and intrinsic values, which are particularly important in environmental conservation in general, especially for wetlands. Therefore, in considering the value of natural areas such as wetlands, trying to determine people's willingness to pay for benefits ranging from aesthetic beauty to recreational opportunities to clean water is very important.

The problem with using willingness to pay to measure the value of wetlands is that it requires a carefully designed survey, as it is not as straightforward as market price. Nevertheless, there is growing evidence of consumers' willingness to pay for ecological benefits. Trends such as the growing demand for ecologically certified wood products, organic foods, shade-grown coffee, and other goods and services with an environmental advantage, suggest that there is increasing market recognition of the economic value of preserving natural areas and processes. It involves finding a willingness-to-pay measure in circumstances where markets fail to reveal that information directly.

Market Failure: Economic decisions of developmental projects, which exclude ecosystem values, lead to ecosystem degradation. Economists trace this problem to market failure, that is the failure of markets to reflect the full or true cost of goods or services. In the case of a wetland, the calculation of the economic value for converting the wetland area to housing or commercial layouts does not include costs such as loss of water quality/quantity or flood control. Since these ecosystem services are available free to all and not purchased, there is a tendency to neglect the quantification of the vital function of these ecosystems and indirect benefits derived from them. It is only when these services are lost, the actual financial or commercial costs are incurred. So paradoxically, the zero price for wetland services is of very high value to human well-being. Since it is difficult for an individual owner to receive direct monetary benefit for those benefits, which a wetland provides to others (e.g., downstream water quality improvement or producing waterfowl which migrate elsewhere), the true value of such benefits is generally not taken into account in land use decisions [http://www.on.ec.gc.ca/wildlife/factsheets/fs_wetlands-e.html].

[http://www.ramsar.org/key_rec_7.01e.htm]

The factors that contribute to market failure in the case of natural systems are:

Distribution of costs and benefits between owners and non-owners: Unlike other assets, a wetland may deliver more benefits to the community (food, fodder, recreation, etc.) than to an individual owner. Compared to the general community, the individual owner may receive only a small proportion of benefits, such as groundwater replenishment, and therefore will tend to undervalue these benefits.

The tragedy of commons: With a widely shared resource there is little incentive for an individual to control activities to benefit others. For example, a wetland may support large populations of waterfowl, but without any sort of limits or fees, there is no incentive for any individual harvester to limit the number of waterfowls taken for incentive or bait, food or classroom experiment. The result would be a rapidly shrinking waterfowl population and the reduction of a specific benefit for everyone who uses the wetland.

Missing costs: The market price of a commodity may not reflect all the production costs. For example, if an industry disposes its effluents into a stream that feeds into a wetland, the economic damage done to the wetland, whether it's fewer fish produced or impaired water quality, is not reflected in the market price of the goods. In other words, the market does not include the lost economic value of the wetland in the company's production costs.

Cumulative effects: When taken together, a combination of relatively small incremental changes to a wetland or a number of wetlands within a watershed, can have more dramatic effects than those recognised when individual changes are made. These cumulative effects result from past, present and future changes and are difficult to recognise and assess physically as well as economically in part because of the dynamic nature of the ecosystems. The ability to measure value is also limited by the understanding of the ecological functioning and the benefits that wetlands provide for ecosystem stability. This lack of ecological understanding undervalues wetland benefits that contribute to market failure

[http://www.on.ec.gc.ca/wildlife/factsheets/fs_wetlands-e.html]

Counteracting Market Failure: To counter the problem of market failure, it is necessary to find ways to calculate the economic value of wetland benefits in a way the market understands – in financial terms. This helps both the individuals and policy makers to easily compare alternative uses and policy options. A value for the economic benefits that would be lost through the development of a wetland, for example, could prompt policy makers to put resources into the conservation of the wetland instead. Similarly, such evaluations can lead to a better understanding of tax incentives, rebates or subsidies that could give individuals an economic incentive to retain a wetland. In effect, the community can purchase the wetland services from the individual, through which one can provide panacea for market failure to some extent

[http://www.on.ec.gc.ca/wildlife/factsheets/fs_wetlands-e.html].

3.0 VALUATION PROCEDURES

3.1 Choosing the appropriate assessment approach

The first stage in the evaluation process is to choose appropriate economic assessment approach based on the problems confronting the analyst. There are three approaches or issues most relevant to the economic analysis of wetlands. They are as follows:

- (i) **Impact analysis** – would be appropriate, if the problem is a specific external impact (*e.g., effluent from a textile industry polluting a wetland, oil spills on a coastal wetland, etc*)
- (ii) **Partial valuation** - would be suitable, if the problem is the necessity of making a choice between wetland use options (*e.g., conversion of wetland to residential land or sports complex, whether to divert water from the wetlands for other uses, or to convert/develop part of the wetlands at the expense of other uses*).
- (iii) **Total valuation** - if the problem is more general (*e.g., developing a conservation/restoration strategy requires assessment of total net benefits of the wetland system*).

Total economic value can be expressed as: $TEV = \text{Direct Use Value} + \text{Indirect Use Value} + \text{Option Value} + \text{Existence Value}$

3.2 Defining the wetland area

The second stage in this process is to define the wetland area and specify the system boundary between this area and the surrounding region based on maps of land use/land cover (*e.g., agricultural use, vegetation etc.*), flood extent and soils. The boundary of the wetland along with land use and land cover in the catchment / basin is to be mapped, using remote sensing data, Survey of India (SOI) maps or any other maps.

3.3 Identifying and prioritizing wetland resources

The third step involves using various data sources, including scientific studies, consultancy reports and national resource inventories, to produce a more definitive list of components, functions and attributes present in the wetland, and then place them in their order of importance. This may be in rank order, say 1 to 10, or expressed as being high, medium or less significant based on its importance. Clearly, no single wetland will exhibit all of these, and it is important for the multidisciplinary team to work together to identify the key

components, functions and attributes of the wetland being studied and to use all the available ecological, hydrological and economic information to score these various characteristics

3.4 Relating wetland resources to use value and gathering information required for assessment

The fourth step is to determine whether each of the wetland resources (e.g., components, functions and attributes) is associated with direct, indirect or non-uses. Different physical, chemical and biological data will be required depending on the values that are to be assessed, and the methodology for collecting and analysing the data must be specified.

Interviews with local communities, census data and consultancy reports are usually good sources of information on direct use. For example, obtaining agricultural and fish yields may involve interviews with farmers and fishermen, collection of statistics from government offices and visits to markets.

An indirect use value requires detailed field investigations, concentrating on the physical links between wetland system functioning and the economic activities affected. For instance, to assess hydrological functioning, water quality, sedimentation, pollution retention analysis, etc., are required

Option, quasi option and existence values – may be more difficult to determine, and it will often be done with the help of the multidisciplinary team, keeping in mind the difficulties of quantifying these values.

Data collection begins with a *literature survey* of available statistics, existing studies, and their analysis for the region, which may yield some of the required information. Next, site surveys of specific economic activities have to be undertaken. In the first instance, a *rapid rural appraisal* based on brief interviews with farmers or producers would help to collect basic information on human uses and economic data. More detailed *baseline surveys* may be required for in-depth data collection for actual valuation purposes. In all cases, it is important to be clear in advance about the information required so as to avoid collecting 'data for data's sake'.

3.5 Quantifying economic values

Interviews with local communities, census data and consultancy reports are usually good sources of information in calculating the wetland resources. Various valuation techniques are:

(i) *Market prices method*

- The prevailing prices for goods and services traded in domestic or international markets are used for quantifying wetland resources.
- Market prices reflect the private willingness to pay for wetland costs and benefits that are traded (e.g., fish, timber, fuel wood, recreation, etc).
- Price data are relatively easy to obtain.
- Market imperfections, policy failures and seasonal variations may distort market prices, which will therefore fail to reflect the economic value of goods or services to society as a whole.

(ii) *Efficiency prices method*

- Use of market prices but adjusted for market imperfections and policy distortion.
- Shadow prices may also be calculated for non-marketed goods.
- This reflects the true economic value to society as a whole, 'artificial' prices may not be accepted by the decision-makers.

(iii) *Travel cost approach*

- Widely used to estimate the value of recreational sites including public parks and wildlife reserves in developed countries.
- The travel cost approach derives willingness to pay for environmental benefits (e.g., eco-tourism).
- It needs information on the amount of money and time that people spend to visit the location.

(iv) *Contingent valuation method*

- Contingent valuation surveys directly ask people what they are willing to pay for something they value or are willing to receive in compensation for tolerating a cost.
- Personal valuations for increase or decrease in the quantity of some goods based on a hypothetical market. The aim is to elicit valuations or bids, which are close to what would be revealed if an actual market existed.

(v) *Hedonic pricing method*

- Hedonic pricing has the potential for valuing certain wetland functions (e.g., storm protection, groundwater recharge, etc) in terms of their impact on land values, assuming that the wetland functions are fully reflected in land prices.
- The value of an environmental amenity (such as a view) is obtained from property or labour markets. The basic assumption is that the observed property value (or wage) reflects a stream of benefits (or working conditions) and that it is possible to isolate the value of the relevant environmental amenity or attribute.
- Application of hedonic pricing to the environmental functions of wetlands requires these values to be reflected in surrogate markets. The approach may be limited where markets are distorted, and choices are constrained by income and information. Information about environmental conditions is not widespread and data are scarce.

(vi) *Production function approach*

- Estimates the value of a non-marketed resource or ecological function in terms of changes in economic activity by modelling the physical contribution of the resource or function to economic output.
- Widely used to estimate the impact of wetlands and reef destruction, deforestation, water pollution, etc., on productive activities such as fishing, hunting and farming.

(vii) *Related goods method*

- Utilises information about the relationship between non-marketed goods or services and a marketed product to infer value.
- The *barter exchange approach* relies on actual exchange of non-marketed goods and this approach requires information on the rate of exchange between two goods.
- The *direct substitute approach* simply assumes that marketed goods can be substituted for non-marketed goods and requires information on the degree of substitution between two goods.
- The *indirect substitute approach* also relies on substituted goods, but if the latter is not exchanged in the market its value is inferred in terms of a change in economic output (i.e., the direct substitute approach combined with the production function approach). This indirect substitute approach requires information on the degree of substitution and contribution of the substitute goods to economic output.

These approaches may provide a rough indicator of economic value, subjected to data constraints and the degree of similarity or substitutability between related goods.

3.6 Implementing appropriate appraisal method

In the ultimate step, the economic analysis of the wetlands should be placed in the appropriate framework as preferred during the planning for the study. For instance, ***cost-benefit analysis (CBA)***, normally involves calculating on an annual basis the benefits and costs of conserving the natural wetland functions, products and attributes over a selected time period. The three most common methods for comparing costs and benefits are net present value, internal rate of return and benefit-cost ratio. Valuation exercise is normally subjected to sensitivity analysis, which defines the variation in results arising from different assumptions or benchmark values used in the study, such as discount rates.

The other possible available appraisal methods are as follows:

Environmental impact assessment - this framework is used where there is a need for detailed documentation of essential environmental impacts, adverse effects and mitigation alternatives.

Cost-effective analysis (CEA) - it selects land use option that will minimise costs of realising a defined non-monetary objective. In this case, there is no need to value benefits, but to focus on cost information that is more readily available and provides implicit values of objectives.

Multi-criteria analysis - this involves mathematical programming techniques to select options based on objective functions including weighted goals of decision-makers with explicit considerations of constraints and costs.

Risk assessment or risk-benefit analysis - this evaluates benefits associated with a land use option in comparison with risks.

Decision analysis (DA) - this involves step-by-step analysis of the consequences of choices under uncertainty.

These appraisal methods may also require economic valuation as part of the assessment procedure. Initial planning of the study should determine which framework is desirable for assessing costs and benefits, as the choice of framework may affect all the above steps in the analysis.

4.0 DATA REQUIREMENT FOR EVALUATION

The following are some of the data collecting techniques useful in quantifying various resources or activities.

- **Resource/Activity:** *Wetlands*

Valuation Method: *Change in Productivity Method or Contingent valuation method*

Data Requirement:

- (i) Type of wetland products,
- (ii) Cost of production and price information for these wetland products (for fisheries, wildlife harvesting information etc.) will be necessary,
- (iii) Spatial extent of wetlands (temporal changes in spatial extent),
- (iv) Number of individuals depending on wetland, and
- (v) Extent of wetland damage due to adverse weather conditions.

- **Resource/Activity:** *Agriculture*

Valuation Method: *Change in Productivity Method or Contingent valuation method*

Data Requirement:

- i). Area and crop productivity for different crops,
- ii). Itemised cost of production per hectare by crop (fixed and variable costs),
- iii). Output prices by type of crop (on-stand price and market price),
- iv). Harvesting costs,
- v). Percentage sold in export market for crop,
- vi). Time series data on rainfall and production, and
- vii). Incidences of crop damage due to adverse weather conditions.

- **Resource/Activity:** *Fisheries*

Valuation Method: *Change in Productivity Method, Market prices method, or Contingent valuation method*

Data Requirement:

- i). Catch/effort,
- ii). Size of the fishing fleet (including the number of fishermen),
- iii). Cost of fishing (wages and fuel costs),
- iv). Prices of fish by species (ex-vessel),
- v). Species composition of catch,
- vi). Type of fishing gear,

- vii). Boat capacity and type,
- viii). Area of wetlands,
- ix). Water quality, and
- x). Any other information relevant.

5.0 OTHER REQUIREMENTS FOR THE VALUATION STUDY

Resources required for a valuation study: Economic valuation of a wetland is based on quality data, which in turn depends on availability of resources that is required for collecting and analysing the data. For instance, primary data collection for several valuation surveys may be required, involving several hundred man-days of work, including training of survey staff, interviews, analysis, etc. Field equipment, well-equipped laboratories, computers etc., will be required in the case of hydrological, chemical and biological data collection and analysis.

Interdisciplinary collaboration: Absolute valuation itself is a component of economics, which also requires an understanding of the functions of the wetland, and therefore requires an interdisciplinary approach. Hence, economists, ecologists, hydrologists, environmentalists, agronomists, engineers and other experts should work together as a multidisciplinary team to tackle wetland valuation.

Training programmes: Training programmes along with institutional capacity building are necessary to support staff, surveyors, planners and decision-makers in collecting required information and to ensure the valuation study is effectively used in decision-making process. In this regard economists, planners and decision-makers must be trained in wetland valuation techniques as part of broad-based environmental management courses.

Research and economic valuation studies: The fundamental research effort is badly needed in order to improve wetland valuation techniques. This is especially the case for non-use values and for application in regions where markets are distorted. Economic valuation studies of wetlands should be undertaken to make sound decisions on development options and to set regional and national policies.

Networking: Results of research and experience from application of valuation techniques are rarely dispersed sufficiently. Networking of experts from various areas can serve as a useful medium for exchange of ideas and information. Two types of networking are required: first, a network by which researchers can exchange results and discuss basic principles; and second, a network by which practitioners can swap experiences of applying methods in different wetland types, focusing on the practicalities of finding information, undertaking surveys and assessing the response to questionnaires.

6.0 OBJECTIVES

The objective here is to demonstrate the potential of economic valuation of wetlands and procedure for conducting valuation.

7.0 VALUATION OF LAKES IN BANGALORE – A CASE STUDY

Bangalore District is located in the heart of south Deccan of Peninsular India. It is situated in the south-eastern corner of Karnataka state ($12^{\circ}39' - 13^{\circ}18' N$ latitude and $77^{\circ}22' - 77^{\circ}52' E$ longitude) with a geographical area of about 2,191 sq. km at an average elevation of 900 m above the mean sea level. The climate of the district has agreeable temperature ranging from the highest mean maximum of $36.2^{\circ}C$ in April to lowest mean maximum of $11.4^{\circ}C$ in January. It has two rainy seasons from June to September and from October to November coming one after the other but with opposite wind regime, corresponding to south-west and north-east monsoons. The mean value of the rainfall of about 900-mm with standard deviation of 18.7 mm was recorded from the year 1875 to 1976.

Status of a wetland depends on its management, level of anthropogenic activities, management of land, solid waste collection and disposal, disposal of used water and also attitude of the people at large. Urbanisation and anthropogenic stress to meet the growing land needs of Bangalore City have resulted in disappearance of wetlands, which has led to the discontinuity of the drainage network. Studies in Bangalore city, reveal about 35% decrease in number of water bodies from 1973 to 1996 (Deepa, et al., 1999). Earlier investigations have revealed that nearly 30 % of lakes are used for irrigation. Fishing is being carried out in 25 % of lakes surveyed. About 36 % of lakes are used for washing purposes and only 3% are used for drinking purposes. Agriculture is practiced in 21% of lakes. Approximately 35% of lakes are used for grazing by cattle. Mud lifting was recorded in 30 % and brick making in 38 % of the lakes (Krishna et al., 1996).

Economic valuation was undertaken in three lakes namely Hebbal, Amruthalli and Rachenahalli lakes. Hebbal and Amruthalli lakes are situated in Bangalore North taluk (east of Bellary road) while Rachenahalli is situated in Bangalore South and North taluks.

7.1 Hebbal lake valuation

To assess the importance of Hebbal Lake, a socio-economic survey was carried out in the catchment areas of the lake (Ranjani V.G and Ramachandra, T.V, 1999). A random survey of the houses situated within 1-km radius from the lake was carried out, using a questionnaire designed for the purpose. The study was done in four areas around the lake

namely Hebbal, Guddadahalli, Bhoopasandra and U.A.S. Layout. The first three areas (Hebbal, Guddadahalli, and Bhoopasandra) were semi-urban and the last one (U.A.S. Layout) was completely urban. The economic valuation of wetland resources was done on the basis of Contingent Valuation Technique. Table 2 gives the economic details of lake water benefits in terms of rupees.

Table 2: Results of the socio-economic survey

Area	Domestic	Agriculture	Livestock	
	(per 1000 people per day)	(per ha. per day)	(per 1000 animals every 2 days)	
			Water use	Fodder
Hebbal	Rs. 1937.50	Rs. 19.00	Rs. 2170.80	Rs.33500.00
Guddadahalli	Rs. 1603.30	Rs. 19.00	Rs. 1250.00	Rs 37500.00
Bhoopasandra	Rs. 1547.80	Rs. 5.00	Rs. 1270.80	Rs. 16666.70
U.A.S.Layout	Rs. 1547.00			

Livestock: The dependency for fodder is about Rs. 33,500 per 1000 cows for every two days. The dependency for the livestock on the lake water amounts to about Rs. 2170.8 per 1000 cows every two days. The dependency in the Guddadahalli area for fodder is about Rs 37,500 per 1000 cows every two days and the remaining Rs 1250 per 1000 cows every two days is the amount for water needed in economic terms to maintain the livestock. The total dependency for rearing livestock amounts to Rs. 38,750 per 1000 cows every two days. In Bhoopasandra area, the economic dependency for the livestock rearing is Rs. 17,937.5 per 1000 cows every two days. The dependency for water amounts to Rs. 1270.8 per 1000 cows every two days and for fodder, Rs. 16,666.7 per 1000 cows every two days. Here, people rear cows to earn a living and sell the milk in the surrounding areas. The fodder available in the local market is very expensive and therefore people use the weeds in the lake as fodder, a cheap source of food.

Agriculture: Agriculture is still practiced in certain parts of Hebbal, Guddadahalli and Bhoopasandra areas. Many of these areas use the lake water for irrigating their fields (for growing a variety of greens). The dependency in the Hebbal lake catchment for irrigation is around Rs. 19 per ha. The dependency in the agriculture sector for Guddadahalli area is Rs. 19 per ha. This area also, like Hebbal is primarily agricultural, and depends on the lake or ground water for irrigation. In the Bhoopasandra area, the dependency on the lake for agriculture is about Rs. 5 per ha. This is because, a lone farmer in the area owns a coconut grove and he uses the lake water as well as the treated water to irrigate the land.

Domestic sector: The dependency for the domestic sector was calculated by determining the water use per individual. In the Hebbal area, the dependency was Rs. 1937.5 per 1000 people per day. While in Guddadahalli area, it was about Rs. 1603.3 per 1000 people, and Bhoopasandra area, Rs. 1547.8 per 1000 people. In the UAS layout, the dependency is Rs.

1547 per 1000 people. Residents in Hebbal area depend on ground water for their daily use more than the other areas, as they lack access to treated water supply.

The dependency was the highest for livestock maintenance since, fodder for the livestock is completely obtained from the lakes. The agricultural dependency is low in the areas ranging from Rs 5 to about Rs 19 per ha. With lake restoration the agricultural dependency has increased, as the people have relatively clean water of the lake. The dependency of the domestic sector ranged from Rs. 1547-1937 5 per 1000 people per day. This dependency was highest in Hebbal area, as the people there depended on the ground water for their daily needs. An interesting thing that came into notice was that the people there used more water for bathing and the water used for bathing alone per individual was much higher than the surrounding areas. Though Guddadahalli is also dependent on ground water for its daily needs, the dependency was less compared to Hebbal. The other areas (Bhoopasandra and U.A.S. Layout) have access to treated water, and so the people do not depend much on the ground water to satisfy their daily needs.

7.2 Rachenahalli and Amruthalli lake valuation

Socio-economic valuation was undertaken in two lakes, namely, Rachenahalli and Amruthalli (Rajinikanth R and Ramachandra, T.V, 2000), to assign quantitative values to the goods and services provided by these wetlands. The economic value was measured in terms of public willingness to pay for the commodity. Total valuation assessment approach was used to assign the value of particular wetland as a whole in terms of rupees. This economic valuation concerned ultimately with the allocation of wetland resources to improve human welfare. Socio-economy survey was conducted to:

- quantify the values of wetland resources; and
- determine the economic dependency of the people living in the surrounding areas on these lakes.

Approximate valuation of wetland resources based on their use values (human dependency and interactions with the wetland resources) and non-use values (no interactions with the wetland resources) were determined by conducting interviews with the local communities. A random survey of the houses around the lake was carried out using a standard questionnaire format exclusively designed for this purpose. It contains information on various human uses of wetlands for irrigation, domestic, recreation, food, energy and also livestock uses as a direct use value. The economic dependency of the people residing closer to wetlands is shown in **Table 3** and the values are expressed in rupees. Ground water table is provided as an indirect use value, and biodiversity, culture and heritage as non-use values in **Table 4**.

Five villages were selected in this regard, namely Amruthalli (around Amruthalli lake) and Rachenahalli, Mestripalya, Srirampura, and Dasarahalli (around Rachenahalli lake).

The valuation of wetland products was done using Market prices method and Contingent Valuation method with respect to public willingness to pay. By conducting this study, the requirements of the local communities and their economic dependency on the wetlands can be assessed.

Table 3: Socio-economic details

ITEMS	Quantity of Amruthalli lake resources	Amruthalli lake value in Rs.	Quantity of Rachenahalli lake resources	Rachenahalli lake value in Rs
Domestic consumption	277.9 l/ house/day	1.667/house/day	214.97 l/house /day	1.289/house/day
Livestock consumption	59.28 L/cow/day	35.5 /100 cows/ day	60.39 l/cow/ day	36.18 /100 cows/day
Agricultural consumption	7201.02 L/ hectare/day	43.19/hectare/day	12087.8 l/hectare/day	72 /hectare/ day
Agricultural products:				
Paddy:	15.1Q/ha/0.5year	21140/ha/0.5year	32.00Q/ha/year	44814/ha/year
Ragi :	7.6Q/ha/0.5year	4560/ha/0.5year	12.5Q/ha/0.5year	7500/ha/0.5year
Flowers:	3.95Q/ha/year	11847.9/ha/year	6.64/ha/year	19920/ha/year
Guava:	74.23Q/ha/year	37115/ha/year	60.1Q/ha/year	30050/ha/year
Vegetables:	--	--	7.69Q/ha/year	10381.5/ha/year
Coconut:	3000Nos./ha/yr	11253/ha/year	5100.2Nos./ha/yr	19125/ha/year
Energy resource	0.47 Kg /person/day	117.5/1000 persons/day	1.298 Kg/ person/day	324.5/1000 persons/day
Fishing products	-----	-----	75 Kg./day	900/day

In the case of Rachenahalli lake (by surrounding villages) the estimation is about Rs. 10,435/day (during cropping and fishing season) and Amruthalli lake is about Rs.20.0/day. This shows that, the economic dependency in the case of Rachenahalli lake is more than that of people living around the Amruthalli lake due to better water quality and ecosystem, which is explained in detail below.

Agriculture: Wetlands are an obvious source of water for agricultural use. The economic dependency in Rachenahalli lake catchment for irrigation and its products is about Rs. 9173.0 per day, during cropping season. While Amruthalli lake, has no agriculture value. This is mainly due to decline in the water quality and quantity mainly due to eutrophication and drying of water during summer seasons.

Fuel: Rachenahalli and Amruthalli lakes also yield fuel wood for cooking and heating. The economic dependency of communities in Rachenahalli lake is around Rs. 325 per day, while in Amruthalli lake it is about Rs. 13 per day.

Fish: Wetlands also provide food for local communities in the form of fish and has socio-economic value attached to it. The dependency of the community on Rachenahalli lake is about Rs. 900 per day, during fishing season. This is mainly due to higher concentration of oxygen content. But Amruthalli lake has no value due to lack of oxygen concentration or oxygen deficiency, light (transparency) and temperature.

Livestock: The economic dependency for livestock in the Rachenahalli lake water is about Rs. 37 per day and in Amruthalli lake, it is about Rs. 7 per day. This mainly depends on the quality and availability of water in the wetlands. Amruthalli lake has lower value due to eutrophic condition of the lake that has made the wetland resource (water) unusable.

The ground water table of Rachenahalli lake ranges from 50 ft in the immediate vicinity and 250 ft at farther places (2-3 kms), while in the surrounding region of Amruthalli lake ground water table ranges from 180 – 400 ft. This is mainly due to sediments accumulated in lake-bed becoming impervious which hinders recharging. Sediment accumulation is due to siltation, which is a result of removal of vegetative cover in the catchment area. Apart from this, waste disposal in lake has resulted in eutrophic condition of the lake as a consequence of urbanisation and industrialisation.

Amruthalli lake is degraded mainly due to siltation, excessive input of domestic sewage, street and industrial effluents and dumping of organic waste materials from the surrounding areas. These have turned the lake eutrophic. Due to this, the economic dependency of people living in the surrounding area has become less. To avoid eutrophic conditions and to improve the economic dependency of people residing closer to the lake, appropriate conservation and restoration strategies are needed.

Table 4: Valuation of Rachenahalli and Amruthalli lakes

Lake	Direct use		Indirect value	Existence value
	Use	Value in Rs		
Rachenahalli	*Agricultural *Fuel *Fish *Livestock consumption	9173.0 324.5 900 37.5	*Ground water table varies from 50 (vicinity of lake) ↑ 250ft (at 2-3 km away from lake) ↓ *It has greater capacity to retain flood waters from heavy rainfall and disposal of treated water from JNCASR	* birds and migratory birds *culture and heritage value *pooja during festivals
Result	Total value is Rs. 10435 per day, during cropping and fishing season.		Ground water recharge and flood protection is increased due to lakebed perviousness	Functional aspects, bio-diversity and cultural, recreational aspects indicate importance of the wetland eco system.
Amruthalli	Use *Fuel *Livestock consumption	Value in Rs. 12.5 7.5	*Ground water table varies from 180ft (vicinity of lake) ↑ 400ft (3 km away from the lake) ↓ *It has lower flood protection value.	*Existing lake has no culture, heritage and biodiversity value
Result	Total value is Rs. 20.0 per day. Lower value is due to eutrophic condition of the lake which has made the wetland resources unusable		It has no ground water recharge and fewer flood control values mainly due to impervious lakdbed resulting from the accumulation of silt.	This is due to pollution on account of anthropogenic activities in and around the lake.

8.0 ACTION PLAN FOR CONSERVING WETLANDS

Investigating the economic benefits of wetlands is a step in the direction of formulating Wetlands Conservation Action Plan (WCAP). The WCAP should be a cooperative programme involving government and non-governmental organisations in efforts to establish a comprehensive wetlands conservation programme for their restoration, conservation and management. The goal is to create, reclaim, rehabilitate and protect wetland habitat in the watershed basin or a catchment based on ecosystem management approach. The strategies towards this goal are [<http://www.on.ec.gc.ca/wildlife/docs/glwcap1997-2000-e.html>]:

1. *increase public awareness and commitment to protect wetlands from becoming extinct through a variety of outreach materials and activities;*
2. *develop a wetland database and increase understanding of wetland dynamics;*
3. *promote the wetland conservation in State protected areas;*
4. *enhance co-operation among State, District, Regional and Non Government partners;*
5. *strengthen legislation, policies, agreements and compliance;*
6. *strengthen local planning and commitment to protect wetlands;*
7. *improve coordination and planning between government and non-governmental organisations; and*
8. *evaluate the outcome of the programme and ensure a sound scientific basis for policy.*

9.0 WETLAND POLICY GUIDELINES

The objective of policy with respect to wetland conservation is to promote the conservation of wetlands to sustain their ecological and socio-economical functions, now and in the future [<http://ces.iisc.ernet.in/energy/water/recom.html>]. Towards this end, the goals are,

- **Maintenance** of the functions and values derived from wetlands;
- **No net loss** of wetland functions in regional lands and water;
- **Enhancement and rehabilitation** of wetlands where the continued loss or degradation of wetlands or their functions have reached critical levels;
- **Recognition** of wetland functions in resource planning, management and economic decision making with regard to all national/state programmes, policies and activities;
- **Securement** of wetlands of significance;
- **Recognition of sound, sustainable management practices** in sectors such as forestry and agriculture that make positive contribution to wetland conservation while also achieving wise use of wetland resources; and
- **Utilisation** of wetlands in a manner that enhances prospects.

The wetland policy at State level provides:

- A signal of commitment to wetland conservation and acts as a catalyst for mutually supporting action across the region;
- A heightened profile for the issue to call attention to wetland, socio-economic and environmental benefits, to ensure that wetlands receive adequate consideration by the State government;
- Direction and support for individual decision makers to ensure that opportunity for the sustained and wise use of wetlands is realised, to avoid or reserve wetland related conflicts;
- Clarification of specific State responsibility for wetlands, as well as a synthesis of existing legislation, policies and programmes which already contribute to wetland conservation;
- A consistent, co-ordinated approach among the many State agencies, which influence wetlands, aimed at adjusting activities which conflict with wetland conservation and ensuring progress towards specific objectives and goals.

A comprehensive policy on wetlands needs to be formulated to enhance the quality and increase the spatial coverage specific to the region, to offer some of the most environmentally productive and cost effective opportunities for wetland conservation. The objectives should focus on addressing the following aspects,

- To reverse the current decline in the wetland base, ensuring no net loss and long-term net gain in the quality, quantity and permanence of wetlands.
- To encourage partnerships in restoration, management, usage, through co-operative planning efforts with the primary focus on wetland conservation.
- Draft procedures for administration of wetland usage and its conservation.

The emphasis is placed on the formation of Regional Wetlands Forum, involving local educational, public and private organisations (involved in wetland issues). For effective functioning, the forum should consist of researchers, school and college-students and teachers, economists, policy makers, representatives from the agricultural community, developmental concerns, conservation organizations, state and local agencies under the collaboration efforts from the Ministry of Environment and Forests, Department of Science and Technology, Indian Council of Agricultural Research and planning departments with the following responsibilities. The policy should address the following.

- 1 Define wetlands, classification (based on degree of saturation, type of vegetation, usage, soil etc), inventory, planning, wetland regulation, and conservation approaches (i.e., acquisition, restoration, management and education).

- 2 Establish regional and state-wide goals to achieve long-term increase in wetland acreage, functions and values in emphasizing the economic uses (fishing, agriculture, drinking water supply, etc).
- 3 Draft programmes for preservation, conservation, restoration, and enhancing wetlands acreage and provide technical and adequate funding for wetland mitigation and management programmes.
- 4 Develop consistent standards concerning wetland water quality, and guidelines for mitigation, monitoring and restoration efforts.
- 5 Encourage actions that promote efficiency of wetland-related permitting processes for the varied usage of wetlands for economic purposes (as fisheries, irrigation etc) by suitable policies and creation of concurrent permit review procedures.
- 6 Enhance co-ordination of governmental (state, central) and non-governmental organisations responsible for wetland conservation. Action oriented restoration and conservation programmes could be initiated and monitored through discussion meetings of academicians, and planning and implementing agencies for providing a platform for exchange of ideas.
- 7 Help in the development of internal policies within state agencies like irrigation department, public works department, forest department, urban development and others that will encourage wetland conservation activities which are compatible with programmatic goals of flood control, ground water recharge, water management, water pollution control, recreation and others.
- 8 Establish inter-agency task force responsible for co-ordinating and information exchange among the agencies, boards, and departments as necessary to ensure co-ordinated development and implementation of wetland conservation program.
- 9 Integrate wetland policy and planning with other environmental and land use processes.
- 10 Undertake cost-benefit analysis of the wetland resources derived by the society and economic evaluation caused due to the loss of wetlands.
- 11 Advise government to provide funds for wetland research and conservation programs.
- 12 Formulate Wetland Protection Act as a legislative vehicle to restrict any disturbance of wetlands leading to loss in biodiversity dependent on them.

Recommendations for effective wetland management are:

- Integration of different Government Agencies for effective implementation of activities related to restoration of wetlands, their sustainable utilization and conservation.

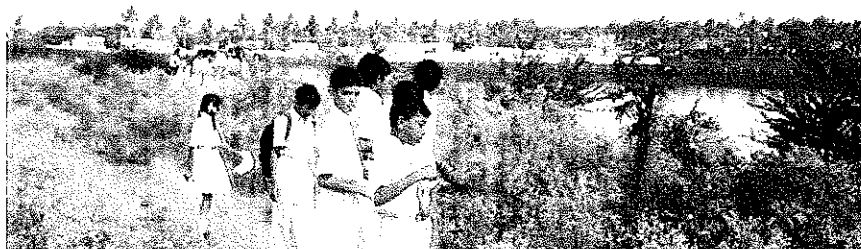
- A National Committee for Lakes and Wetlands reclamation, restoration and development be formed to formulate a National Policy to evolve strategies for their sustainable utilization and conservation
- A Comprehensive Plan be prepared to study selective, representative wetlands in a phased manner to create database with regard to their present status, sustainable use, management and conservation and to formulate strategies for their long-term management.
- Regular monitoring of ecosystems through the involvement of Schools, Colleges and Universities. Student's involvement including curriculum development concerning the protection of the ecosystem.
- Mass awareness programme be chalked out and implemented through Governmental and Non-Governmental Organisations (NGO) for popularization of the importance of the lakes, wetlands and rivers, and their role in the aquatic biodiversity and sustenance of human civilization.
- Lakes and Ponds in each Zilla Panchayath area be identified and their streams recharged through people's participation. People should be made aware of wetlands' significance so that reclamation and conservation of these water bodies be taken up effectively.
- Fishermen's socio - economic aspects be taken into consideration while formulating wetland policies.
- Education and training: Public needs to be better informed about the rationale, goals and methods of aquatic ecosystem restorations. In addition, scientists and researchers with broad training are needed for aquatic ecosystem restoration, management and conservation.

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