

**EVALUATING ECONOMIC SUSTAINABILITY OF URBAN AND PERI-URBAN WATERBODIES
A CASE STUDY FROM KOLKATA PONDS**

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Abstract

The significance of urban and peri-urban waterbodies (ponds) as water resources is being appreciated now as never before. Increasing population in urban and peri-urban centres has put more stress on water management of city administrations. This has necessitated proper management of the ponds economically for better water quality. Kolkata, the second largest metropolis in the country, has about 3000 ponds of different sizes spread within its municipal corporation boundary. These ponds are used as multiple resources – about a million people use it for bathing, washing, pisciculture, performing religious rites and also use its adjoining areas as city parks. The ponds also have a great ecological importance in urban environment – from microclimate control to biodiversity. The present paper firstly aims at valuing the contribution made by urban and peri-urban ponds to support and improve the quality of life of the people residing in adjoining areas (or using it). Secondly, it attempts to deal with the issue of sustainable management of such ponds both at theoretical and at the practical level. The study is based on an extensive survey of Kolkata ponds (the first such study on Kolkata ponds), to find its prime uses and users. For tractability, the present study considers only use-values, such as bathing, washing, immersion of idols, recreational uses along with fish cultivation. The main observations of the study are; a) even without considering existence value, option value etc., the value contributed by a pond is significant though after capitalization of the flow of values it does not match real estate prices; b) non-enforcement of property rights have affected the sustainability in many cases; c) sustainability from the viewpoint of human use and sustainability from the viewpoint of pisciculture may have some mutual incompatibility and therefore requires an integrated approach and d) proper community management can attain sustainability without compromising on quality of life.

1. Introduction

Water is going to become the most important natural resource in the 21st century. For some countries it may become the most critical issue influencing political and social events in the immediate future. Though India enjoys a relatively moderate average-rainfall, water has still become a critical issue. Sharing of water resources has already caused friction between states, culminating in violent riots. Most city authorities cannot provide the required minimum water supply to its citizens. Even in areas with high rainfall, water scarcity has become a problem during non-rainy months.

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Water is considered as the source from where life began. Waterbodies of every form – oceans, seas, rivers, marshes or ponds –have been the niche for thousands of species of flora and fauna. Most of the living beings require water in some form for their survival. Human civilizations have also grown depending on the water resources, as a result of which they have mostly developed near the river valleys. So water bodies have served both the cause of the conservation of nature as well as of human development. This paper will be focussing on a specific aspect of water resources – economic sustainability of urban and peri-urban waterbodies with special reference to the ponds of Kolkata.

The layout of the paper is as follows. In Section 2, we shall distinguish between and define various types of urban waterbodies like wetlands, lakes and ponds that are commonly observed in an urban area. In Section 3, we shall discuss the significance of urban waterbodies. In Section 4, a brief profile of Kolkata's waterbodies is presented. Section 5 deals with the main observations from our survey. In Section 6, we attempt to estimate the value of the flow of utility generated by a few representative ponds in our survey. Section 7 discusses the issue of environmental management and economic sustainability of urban waterbodies with special reference to two ponds selected from our survey. Finally, in Section 8, we draw our conclusions.

2.Types of Waterbodies

Waterbody is a commonly used term, which may describe any place holding water. Seas, rivers, lakes, wetlands and ponds, all are waterbodies though their distinctive uniqueness as a specific form of waterbody is not always evident to all and sundry. A definition of waterbody is therefore required to be useful for a specific study. The waterbodies can be classified in many ways by their sizes, locations, water quality, aquatic ecology and others. It may be artificial or natural; static or flowing, sweet or brackish, deep or shallow, permanent or temporary. Though the terms rivers and seas do not need much clarification, the terms lakes, wetlands, waterbodies, tanks or ponds are quite commonly used interchangeably.

Before going into the discussion of specific urban and peri-urban waterbodies, which are the focus of this study, it may therefore be useful to define few types of waterbodies which have urban and peri-urban presence.

Lakes can be described as waterbody with sufficiently large area having specific ecological characteristics. These can be sweet water lakes like Great Lakes of USA or brackish like Chilika in Orissa. Lakes can be natural or artificial. Vast man-made lakes have been built by building dams on rivers.

However, large waterbodies are often also called lakes in the city, though much smaller than the above-mentioned ones, mostly created for water storage, recreation and open spaces and other major urban requirements

Wetlands have received much publicity in recent times. There has been a sustained international effort for the last three decades to save wetlands mainly through the “Convention on Wetlands of International Importance Especially as Waterfowl Habitats” which is commonly known as Ramsar Convention after the name of the place in Iran where it was held in 1971. According to the Ramsar Convention, wetlands are defined as," areas of marshes, fens, peat lands of water, whether natural or artificial, permanent or temporary with water, that is static or flowing, fresh, brackish or salt including the areas of marine water, the depth of which at low tide does not exceed six meter".

The most comprehensive definition of wetlands was adopted by the scientists in the U.S Fish and Wildlife Service in 1979, after several years of review. The definition is presented in a report titled *Classification of Wetlands and Deepwater Habitats of the United States*. (Cowardin et al 1979)

"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water...Wetlands must have one or more of the following three attributes.

- 1) At least periodically the land supports predominantly hydrophytes,
- 2) The substrate is predominantly hydric soil and
- 3) The substrate is non-soil and is saturated with water or covered by shallow water at sometime during the growing season of the year."

A Pond is generally described as a waterbody of a smaller size, man- made or developing it from its natural origin. In the present study the term pond has been used as smaller waterbody in the urban and peri-urban area. The term waterbody has often been used for ponds also.

3. Importance of Urban Waterbodies

India is fast getting urbanized. In 1991, 25.72% of Indian population lived in urban areas. Whereas the decennial population growth of the rural areas has been 19.71%, the urban population growth was as high as 36.19%, as a result of which the present urban population constitutes 27.8% of the total. This increase is mostly not a planned one. Urban India depends heavily upon various types of waterbodies to meet its daily requirement of water. The requirements fulfilled by these waterbodies, as we shall see later, do not even get reflected in urban resource accounting. Now, an increasing population implies a greater demand for water and the pressure on these waterbodies are immense. At the same time, due to the requirement for more land for housing and other urban expansion, the waterbodies are being filled up. So, in spite of their over-riding importance, the very existence of urban ponds is 'critically endangered'.

This is a highly worrying factor; for, the role of the ponds in urban and peri-urban milieu is multifaceted. It is not only just a pool of water but has a role of social, ecological and civic importance. The major use is no doubt bathing. A large number of people use these surface water sources for bathing, cleaning and other requirements. These people can be migrant labourers or poor local inhabitants without any access to such civic facilities. For a large number of people working in markets, small factories, living in slums or in poor housing conditions, ponds are the only source of water for all human requirements except drinking. The major productive activity related to these ponds is fish cultivation. Most of these water bodies are used for pisciculture.

Environmentally these waterbodies serve the purpose of an open space in the crowded urban localities. Their role as controllers of microclimate needs more study. In many cases the banks of these waterbodies are the only spaces for development of greenery. Local natural life – aquatic, avifauna and terrestrial – sustains around these water bodies. Ponds and the surroundings are one of the most important protectors of biodiversity.

Social roles are equally important. Waterbodies have generally been associated with different aspects of Indian cultural and religious practices. In urban places, these waterbodies also act as a

centre of local social and cultural activities. There are clubs and temples by the side of these water bodies. Often there is immersion of idols and fairs are organised on the fields next to these waterbodies. Finally, these waterbodies act as a source of water for fire fighting in the crowded and ever-expanding urban areas.

One function of ponds (which has only recently attracted the attention of environmentalists) is that they serve as receptors for rainwater harvesting and maintaining local ground water levels. Thus urban waterbodies are a special component in water use management, to which little attention has been paid. The inter-relation of an urban waterbody with environment, economy and society is presented in **Table 1** below.

Table 1
Role of Ponds in Urban and Peri-Urban Areas

Urban Environmental Components	Activities	Description
Water Resource	Bathing	A large number of people from lower economic background use them for bathing
	Washing	Washing of clothes, utensils and other domestic requirements
	Rainwater Harvesting	Acts as rainwater storage
Environment	Climate Control	Ponds affect local micro-climate, making it cooler and soothing
	Open space	Ponds provide an open space providing room for air movement. Space for recreational use.
	Trees	Generally the pond banks have tree plantations, preserving urban nature
	Aquatic Ecology	Ponds support many aquatic and other species, a receptacle of biodiversity in urban context
Economy	Fish cultivation	Source for local employment and good protein
Social	Community Gathering	People spend time sitting around these ponds. Many ponds have seats around them and are an important place for local community gathering.
	Clubs	Because of open space, there often exist many clubs by the pond side. These clubs also manage the ponds.

Culture	Temples	Many ponds have temples by their sides. Temple authorities also manage some ponds.
	Holy ponds	Some ponds have a history associated with them and/or are related to some shrines and are considered as holy ones.
	Fair	Due to the presence of temples, fairs are organised in the open spaces in front of many ponds
	Immersion	Immersion of Idols is an important event in Hindu festivals. A number of ponds are specifically used for that
Safety	Fire Extinguishing	In congested urban areas, ponds are very useful as a source of water supply for extinguishing fire.

4. Kolkata's Waterbodies

Background: Kolkata, previously known as Calcutta, is the capital of the state of West Bengal in eastern India. It is the second largest metropolis in the country. It is situated on the left bank of the river Hugli (Ganga). Kolkata is well connected with the rest of the country by roads, rail and air. Kolkata experiences a humid and hot summer but not so cold a winter. It receives moderate to heavy rainfall. Mean maximum temperature rises above 36°C and mean minimum temperature goes down to about 12°C. Average rainfall is 1580 mm and most of the rain falls in four months from June to September.

The Kolkata Municipal Corporation area has been selected as our study area and ponds within this area are the focus of the present study. The total area of the Corporation now stands at 185 square kilometers and consists of 141 wards. 41 wards were added in 1984 where the process of urbanization is still in progress, as a result of which a large number of ponds still exist in those areas. The wards are grouped in 15 Boroughs.

Socio-economic Profile: The present Kolkata population as per the 2001 census was 4.58 million with a population density of 24760 persons per square km. Though decadal population growth rate is only 4.1%, the decadal population growth rate in the newly added areas is 23.89%. Kolkata like other cities of developing countries have a high share of slum population, which is about 40 percent of total population. These data are important as increase in population in new areas are increasing pressure on existing water resources and most of the users, as we shall find later, are from poor households.

Waterbodies: Kolkata has grown up in a land of floodplain, marshes, rivers and streams. Kolkata's waterbodies can be classified into three major groups:

- a) East Kolkata wetlands
- b) Three major lakes
- c) Ponds of various sizes numbering around 3000

Kolkata also has also a number of canals in and around the city, which are not being considered in this study. A brief description will provide an understanding of these three different types of waterbodies.

East Kolkata Wetland: A large area of wetlands lies on the eastern fringe of the city of Kolkata. At present the total wetland area is about 3898 hectares (Mukherjee 2002). East Kolkata wetlands have attracted attention of the environmental scientists for more than two decades because of its two major functions. First, these wetlands are used for pisciculture, which provides employment to a large number of people. Second, for carrying out this pisciculture, it utilizes city sewage thus treating the city wastewater simultaneously. On 3 February 2000, east Kolkata wetlands have been designated as Ramsar site thus ensuring its preservation (Chattopadhyay and Mazumdar 2002). A part of the wetland is now being used also for recreational purpose like boating.

Lakes: Two major man- made lakes in Kolkata are Ravindra Sarovar (30 hectares of water area) in south Kolkata and Subhas Sarovar (16 hectares of water area) in east Kolkata. These two lakes were developed as part of place for recreation, water sports and tourism. Nevertheless, these two lakes are intensely used by hundreds of people for daily bathing and washing. The other lake called Nature Park (60 hectares water area) is in fact a cluster of wetlands, also used for pisciculture utilizing municipal sewage water, but it has also been developed recently for recreational activities and tourism.

Ponds: Ponds are mostly of totally different nature. These are of comparatively smaller sizes varying from 0.03 ha to few hectares. Thus ponds can be considered as the smallest unit of waterbodies for this discussion. Pond excavation was once a part of social and religious customs. Ponds are distinctly separate from lakes and wetlands as they are nearly all located within residential areas and are meant for local uses.

A distinction between the ponds and wetlands in Kolkata are presented in **Table 2**

Table 2
Comparison between Wetlands and Ponds in Kolkata

Functions	Wetland	Urban Pond
Location	At the margin of human habitation	Inside Human habitation
Users	A specific group of people like fishermen	Different groups of Common people
Size	Covers a wide area	Small but many in numbers
Ecological Importance	Very Important	Less important
Wastewater Treatment	Utilized for Wastewater Treatment	Should not be utilized
Social importance	Absent	Significant
Flood reduction	Important role	Negligible role
Management Level	Regional	Community

5.0 Survey of Ponds in Kolkata- Main Observations

As mentioned above, urban ponds provide a number of services. Kolkata having about 3000 ponds should have been a model case to find out the role of the ponds in any city. The role of city planning with regards to these water resources could have been a useful reference for the economic considerations of ponds. Unfortunately the city planners of Kolkata never thought about these ponds. In the last decade, a number of documents on planning of Kolkata have been published by KMDA (Kolkata Metropolitan Development Authority) and by Department of Environment, Government of West Bengal, but ponds of Kolkata got no mention in them. So the following studies of 25 ponds randomly selected in different parts of Kolkata may be considered to be a starting point in understanding the multifaceted role of these urban waterbodies.

There is some uncertainty as to the exact number of ponds in Kolkata. A list of KMC updated in 1997 had 1786 ponds in 141 wards. The list is not complete and this was confirmed by some sample survey in the wards. The latest counting by one department of KMC as reported in media is 3733 (Hindustan Times, 29 July, 2003). But the other departments of KMC has not agreed to the result (Anandabazar Patrika, 20 August, 2003) However, an overall distribution of ponds can be obtained from the available data. It shows that out of 141 wards, as many as 52 wards (which comprise 37 percent of the total number of wards) do not have any ponds. If we divide Kolkata into two groups: a) 100 'original' wards and b) added 41 wards, 45 percent of the first 100 wards do not have any pond.

25 ponds selected for the study are spread over 21 wards and 12 boroughs – covering the entire KMC area. The survey was conducted by field study at each pond. At all the ponds, the number of users for various uses was counted between 8 am to 2 pm for one day. A number of users were surveyed through prepared questionnaires at each pond. Besides, other relevant data about the ponds were collected from the users, from the local people, from the owners or the managing organisation, if any. The study revealed the following important information.

Number of users: As already mentioned each pond was surveyed from 8AM to 2PM to find out the actual number of users. Total number of bathers was 8604 in 25 ponds during this period. The lowest number of bathers was 125 and the highest was 780. Total number of users, including those washing clothes, cleaning utensils etc was 10199.

As the counting was done not for the total use period (roughly 6 am to 5 pm), the survey did not yield the exact number of users. So we assumed that the actual number of users is 25% more than what was obtained from the survey. Also considering a 20 percent increase in overall use during the summer months, the total number of persons using the surveyed ponds per day during the summer months would be 15299. Thus, the average number of users per pond would be 612 persons (see **Table 3**). Assuming that around 1500 ponds (that is, less than 50% of the total) are used extensively within the Kolkata Municipal Corporation (KMC) area, the number of all kinds of users would be about 1 million. So these urban ponds serve a huge number of people and therefore deserve to be part of urban planning and its economic study has become a necessity.

Table 3
Number of Pond Users (on a per-day basis) in 25 ponds

Actual number of bathers between 8 am – 2 pm in 25 ponds in winter	8604
Actual number of all users between 8 am – 2 pm in 25 ponds in winter	10199
Total number of users in winter throughout the day – 25 percent additional users in 25 ponds	12749
Total number of users in summer in 25 ponds – 20 percent increase from the winter season	15299
Average user per pond per day during summer	612

Economic background of the Users:

The user survey data also revealed that majority of the people (67.99%) using the ponds belong to the lower income group (monthly income equal to or below Rs.3000). This percentage includes the people (16.75%) who reported no income at all as they were housewives or students or else unemployed. 23.45 percent people provided no information. If this group is excluded, then proportion of lower income group (out of all users) will be 89 percent. So ponds in Kolkata are a major water- resource for the lower income group people.

Uses of Ponds

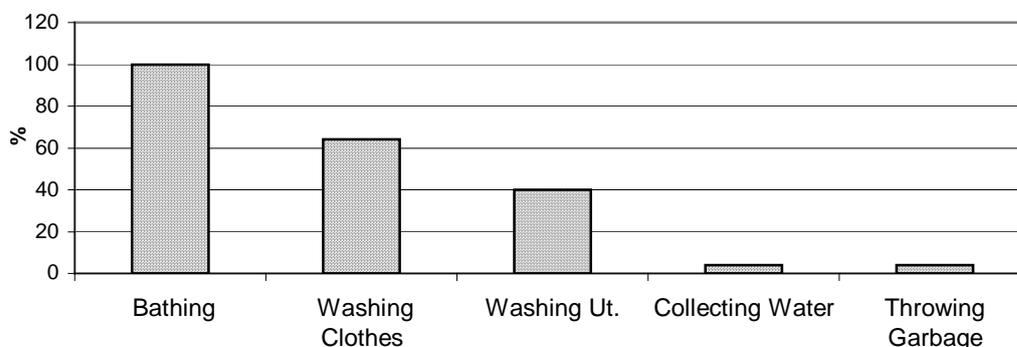
The pond-use pattern shows that all (100%) the ponds are used for bathing. 62% of the ponds are used for washing purposes. One of the important aspects of this finding is that the pond water is a major source for bathing water for urban poor. Bathing is considered a primary healthcare activity and thus the question of water quality gains more importance.

After bathing, the next major activity in the ponds is pisciculture. 92% of the surveyed ponds are used for it. As pisciculture is related with local employment generation, this aspect, too, should be studied carefully.

Finally, it was observed that 56% of the ponds are utilised for immersion of idols.

Figure 1 shows the direct use-pattern of the urban ponds.

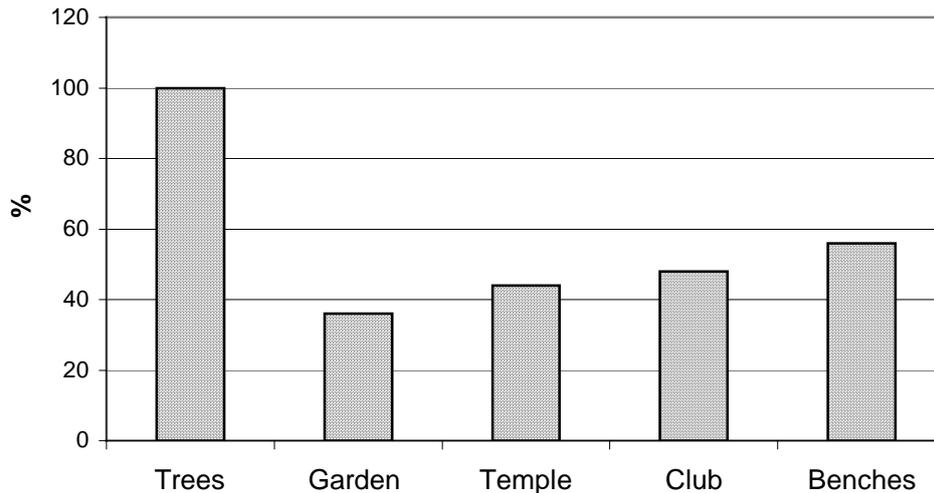
Fig 1 Direct use of Pond Use (%)



As discussed before, the pond surroundings also make significant contribution to the social, cultural and ecological environment of the urban scenario. The survey found that all the ponds have some trees around them. Nearly half (44%) of the ponds have adjacent temples, 48% have some clubs nearby, while 36% of the ponds have decent sitting facilities around them.

Figure 2 shows the indirect use of the urban ponds.

Fig 2 Indirect use of Ponds (%)

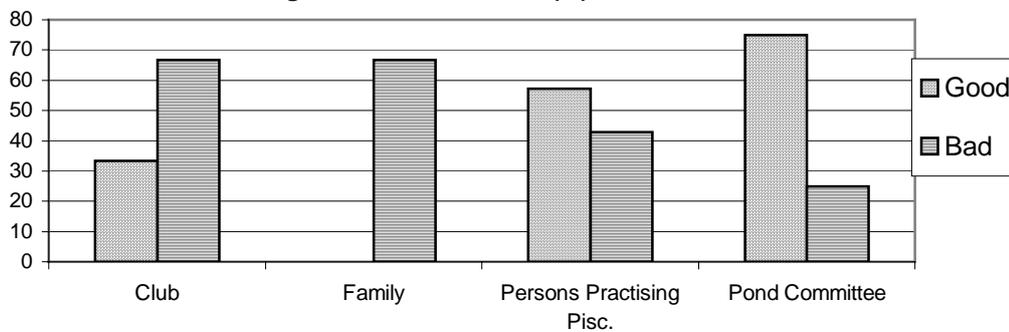


Ownership and Management of Ponds

60 % of the surveyed ponds are owned by private persons. The management of the ponds are carried out by different groups. A number of government owned ponds are looked after by the Pond Committees. Private ponds are mostly looked after by the people who take them on lease for fishing. Some local clubs and religious institutions also manage some ponds. It has been seen that the ponds managed by the Pond Committees are relatively better. Private ponds are looked after the least, as these are mostly owned on lease (for fishing).

Figure 3 shows the management pattern of the surveyed ponds.

Fig 3 Pond Maintenance (%)



6. Valuation of Waterbodies

Unfortunately the value of services rendered by such waterbodies often gets unnoticed. As mentioned before, a pond, like many environmental assets, can be used for consumption purposes as well as an input for some productive activities. This is a typical problem faced by public goods (which environmental assets generally are). Though the ponds are not a public good in a strict sense, however, non-excludability from and partial non-rivalry of consumption make the typical Kolkata pond vulnerable to the same kind of over-exploitation and subsequent degradation problems as are typical of common property resources. Therefore it is necessary to form an estimate of the economic value of a pond. A brief sketch of such a valuation procedure is presented here (see Johansson, 1987). We also attempt to make a rough estimate of the economic value of a few representative ponds with the data generated from this survey.

The economic value of environmental goods like a pond has a composite nature. We initially classify it into two categories -1) use value and 2) non-use value. **Use values** are defined as those benefits that are derived from the actual use of environment. Moreover, economists have also introduced the concept of option value, which is the additional value placed on a natural resource by those who want to have the possibility of using the goods and services in future. This is known as **Option-value** (Munasinghe, 1993). **Non-use values** are also called existence values. The argument is that people care about environmental resources not only because they confer some benefits upon human beings, but also because they wish to maintain or improve environmental assets out of sympathy for animal and nature or just from a moral conviction. There is thus an intrinsic value in these things (animals/nature etc), which go beyond our own self-interest (Pearce and Turner, 1990).

Valuation of Kolkata Ponds:

There are different methods for evaluating environmental resources. **Market price valuation** is carried out based on market price data. **Indirect Valuation approach** considers services or benefits obtained from natural resources that are not marketed but a reasonable assessment is done about their value by an indirect approach (Hanley et al, 1997). There are different methods for doing so like Travel Cost method, Hedonic Pricing method and Substitute Goods approach. (Hanley et al, 1997). **Contingent Valuation Method** involves direct questioning of the consumers to determine their willingness to pay for enjoying the facilities rather than go without them.

For the present study only use values have been considered for our empirical exercise. Fish cultivation, use of water by people for bathing, washing, immersion of idols, recreation uses etc., are therefore seen as the principal uses of these ponds.

Annual value of fish produced in each pond is available from the Annual Accounts of the pond committees. Annual value is defined as the amount obtained from fish sale or angling charges less the direct costs like cost of fish feed, fish spawns, netting etc.

Human uses include bathing, cleaning and washing. Most of the people using the pond do not have proper water supply at home. The value of this service has been calculated by considering the KMC's recent proposed water supply cost in the following way: For households of lowest valuation grade, the proposal is Rs.30 per month. Considering 6 persons per household, it becomes Rs.5 per person per month. Considering bathing consumes 30 percent of the water, cost of each person bathing in pond is Rs. 1.50 per month. For other uses the cost is considered Rs. 4.50 per person per month.

This valuation does not consider the quality of water, which is also an important criterion for the number of people using a waterbody. For well-maintained ponds, the number of users is high.

Some Pond Committees charge a fee for immersion of idols.

Another important service provided by many ponds is the recreational value. Recreational value can be calculated by Travel Cost method. It may be noted that KMC has proposed a charge for morning walkers in Ravindra Sarovar and for some other parks also. In line with that, a charge of Rs. 20 per person per month for morning walkers and Rs.10 per person per month for evening users can be taken as a proxy for calculating recreational value. Though it may be mentioned that these values will increase much in coming years.

Some of the services cannot be valued or would be difficult to value. The service or benefits that are not valued for this study are increase in property value for well maintained pond, improvement of environmental quality of the area, overall aesthetic improvement, option-values, intrinsic – values.

Considering these valuations, annual valuation of flow of utility is presented in **Table 4 and Table 5.**

Table 4
Annual Valuation of Flow of Utility from a Representative Pond

Service	Basis of valuation	Total Annual Valuation Rs.
Recreational Value: Considering 30 morning walkers and 50 evening users	Rs.20/- per morning-walker and Rs.10/- per evening-user per month	13200.00
Use of Water: Considering 516 bathers and 96 other users	Rs. 1.50 per month for bathers and Rs. 4.50 for other users	13320.00
	Total	26520.00

Table 5
Annual Fish Production in 4 Ponds (Audited Figures, 2001)

Service	Basis of valuation	Total Annual Valuation Rs.
Sale of fish and Angling rent	i) Angling: Rs.135650/- ii) Sale of Fish:Rs.137702/- iii)Direct Cost: Rs. 72632/-	Rs. 200720/-

It shows that average value of fish sale from a pond is Rs. 68338. Though the quantity of fish production depends much on the size of the pond, yet considering this for an average pond and considering 1500 ponds producing fish, the yearly value of fish produced in Kolkata ponds would be Rs. 102.5 million. This figure can be taken to as an indicative value to understand the economic importance of these urban waterbodies.

7.0 Environmental Management and Economic Sustainability

To understand the impact of environmental management of urban ponds let us now consider two examples. Two ponds which were selected for survey, one (**Pond A**) was solely used for fish cultivation to generate fund and other pond (**Pond B**) was well maintained for environmental quality. The two ponds are of similar sizes. **Table 6 and Table 7** provide the annual value of utility flow for these two ponds.

Table 6
Annual Valuation of Flow of Utility Pond A (Environmentally unmanaged)

Service	Basis of valuation	Total Annual Valuation Rs.
<u>Fish Sale:</u> Here fish cultivation is done by renting out to the anglers and direct fish catch	Angling: Rs. 1.35,650.00 Sale of fish: Rs. 22,988.00 Direct expenses: Rs.56543.00 (Source: Annual Audit Report 2001)	93283.00
Use of Water: Considering 261 bathers and 65 other users	Rs. 1.50 per month for bathers and Rs. 4.50 for other users	8208.00
	Total	101491.00

Thus the Pond A generates an annual flow of utility valued at Rs.101491.

Table 7
Annual Valuation of Flow of Utility of Pond B (Environmentally managed)

Service	Basis of valuation	Total Annual Valuation Rs.
<u>Fish Sale:</u> Here fish is harvested by direct catch (and not by renting out to anglers)	Sale of fish: Rs.70,480.00 Direct Exp: Rs.38,101.00 (Source: Annual Audit Report 2001)	32379.00
Use of Water: Considering 861 bathers	Rs. 1.50 per month for bathers	12915.00
Charges for Idol Immersion: Charges for immersion of idol depends on size of idol	(Source: Annual Audit Report 2001)	23921.00
<u>Sale of idol's frame</u>	Rs. 3100.00	3100.00
Recreational Value: Considering 50 morning walkers and 70 evening users	Rs. 20 per month & Rs.10 per month respectively	20400.00
	Total	92715.00

Therefore, the Pond B generates an annual flow of utility worth Rs.92715.

The above case studies can be useful to understand the role of environmental management for urban and peri-urban ponds. It can be seen that the difference in total annual valuation of the utility generated by the two ponds is not very significant since a yearly fluctuation of 20 percent from sale of fish is normal. But, there are significant differences between the type of earnings of the two ponds and the services provided. Value generated from the use of water (bathing etc.) consists only 8.1 % of total valuation for the Pond A while in case of the Pond B, the value of service generated from use of water and recreation consists of 35.9 % of total valuation. Due to better water quality, the number of bathers is 3 times higher in the well-managed pond. It has been also found that fish cultivation and human uses have opposing water quality requirements. Thus, there is a trade-off between pisciculture and human uses in respect of use of a pond.

If the values of ecological improvement, aesthetics and increase in property value are considered, the overall valuation will be much more in case of a well-managed pond.

Sustainable development is defined as development that takes care of present development without jeopardizing the interest of future generation. As the waterbodies in the urban areas have a number of roles to play, they need to be sustained. To sustain the ponds for carrying out maintenance and development, fund is required which can be obtained from proper utilization of the pond. The above results show that the ponds could make a reasonable profit from fish cultivation. However, the ponds can also generate significant revenue from by better

environmental management, and utilizing the pond as a consumable resource. In fact, the important public service of providing water resource to at least a million people is going on without any subsidy from government.

Our studies found that privately owned or leased-out ponds are not environmentally managed properly and they are in general the worst victims of degradation. In contrast, ponds managed by community groups, which can enforce some sort of property rights, are utilized better, are subject to less degradation, and in general, generate surpluses that can be used for environmental sustenance.

8.0 Conclusion

It may be concluded from the above analysis that:

- i) Urban and peri-urban ponds are the main sources of water for a large number of people. For Kolkata, the figure is likely to be at least a million.
- ii) Most of the users come from the poorer section of the society.
- iii) The value generated by the ponds is quite significant, even though option-value, existence-value etc. have not been considered.
- iv) Since providing water to its citizens is a basic duty of the State, the Municipal authorities/Government have a moral responsibility to ensure that the ponds are properly managed/ not degraded. In this context, it may be noted that the cost saved by the authorities in not having to provide water to a million more people could have provided the right basis for our valuation exercise, had the data been available. That would have considerably enhanced the valuation.
- v) Sustainability from the viewpoint of human use and that from the viewpoint of pisciculture may have some mutual incompatibility and therefore requires an integrated approach.
- vi) Non-enforcement of property rights affects sustainability, while proper community management can attain a reasonable degree of sustainability without compromising on the quality of life.

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