VALUATION OF ECOSYSTEM SERVICES – A CASE STUDY OF KOLLERU LAKE IN ANDHRA PRADESH

By

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THESIS

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DECLARATION

I, hereby declare that this thesis entitled **"Valuation of Ecosystem Services – A Case Study of Kolleru Lake in Andhra Pradesh"** is a bonafide record of research work done by me during the course of research and that it has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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Introduction

Chapter I
INTRODUCTION

"To sustain and restore wetlands, their resources and biodiversity for future generations"

Wetlands are one of the most productive ecosystems, comparable to tropical evergreen forests in the biosphere and play a significant role in the ecological sustainability of a region. They perform a multitude of biological and environmental functions and offer a wide variety of benefits to local people. As an essential part of human civilisation, they support the life system through provision of goods and services, food, drinking water, energy and fodder. They support significant biological diversity and offer the right habitat for nesting and migratory birds, many species of fish and other animals. The value of wetlands like cultural, economic, ecological and social is overlapping and inseparable.

Wetlands represent the transitional zone between land and water, usually formed in the depressions and groundwater seeps. The RAMSAR Convention defines wetlands as: "*Areas of marsh, fen, peat land, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters" and may include "riparian and coastal zones adjacent to the wetlands or islands or bodies of marine water deeper than six meters at low tide lying with in.*".The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 159 contracting parties to the Convention, with 1847 wetland sites, totaling 181 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance (RSIS, 2002).

Wetlands are estimated to occupy nearly 6.4 per cent of the earth's surface (IUCN, 1999). According to the *Directory of Asian Wetlands* (1989), wetlands

occupy 58.2 million hectares accounting to 18.4 per cent of the country's area (excluding rivers), of which 40.90 million hectares (70%) are under paddy cultivation. Another survey conducted by the Ministry of Environment and Forests (MoEF) in 1990 identified 67,429 wetlands in India, covering an area of about 4.1 million hectares. Of this, 1.5 million hectares (2,175) were natural and 2.6 million hectares (65,254) were manmade (excluding paddy fields, rivers and streams) and the rest were mangroves occupying an estimated 0.45 million hectares. The Directory of Indian Wetlands published by World Wild Life Fund (WWF) and Asian Wetland Bureau in 1995 recorded 147 sites as important of which 68 were protected under the National Protected Area Network by the Wildlife Protection Act of 1972. Out of these wetlands, 25 sites covering a total area of 6, 77,131 hectares have been designated as Ramsar sites in India. The Kolleru Lake, situated between the Krishna and Godavari deltas in Andhra Pradesh is one of the important coastal wetland ecosystems in India. Two other wetlands are situated in Kerala; the Ashtamudi wetland and the Vembanad- Kole wetland, together occupying an area of 2, 12,650 ha.

Across the globe, the wetlands are getting extinct due to manifold reasons, including anthropogenic and natural processes. Burgeoning population, intensified human activity, unplanned development, absence of management structure, lack of proper legislation, and lack of awareness about the vital role played by these ecosystems are the important reasons that have contributed to their decline and extinction. Many wetlands have been permanently destroyed and many have lost the scope for rehabilitation.

Though accurate statistics on wetland loss in India are not available, the Wildlife Institute of India (1975) conducted a survey on these aspects and revealed that 70 – 80 percent of individual fresh water marshes and lakes in the Gangetic flood plains have been lost in the last five decades. At present, only 50 percent of India's wetlands remain and that they are being lost at a rate of 2 to 3 per cent every year. About 32 per cent of these sites were lost primarily through

hunting and associated disturbances, while 22 per cent were lost to human settlements, 19 per cent to fishing and associated disturbances, and 23 per cent through drainage for agriculture. Removal of vegetation in the catchments area led to soil erosion and siltation that was estimated to contribute to over 15 per cent of wetland loss. Nearly 20 per cent of wetlands have been lost mainly due to pollution from industries (WCMC, 1998).

The World Development Report (1994) reported that the observed rate of wetland loss in India could lead to serious consequences as large populations are dependent on these wetlands.

Even when seen from an entirely anthropocentric viewpoint, functions such as flood control, support of the food chain, regulation of the local climate and enrichment of underground water reserves make wetlands vital to human existence and economic prosperity. Despite their important role in maintaining the ecology and economy of the regions, almost all wetlands are endangered by lack of appreciation of their role. Their values have seldom been understood by the people in the right perspective and often they continue to be over exploited. This valuation forms the basis for policy making with respect to resource allocation and mobilisation of funds for conservation of these resources.

Conservation efforts of natural ecosystems in developing countries are constrained by resources crunch and information asymmetry. Further, the allocation of public funds is often scanty as the economic worth of these resources is not reflected in decision making. Estimation of Total Economic Value (TEV) of the natural resources for favouring decision making as well as awareness creation among general public is a challenge for economists. Various economic valuation methods designed and tested elsewhere have been appropriately modified to suit local socioeconomic conditions, and these tools help to assign monetary values for the ecosystem services and other indirect benefits. Even though enough valuation studies are available in other countries, such studies are scanty in India. The

prominent among them are studies on Bhoj wetland (Verma *et al*, 2001) and Yamuna corridor (Babu and Kumar, 2001).

Here an attempt is made to estimate the value of a wet land ecosystem, which is declared as a Ramsar site. The study estimates in monetary units, the value of Kolleru wetland for the people that live and work within its boundaries. The specific objectives of the study are

1. To identify the services provided by the Kolleru Lake as perceived by the stakeholders and
2. To assess the Willingness To Pay (WTP) for ecosystem services.

Scope of the study

In the present context of global warming and climate change, water quality and quantity are considered as the most important issues in global environmental protection. The international community has given special attention to wetlands, because of their complex nature and unique local conditions, which allow for great biodiversity in the area. Despite their multitude of biological, environmental and economic functions, the wetlands are often over exploited and ultimately lose their value. Valuing the ecosystem services – both direct and indirect values provided by the wetlands is the basic step for their conservation. Assessments of this sort are essential when formulating sustainable management plans, so as to avoid the under estimation of the true value of nature to some extent. The exercise would give an idea to find out how local inhabitants and the stakeholders would value the existence of their own lake. The methodology if found sound, could be further explored for valuing the stakeholders perception for natural resource management with respect to other ecosystems as well.

Limitations of the study

- The study forms only a part of the Post graduate course and hence time and financial resources are constraints.
- The study attempts to value based on the perception of the stakeholders about the importance of conserving a wetland ecosystem, which had been subjected to large scale conversion to undertake environmentally unfriendly but economically profitable commercial fish cultivation. The men residing in the lake area being unaware of the complex ecosystems and the services provided their responses many a time may not be the true reflection of the actual scenario. This short coming of CVM and WTP has already been mentioned by Venkatachalam (2004).
- The WTP is the best fit given, at the present level of awareness and knowledge about the importance of wetland ecosystem among the stakeholders. If we could improve the awareness level of the lake dwellers, then the WTP may definitely take higher levels. Hence the present study results could be viewed by as an indicator for the greater cause only.

The researcher has taken all possible precautions to avoid response biases and has cross verified the facts and figures to the extent possible, so as to make the study result as valid as possible.

Plan of the thesis

The thesis consists of five chapters as given below. The first chapter deals with introduction wherein objectives of the study, the scope and limitations are discussed. The second chapter covers review of related studies in the light of the present study. The third chapter relates to the details of study area and methodology used in the process of investigation. The results and discussions are presented in the fourth chapter and chapter five gives the summary and conclusion of the study followed by references, appendices and abstract.

Review of Literature

Chapter II
REVIEW OF LITERATURE

A comprehensive review of past studies is highly essential for proper understanding of the concepts, research design and method of analysis in any research programme. Hence a review of past studies related to objectives of the study is presented in this chapter.

A large number of studies estimating in monetary units, the ecosystem services provided by wetlands, forests and national parks are available. Even though several estimation methods are available to value the services provided by the natural resources, the common methods found in the literature are Contingent Valuation Method (CVM) and Travel Cost Method (TCM) .Studies conducted by Loomis *et al* (1986), Carson *et al* (1993), Mc Fadden (1994), Bennett and Larson (1995),Echeverria *et al* (1995), Foster *et al* (1996), Henson (1996),Fisseha (1997), Hadker *et al* (1997), Terawaki (1997), Dunffa (1998), Hanley *et al* (1998), Fu *et al* (1999), White and Lovett (1999), Henn (2000), Marie (2002), Bandara and Tisdell (2003),Khan (2008), Parid *et al* (2004), Kusuma (2005), Mansor *et al* (2005), Vasudevan and Suryaprakash (2005),Ajayi (2006), Chaudhry (2006), Chithra (2006),Marikan *et al*(2006),Whitehead *et al* (2006),Dana *et al* (2009),Samaraweera and Marothia (2007), Alvarez and Larkin (2008), Boontho (2008) are a few to quote which used either CVM or TCM to estimate the ecosystem services and willingness to pay for conserving the resources pertaining to natural resources like forests and parks.

As the present study is concerned with valuing the ecosystem services provided by a wetland, only those studies conducted on valuation of wetlands using CVM and Willingness To Pay (WTP) are included in the review. Most of the studies pertain to wetlands in other countries and only a few works have been done in India. In addition, studies dealing with the environmental problems and

threats of Kolleru Lake and its management are also available. For convenience and clarity, the literature reviewed has been given under two sub heads;

2.1 Valuation of wetland ecosystem services using CVM and WTP

2.2 Studies on Kolleru Lake

2.1 Valuation of wetland ecosystem services using CVM and WTP

Carson and Mitchell (1993) compared an estimate of WTP for a change from boatable to fishable quality water on the Monongahela river in Pittsburgh area. The comparison was made with the WTP from a national sample for the same improvement in national water quality. The estimates were $ 26 and $ 68 respectively.

Signorello (1995) conducted a Contingent Valuation survey to estimate the birdwatchers WTP for a specified ticket price to gain access to the Mediterranean wetland in Italy. The results showed that the annual benefits per hectare vary from Lit (Bid) 159,780 to Lit 189,241.The estimated Lower Bound Mean (LBM) WTP was Lit 17,150. These results suggested that the wetlands under investigation provided benefits, much larger than those associated with many conventional market activities.

Singh (1996) asked residents of New Jersey how much they were willing to pay to preserve and improve coastal wetlands. Survey results revealed that the contributions were significantly higher for respondents who had visited the wetlands; with higher education; and who live in suburbs and exurbs.90 percent of the respondents indicated that the wetlands should remain as an area for fish, shell fish, wildlife, for recreation and for controlling coastal flooding.

Chopra (1997) has conducted a study on economic valuation of Kaoladeo National park in India which is a Ramsar site of national importance. She had

mainly emphasized on the importance for tourism and hence applied the Travel Cost Method (TCM).The consumer's surplus estimated from local cost estimates, amounted to Rs.427.04 per visit by an Indian and Rs.432 per visit by a foreigner. Estimating the total number of tourists between 1992-93 and 95-96, she calculated the total value as Rs.42.5 million.

A study conducted in the New England region of the United States by Streever *et al* (1998) estimated the WTP value and examined the attitudes about wetland conservation in New South Wales, Australia. Respondents to a questionnaire survey indicated a median willingness to pay of A $ 100 with upper quartile of A $ 150 and lower quartile of A $ 50 per household per year for 5 years and a mean of A $ 124.37. A conservative estimate of the aggregate value of wetlands in New South Wales, WTP was A $ 38 million per year for the next 5 years, based on certain assumptions.

Maharana *et al (*2000) estimated the recreational value of Khecheopalki, a lake situated in the west District of Sikkim state, India, which has recreational, biodiversity and sacredness values. The demand function for recreation increased with decreases in travel cost and distance for Sikkimese visitors. WTP for maintenance and preservation of the lake by all types of visitors ranged from US $ 0.88 for members of the local community to US $ 7.19 for international / sacredness values that were attributed to conservation of the site for biodiversity and pilgrimage.

Hammitt and Liu (2001) estimated the value for protecting the Kuantu wetland in Taiwan using Contingent Valuation Method. Using the open-ended format, the estimated annual mean household willingness to pay to preserve the Kuantu wetland was about US$21. Using the dichotomous-choice questions, the value was about US$65. These estimated results suggested the total present-value WTP to preserve Kuantu wetland was about US$200 million to US$1.2 billion (discounted at 5–10%).

Verma *et al* (2001) used CVM to estimate the WTP of the people of Bhopal for enjoying better recreational facilities from Bhoj wetland in India. Two payment vehicles were used - one in the form of a voluntary payment to the body that would undertake the management of the Bhoj wetland in the future; and the second, a compulsory tax imposed on the people of the city, the collections of which would go to its maintenance. The median WTP was Rs 241/household/annum for the voluntary payment and Rs.29.50/household/annum for the compulsory tax. Total estimated WTP per annum voluntarily and as tax amounted to Rs 48.4 million and 5.9 million respectively.

Mladenov *et al* (2001) estimated the visitors' preferences for the preservation of the Okavango Delta in Botswana using CV and TC approaches. The results showed that the quality of wildlife viewing was significantly correlated with WTP for preservation and suggested that impaired biodiversity would negatively affect the value of ecosystem. The combined CV and TC values totaled to US $ 285 per visitor per annum when extrapolated to the annual pool of visitors to the Delta in 2002, the value was translated to US $ 23 million ie., a large reservoir of fund from the tourism sector that could be used for preservation.

Babu and Kumar (2001) have conducted a study on valuation of ecological functions and benefits of Yamuna river corridor in Delhi. The four major ecological functions of the wetland ecosystems, namely hydrological functions, biological productivity, nutrient storage and habitat for flora and fauna were studied using direct and indirect benefits. It was shown that if the floodplain areas were converted for other 'developmental' uses, the ecological functions and corresponding benefits would be lost and the loss accounted to Rs 0.35-0.54 lakh per ha per annum.The capitalized value of this benefit estimated between Rs.3.72-Rs 22.34 lakh/ha is compared with the price of the flood plain land for 'other developmental' purposes in a cost-benefit framework which eminently justified the conservation of the wetland ecosystems of the Yamuna river corridor.

Cluston (2002) has conducted a study to estimate ecological and economic values of Moreton Bay wetlands, Australia, employing CVM. The study results indicated that WTP when provided with ecological information was not significantly different from WTP otherwise. The information on use values produced a higher WTP ($ 8.93) than when no information was provided. The mean WTP to protect wetlands was higher for visitors (mean =$25.15) than for non-visitors (mean =$12.91).

Chen (2005) estimated the total recreational value of water improvement in Lake Wuliangsuhai, Inner Mongolia in China. The total recreational value of the lake ranged from 10.5 million Yuan to 21.7 million Yuan. WTP for the improved lake was from 1.4 million Yuan with mean WTP at about 59.52 Yuan. The WTP level that maximizes the total annual income was around 44 Yuan and the maximum total annual income from boating and entrance was about 921377 Yuan.

Loomis *et al* (2005) used CVM to estimate homeowners' willingness to pay for water leasing to maintain stable lake levels at an irrigation reservoir in a residential neighborhood of Colorado. A binary logit model was used to analyze households' voter referendum responses for maintaining the lake level. The median WTP was found to be $368 per year for lakefront residents and $59 per year for off-lake residents. The results showed that the increase in homeowner association fees would generate approximately $43, 000, which was enough to lease sufficient water to reach the target lake level in a normal water year.

Antonopoulou *et al* (2006) estimated the indirect-use value and the non-use value of the Volvi wetland using the CVM.The Payment vehicle used was the bi-monthly electricity bills. Factors influencing WTP included level of education, age of respondent, monthly family income and area of residence. The estimated mean WTP came to about € 0.48.

Michailidis (2006) estimated the socio economic and environmental values of three irrigation lakes, constructed at Panagista village in Central Macedonia (Greece) by using CVM. It was assumed that the consumers' satisfaction of water supply service, their opinion about the water management system and its affordability might have an impact on their WTP.Various outputs like water supply,recreation,health effects, social impact and environmental consequences were valued through the CVM.

Thomas and Smith (2006) conducted a survey to elicit public response to a proposal to fund the purchase of a conservation easement program to protect an environmentally sensitive riparian corridor in Ohio (Columbus). The results from two versions of the CVM –a payment card and a referendum –revealed that mean household WTP was $ 16.80 and $ 29.16, respectively. Factors influencing WTP included proposed cost, age of respondent and individual sense of local environmental priorities.

Whitehead *et al* (2006) estimated the economic values of Saginaw Bay coastal marshes (US) with multiple methods. Using the site selection travel cost model and conservative aggregation assumptions, an increase in 1125 acres of coastal marsh was valued at about $ 94,000 annually. The annual value of protection was estimated at $ 113,000, and the present value at $ 2.2 million, using the CVM.

Imandoust and Gadam (2007) used CVM to estimate people's willingness to pay for improvement of Pavana river water quality in Pune (India) among households, farmers, fishermen, washer women and bath taking people. The mean willingness to pay was estimated at Rs.17.6 per family per month.

Kalpana *et al* (2007) assessed the economic linkages between the Kabartal wetland in the upper Indo-Gangetic flood plains in northern India and the local people living around it through CVM. The willingness of people to accept

compensation, as an alternative to access to Kabartal wetland, regressed on various socio-economic and attitudinal parameters, gave an estimated mean value of US $27,500 per household over a period of 60 years.

Kwak *et al* (2007) estimated the conservation value of the Woopo wetland, Ramsar site, in Korea through CVM. Respondents in general accepted the hypothetical market and were willing to pay a significant amount (2,731 to 3,960 Korean won= USD 2.10 to 3.05), on an average per household to conserve the wetland.

2.2 Studies on Kolleru Lake

Kolleru Lake has been an area of key research interest by biologists, geologists, ecologists and sociologists. There are many reports, which include scientific papers on the lake. The Kolleru Lake Development Authority which was established in the year 1982 has made attempts to compile such works, and also has made several attempts to conduct its valuation studies. Some of the relevant reports are mentioned here.

Pandurangam (1967) had made a geographical measurement of the lake and suggested remedies for the improvement of drainage and irrigation. He had made solid recommendations for the development of fisheries, construction of roads and bridges, provision of infrastructural facilities in the villages of the Kolleru Lake and also suggested measures for the development of the piggery, duckery and dairying activities.

Seshavatharam and Dutt (1978) had made a comprehensive study on the ecology of the Kolleru Lake.Later, Ramakrishnaiah (1980) critically examined the implications of the ecological disturbances in the lake. He had made recommendations for the improvement of the drainage system in the region which

included constructing a regulator at "+7" contour near 'Kottada' village, systematic maintenance of 'Perantalakanuma' to eradicate the weed growth for efficient discharge and strategies to coordinate the activities of agriculture and pisciculture without causing undue and hasty ecological imbalance.

Ramakrishna (1980) has submitted a detailed report on the integrated development of the lake area, to the Government of Andhra Pradesh. The recommendations included specific suggestions in civil constructions, ecology management and governance; agriculture should be allowed only beyond +5 M.S.L, cross bunding of inlet channels should not be permitted, adequate steps should be taken to prevent or reduce the soil erosion in catchment area for the reduction of siltation in the lake region, bird sanctuaries should be developed at 'Agadallanka', 'Prathikollanka' and 'Manapakalanka'. A single agency with sufficient statutory and financial powers to implement these schemes with regulators and powers to protect the ecology of the lake was to be set up.

Kishore (1985) had submitted a report to the Government of Andhra Pradesh on the problems of agriculture in *pattalands* within the Kolleru area. He had highlighted the importance of drainage management programmes, for better agriculture production and ecosystem sustenance.

In 1995, Raju has submitted detailed management plan for the lake region with the focus on conservation. The plan made suggestions to restrict anthropological interventions in the area such as agriculture and industries.

Rao *et al* (2000) estimated the area under fish pond culture within the lake area using high resolution data from satellites. The changes that have occurred during the last 10 years in Kolleru lake area have been studied. The satellite data from Land Sat and IRS have been analyzed and classified, after geometric rectification of the images. It was found that more than 65 per cent of the lake has been encroached for conversion into fishponds by 1999.

Raju *et al* (2003) had made a study on the environmental threat to Kolleru Lake and indicated that the proposed cross bund across the 'Upputeru' near 'Patapadu' to 'Chinnagollapalem' island would convert the fresh water Kolleru Lake and Upputeru river and its distributaries into saline.

Rao et al (2004) used the digital processing methods of the IRS-1D LISS-III and revealed the highly degraded condition of the lake. The image enhancement through automatic log residual method clearly indicated that about 42 percent of the 245 sq km lake area was encroached for aquaculture and 8.5 percent more area was occupied for agriculture, while the rest of the lake was either being dried out by reclamation or is infested with weed. The study provided unambiguous visual information on the alarming levels of human-induced environmental degradation of Kolleru Lake, which is one of the important coastal wetland ecosystems in the country.

A study conducted by Sarma (2005) on the problems of the large scale encroachment and false pattas (title deed of land) in the area revealed that these pattas were used as collateral security in the banks and co-operative societies to get loans worth crores of rupees. The developmental activities in the area by government agencies without concern for ecological balance also have created problem which has naturally made the life of natives miserable.

Amongst the large volume of literature available on Kolleru Lake only a few relevant ones are quoted here. The studies highlight the absence of any attempt on economic valuation of the lake, from a user perspective. Hence this study gains relevance and significance in the context of the debates on the need to preserve the ecosystem of Kolleru VS the livelihood security of the inhabitants of the lake.

Materials and Methods

Chapter III
MATERIALS AND METHODS

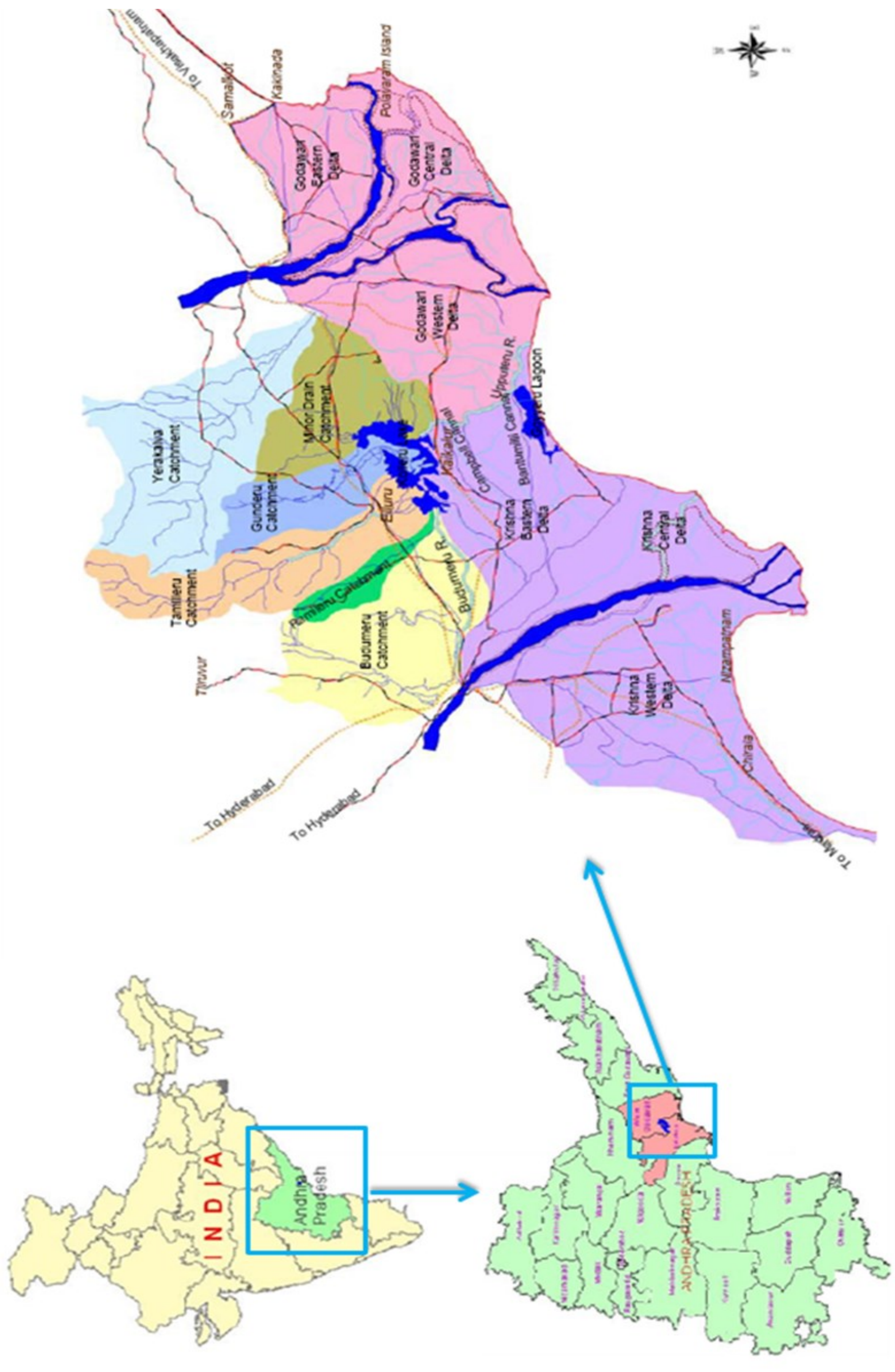
Appropriate research design is a pre-requisite for successful conduct of a research study. The present study on the Valuation of Ecosystem services of Kolleru Lake in Andhra Pradesh aims to identify the services provided by the Kolleru Lake as perceived by the stakeholders and to assess the WTP for ecosystem services. In this section a brief description of the study area and the methodology used for the study are discussed in detail.

3.1 Description of Study area

Kolleru Lake is one of the largest fresh water eco systems (wetland) of international importance recognized under Ramsar Convention, Iran (1971) covering 90,100 ha. The lake was declared a wild life sanctuary in November 1999 under India's Wild Life Protection Act and designated a wetland of international importance in November 2002. In addition to this, the lake region is identified as one of the important wetland bodies of Asia and is included under the 14th category. It was described in an Imperial Gazette as "Peerless Fishermen Paradise and Birds Heaven".

3.1.1 Location

Kolleru Lake is an etrophic natural lake, located between the deltas of Krishna and Godavari River about 55 km, east of Vijayawada and 25 km North West of coastline in the state of Andhra Pradesh, India. It lies between 16° 30' N to 16° 45' N latitudes and 81° 05' E to 81° 20' E longitudes. It broadly lies between Kaikaluru in Krishna District and Eluru in West Godavari District of Andhra Pradesh. The lake is situated 35 km inland from the present coast line on the East Coast. The location map of Kolleru wetland is given in Fig.1.


To Visakhapatnam
Samalkot
Kakinada
Polavaram Island
Godavari Eastern Delta
Godavari Central Delta
Godavari Western Delta
Yerakalva Catchment
Minor Drain Catchment
Gunderu Catchment
Tammileru Catchment
Budumeru Catchment
Eluru
Budumeru R.
Upputeru R.
Krishna Eastern Delta
Krishna Central Delta
Krishna Western Delta
Nizampatnam
Chirala
To Hyderabad
To Hyderabad
INDIA
Andhra Pradesh

Ecologically Kolleru Lake is a wetland eco-system, with a total catchment area of

4763 sq. km spreading over West Godavari and Krishna districts. It is formed between the alluvial plains of River Godavari and Krishna due to natural geological formation covering seven mandals in West Godavari district with an area of 38,070 ha and two mandals in Krishna district with an area of 11,299 ha. The mandal wise geographical spread of Kolleru Lake is presented in table 3.1.

Table 3.1 Mandal wise geographical spread of Kolleru Lake

S.No	Mandal	District	Area (ha)
1	Eluru	West Godavari	15,296
2	Unguturu		85.76
3	Pedapadu		504.96
4	Denduluru		375.04
5	Akiveedu		4424.96
6	Nidamarru		4376.32
7	Bhimadole		13,007
Total			**38,070**
8	Kaikaluru	Krishna	6,589
9	Mandavalli		4,710
Total			**11,299**
Grand Total			**49,368**

Source: Anon, 2007

3.1.2 Physiography

The lake experiences brackish water condition in the southeastern region during summer months when the inflow of the fresh water into the lake is low. The saline water reaches up to the middle regions of the lake, while in the northern parts freshwater conditions exist. The depth of the lake varies from 1 to 1.6 m and it reaches up to 3 to 4 m during high floods.

The Kolleru Lake maintains connection with the sea through Upputeru (uppu = salt, eru = canal) and this has a typical lagoon character. Towards the south of the lake there is a vast stretch of low lying marsh land of about 135 km

separated from the lake by a set of ancient beach ridge. Beach ridges are low, narrow, elongated and nearly parallel set of ridges each representing a former shore line. Tidal marsh is 40 km away from the sea towards Kolleru along the meandering course of Upputeru.

3.1.3 Water - Spread area

The water spread of the lake varies from 135 sq.km at +3 MSL (Mean Sea Level) level to 901 sq.km at +10 MSL.Of this, upto +5' MSL was declared as Sanctuary in 1995 under Section 18 of Wildlife Act, 1972.The water spread area of the lake is around 1000 sq.km during the flood season (July to November) and is around 312.41 sq.km during winter and summer months.

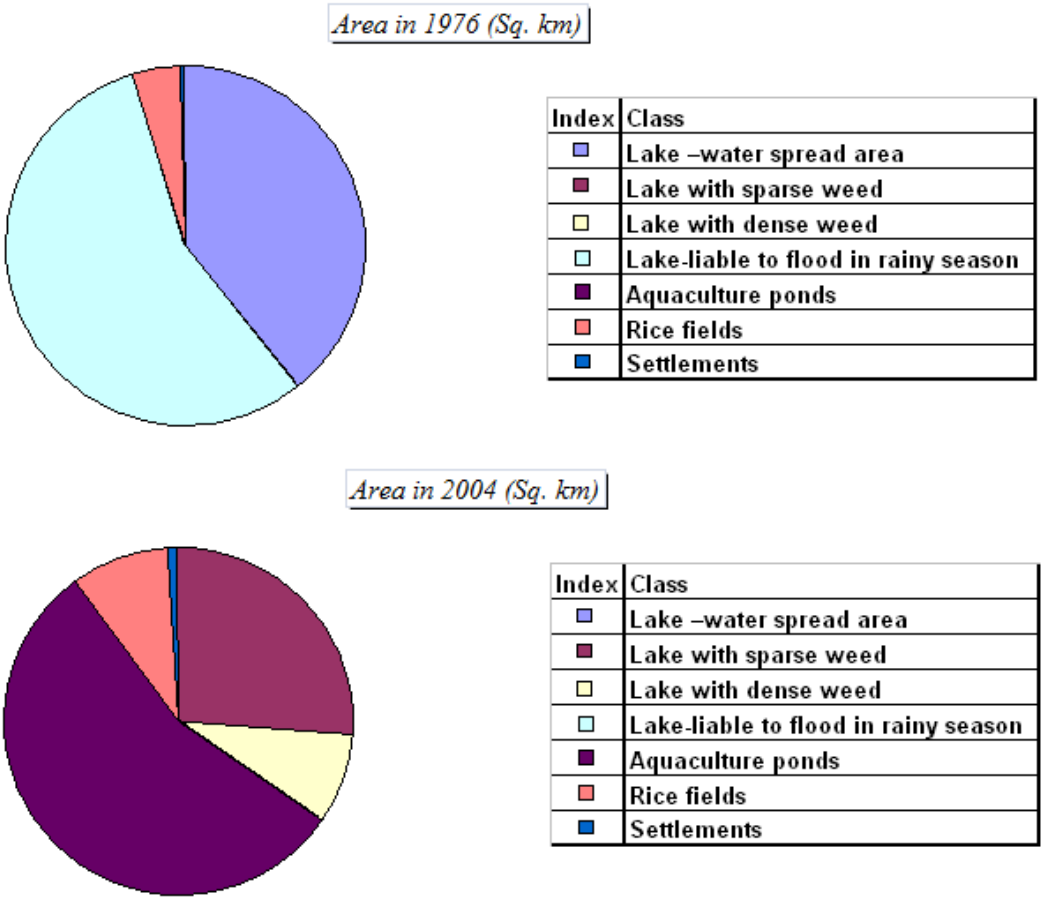
Satellite images taken in the year 2004 indicated that the total water spread area of the lake was 62.65 sq.km (34.73% of 1967 lake area) (Table 3.2) which included 47.45 sq.km of sparsely covered weed growth and 15.20 sq.km covered with dense aquatic plants. Marappan (2006) had reported that the aquaculture which had developed between 1967 and 2004 occupied an area of 99.74 sq.km, rice fields increased from 8.40 sq.km to 16.62 sq.km and human settlements from 0.31 sq.km to 1.37 sq.km in Kolleru. The comparative status of Kolleru Lake between 1967 and 2004 is presented in Table 3.2 and Fig.2.

Table 3.2. Status of Kolleru Lake between 1967 and 2004

S. No	Class	Area in (sq. km)	
		Year 1967	Year 2004
1	Lake - water spread area	70.7	0
2	Lake with sparse weed	0	47.5
3	Lake with dense weed	0	15.2
4	Lake - liable to flood in rainy season	101	0
5	Auaculture ponds	0	99.7
6	Rice fields	8.4	16.6
7	Settlements	0.3	1.4
Total		180.4	180.4

Source: Marappan *et al*, 2006

Fig. 2: Status of Kolleru Lake in 1967 and 2004



3.1.4 Drainage

Enclosed between the two major river basins of the Godavari and the Krishna, the lake has been functioning as a natural flood-balancing reservoir between the deltas of the rivers. It serves as a habitat for various resident and migratory birds besides sustaining fishing, agriculture and related occupations of the people dependent on it for livelihood. The Lake is fed directly by two seasonal rivers, the Budameru and the Tammileru (East and West branches) besides 30 inflowing drains and channels (WG, 2007). The drainage area of these two rivers is about 5,121 sq.km. A number of channels also enter the lake and most of them are from the northern side. Some artificial drains from Krishna and Godavari irrigation canals are diverted into the Kolleru Lake. The lake receives through its major drains and canals an inflow of more than 1,00,000 Cusecs of water which is discharged at the rate of 6,650 Cusecs (at lake level '+7') into the sea by its narrow and only outlet, the sluggish "Upputeru"drain. The bed level of Kolleru is 2' to 3' higher than the bed level of the inflowing rivers. Therefore, there is backing effect into the drains from Kolleru Lake.

At present, the rapid encroachment of the lake bed has caused changes both in the drainage pattern and internal flow characteristics leading to a series of environment and economic problems.

3.1.5 Climate

The lake area enjoys a semi-arid (Dd) type of climate of Thornthwaite classification. Summer temperature is up to 38^0-40^0 C. Winter temperature is up to 19^0 –23^0 C. It receives an average rainfall of 70-100 cm per annum from the southwest and northeast monsoons. Major part of the rainfall is due to South West monsoon (July-September). Considerable rainfall occurs during October and November months due to cyclonic activity in the Bay of Bengal (Srivasuki, 2002).

3.1.6 Flora and fauna

The floristic studies indicate that the entire lake is covered by littoral vegetation, predominantly of hydrophytes. There are about 18 species of aquatic macro-phytes belonging to 14 families of vascular plants in the lake region. It showed variation in different spots with emergent, submerged and free floating aquatic macrophytes. The floating vegetation dominated by *Ipomea aquatica* and *Eichhornia crassipes* are seen throughout the lake and formed dense mats. About 180 sq.km of the lake area is under dense weed cover (CSIR, 1978). The submerged weeds constituted by *Ottelia alismoides, Vallisneria spiralis, Ceratophyllum* were abundant in deeper parts of the lake and along ferry lines. *Nymphaea nouchali, Nymphaea stellata, Nymphoides hydrophylla and Salvinia cucullata* are also seen. Extensive strands of *Phragmites karka* is seen spread vast stretches in many areas of the lake. Other weeds such as C*yperus sp, Paspalidium, Pistia, Alternathera* and *Typha* were present in small patches. *Utricularia, Polygonum* and *Scirpus sp* were distributed in some areas only. There are about 30 varieties of hydrophytes and 22 varieties of herbs, shrubs and trees in the lake area (Srivasuki, 2002).

Ornithologists report the presence of 188 migratory birds in this area. They include Gargeney teals, Mallards, Flamingos, Grey Pelicans, Adjutant storks etc., and they visit the lake from October to March every year. The lake was famous for Grey pelicans (*Pelecanus Philippensis*), which used to migrate from central Asia (Siberia) for breeding (Anjaneyulu, 2003)**.**The most common air fauna found in the lake region are Jacanas, Herons, wild species of ducks and teals, Darters, Cormorants, Sparrows and Raptors.The important fish species found in the region are carps, cat fishes and spinyeels.Besides, prawns found in this lake are *Matepenaeus monoceros*, *Macrobrachium*, *Malcolmsonii*, *Rosenberai* and *Rude*. About 63 varieties belonging to 29 families of the fish are found. Table 3.3 indicates the existing species of culture fish and prawn in the area. The other

category of fauna like frogs, crabs and sails are also found but on the decline due to various reasons (Rao, 2005).

Table 3.3. Species of culture fish and prawn in Kolleru lake area

Category	S.No	Scientific name	Common name
Fish	1	Catla catla	Carp
	2	Cirrhinus Mrigala	Mirgod or Moses
	3	Labeo rihita	Rohu or Silavathi
	4	Entenopharvngodon idella	Grass carp
	5	Cyprinus carpio	Common carp
	6	Hypohthalmidhthys molitrixl	Silver carp
Prawn	1	Penaeus monodon	Tiger prawn

Source: Rao, 2005

3.2 Major economic activities in Kolleru Lake

The Kolleru region is inhabited by a population of 3,36,339 (Census,2001), most of whom belongs to scheduled caste and tribes distributed in 50 bed habitations and 98 belt habitations spread over 73 revenue villages including hamlets. The bed villages are island villages and the belt villages are border villages of the lake.

The major economic activities in the lakebed are agriculture, aquaculture, allied industries like ice manufacturing, transporting, packaging, storage etc. Activities like dairy, chemical, paper, sugar etc., exert great pressure on the natural resources of the lake. In the bed villages, fishing and agriculture are only secondary occupation. Whereas in the belt villages, agriculture is the main occupation and fishing is the secondary occupation. Besides fishing, the area is

highly suited for rearing water buffalo and ducks, both of which are rare now (Anon, 2006).

The local fishermen are still adopting traditional technology. Several plant species of the lake are used by the people for their daily requirements, i.e. for food, fodder, medicine and thatching.

3.3 KLDA (Kolleru Lake Development Authority)

Several attempts were there for the conservation of the lake by the government as well as private agencies. Among the conservation efforts, the most important one was the setting up of Kolleru Lake Development Authority. In 1982, the Andhra Pradesh government set up the Kolleru Lake Development Authority (KLDA), in order to put an end is encroachments on the lake to ensure the preservation of its ecosystem and enrich its flora and fauna.

The Chairman and members of the KLDA are appointed by the Hon' ble Chief Minister of Andhra Pradesh for the formulation of policies for the development of the Kolleru Lake. At the executive level, the Director of the Kolleru Lake Development Authority stationed at the state capital Hyderabad co ordinates the developmental activities.Under his direction, the specialist officer, administrative and technical staff work in the field at Kaikalur.

Despite this, the deterioration of the lake system could not be completely prevented. The administrative report of the KLDA (2001) revealed that about 36,000 acres of the government land had been converted as fish tanks. Inadequate fund allocation is reported as one of the serious reasons that restrict the activity of the authority.

3.4 Methodology

The procedure used in the selection of sample, collection of data, analysis of data and the concepts used in the study are explained in this section.

3.4.1 Sampling design

Kolleru lake area comprises of 73 villages. Out of these, 10 villages falling within a radius of 5 km from the lake were randomly selected for the study. The list of the stakeholder groups, who are dependent on the lake for their livelihood, was collected from the village records, local enquiries and consultation with officials of development departments in the area. From the list, sample of 180 respondents were selected randomly. The sample respondents were post stratified into seven categories based on their economic activity as shown in Table. 3.4.

Table 3.4 Classification of respondents based on their economic activity

S. No	Stakeholder group	Sample Size
1	Farmers	15
2	Fishermans	90
3	Dairy Farmers	20
4	Duck Rearers	10
5	Sheep & Goat Rearers	20
6	Input Suppliers	10
7	Agricultural Labourers	15
Total		180

3.4.2 Collection of data

For primary data collection, a well-structured and pretested interview schedule developed for the purpose was used. Each category of stakeholder was

interviewed, using the schedules developed separately. The copy of the schedule is furnished as appendix (i). The collected data included basic information on socioeconomic characteristics of the respondents, their perception of benefits from lake and their management views. The respondents were asked to identify the services provided by the lake and rate the direct and indirect use values of the lake. The direct benefits were valued based on the level of income derived from lake dependent activities. The indirect benefits were captured through their stated WTP. For eliciting their willingness to pay for the preservation of the lake, a double bounded dichotomous choice question was asked.

The referendum (dichotomous choice) question starts with a specific monetary amount and the respondent is asked whether he or she is willing to part that amount for the good in the question. Single bounded dichotomous choice CV method was pioneered by Bishop and Heberlein (1979) and only one dichotomous choice question is asked with a threshold amount and the respondent is expected to answer either 'yes' or 'no' to that amount.

In double bounded format, instead of single time bidding, two times bidding is practiced. The double bounded approach was first suggested by Hanemann (1984). Here the participant is asked to respond to the follow up question involving another bid amount depending on the response to the first question. If the response to the first bid is 'yes' then the second bid will be a higher amount. If the response to the first bid is 'No' then the second bid will be a lower than the first bid. It has been shown by Hanemann *et al* (1991) that the double bounded procedure is statistically superior to single bounded procedure.

There was no previous study in the study area to determine the bid structure. The bid structure was designed by pre-testing and using double bounded dichotomous choice referendum format for all stakeholder groups. The payment vehicle was one time payment. Payment was supposed to be made as the

membership fee to utilize the wetland services. This payment vehicle was chosen because membership fees are already administered for other public-service purposes and, as they are familiar with it, local people would, up to a point, trust it. The payment vehicle bias could be avoided by choosing membership fees as the vehicle. So it started at Rs. 100 per annum per household which is the current payment to KLDA.

A brief description of lake was given to the respondents and scientific information on the present situation of the lake was put in to their notice before eliciting their willingness to pay for the indirect use value of the lake.

The required secondary data were collected from various institutions like KLDA, Wildlife management division records, Indian Institute of Science (Bangalore), Village records, IFA (India Farmers Association) and A.P Package of Practices.

3.4.3 Analytical framework

The data were collected during the period March to April 2009 and pertains to the year 2008-09. The analysis of the data was done as described below:

3.4.3.1 Services provided by the lake

Respondents were asked to score the ecological services from the lake based on relative importance perceived by them. The scoring was based on a five point continuum ranging from least important to most important and the number of respondents who indicated a specific rank for a specific service was counted. The major objective was to ascertain people's ability to recognize these services and identify their importance.

3.4.3.2 Present status of lake

The respondents were asked to give their opinion regarding the present status of the lake from the point of view of preservation. The opinion was elicited in a five point continuum and the frequency was worked out.

3.4.3.3 Extent of Pollution of lake

The respondents perception about the extent of pollution occurred to the lake were elicited in a four point continuum and percentage analysis of the response was found out.

3.4.3.4 Total Economic Value (TEV)

The Total Economic Value (TEV) of any resource consists of marketable and non-marketable benefits. TEV distinguishes between *use* values and *non-use* values. The TEV is estimated as

TEV= Direct Use Value + Indirect Use Value + Option Value + Existence

Value + Quasi-option Value

The Use Values involve some human 'interaction' with the resource. Use values are grouped according to whether they are *direct* or *indirect*. The Direct Use value refers to those uses which are most familiar to us: harvesting of fish, collection of fuel wood and use of a natural resource for recreation. The Indirect Use value refers to functional benefits derived from the role of ecosystem in supporting human activity like flood control, nutrient retention, climate regulation etc. Another special category of Use 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 future. Quasi-option value is the expected value of the information derived from delaying exploitation and conversion of a natural resource today. The Non use value refers to those current or future (potential) values associated with an environmental resource which rely merely on its continued existence and are unrelated to use. Every natural resource is associated

with a value given to the resource by the individuals who do not currently make use of them, but nevertheless wish to see them preserved 'in their own right', which refers to the Existence value. It is a form of non-use value that is extremely difficult to measure, as existence values involve subjective valuations by individuals unrelated to either their own or others' use, whether current or future (Pearce and Warford, 1993).In the present estimation the TEV excludes the existence value.

3.4.3.5 Willingness To Pay (WTP)

The CVM is a widely used non market valuation method, in environmental economics (Carson *et al*, 1995). "The CV method was originally proposed by Ciriacy (1947) who was of the opinion that the prevention of the soil erosion generates some 'extra market benefits' that are public goods in nature, and therefore, one possible way of estimating these benefits is to elicit the individuals' willingness to pay for these benefits through a survey method (Portney,1994;Hanemann,1994). However, Davis (1963) was the first to use CV method empirically when he estimated the benefits of goose hunting through a survey among the goose hunters. This method gained popularity after the two major non-use values, namely, option and existence values, have been recognized as important components of the total economic values in environmental economics literature, especially during the 1960s, while the conventional revealed preference methods such as Travel Cost Method are not capable of capturing these non-use values (Smith,1993)" (Venkatachalam, 2004). When relevant market behaviour is not observable, the CVM put direct question to individuals to determine how much they might be WTP for an environmental resource, or how much compensation they would be Willing To Accept (WTA) if they were deprived of the same resource. In recent years this method is commonly used in developing countries to elicit the individual's preferences for the basic infrastructural projects such as water supply and sanitation. Later on, a series of attempts were seen, using this approach on valuation of ecosystem services like

river system and wetlands in India (Verma *et al*, 2001; Imandoust and Gadam, 2007). Many studies used regression models to estimate of WTP for ecosystem services. Imandoust and Gadam (2007) used a linear regression model while analyzing the results of WTP for improvement of river water quality. The specification of the model used in their study was

$$WTP = a + b_i x_i + \xi$$

Where,

WTP = Willingness to pay (dependent variable)

a = Intercept (constant)

b_i = Regression coefficients (regression parameters)

x_i = Explanatory variables (independent variables)

ξ = Error term

3.4.3.6 Specification of the model

Following the studies of Imandoust and Gadam (2007) and Babu and Kumar (2001) a linear regression model was fitted for estimating the willingness to pay for preservation of Kolleru wetland. The independent variables were selected after conducting extensive review of literature and pilot study. The independent variables used in estimating the willingness to pay in a few related studies are presented in Table 3.5.

Table 3.5 Independent variables used in valuation studies

S. No	Author	Title of study	Independent variables	Method
1	Verma *et al* (2001)	Economic valuation of Bhoj Wetlands for sustainable use (Bhopal), India	Income(annual/family), Education, Distance from lake, No. of minor members, No. of adult members, Length of residence, Frequency of visit, Ranking of pollution	CVM (Open-ended bidding game)
2	Babu and Kumar (2001)	Valuation of ecological functions and benefits: A case study of wetland ecosystems along the Yamuna River Corridors of Delhi Region, India	Age, Sex, Education, Household size, Income	CVM(Payment Card)
3	Imandoust and Gadam (2007)	Are people willing to pay for river water quality? (Pavana river, Pune city), India	Per capita annual income of the family, Period of living in Pimpri, Size of the family, Importance of cleaning river water, No of visitors to river side	CVM(Open-ended bidding game)
4	Alvarez and Larkin(2008)	Valuing recreational benefits of a National park in Andean Columbia, (Los Nevados National Park), Colombia	Age, Income, Education, Gender, Familiarity with the wild fires, Ecological services provided by the area to be restored, Environment awareness	CVM (Open-ended questions)
5	Boontho(2008)	An Economic Analysis of Phu Kradueng National Park, Thailand	Income, Education, Age, Marital Status, No. of employed family members	CVM

30

6	Kalpana *et al* (2007)	Social and economic considerations in conserving wetlands of indo-gangetic plains: A case study of Kabartal wetland, India	Education, Size of the family, Land of the household falling under the , declared sanctuary, Area cultivated by the household in kharif, Area cultivated under Rabi, Head loads of construction materials brought by the family/annum, Units of other biomass products brought from wetland	CVM
7	Vasudevan and Suryaprakash (2005)	Estimation of the existence value of Sacred Groves by using CVM method in Kerala	Family size, Education of the household, No of females in the family, Land area owned(Acres), No of stakeholder families, Value of land in the locality, Annual expenditure in grove (Rs/Yr), Monthly income	CVM (Payment Card)
8	Samaraweera and Marothia(2007)	User's appraisal and valuation of changes in renewable natural resources status: A Case study from Chhattisgarh, India	Age, Education, Household income, Family Income, Sex, Total farm area owned(ha), Total livestock owned (no.), Interest in protection and restoration of resource, Distance of resources from the place of residence (m), User's perception of resource degradation ,Time spent collecting a resources	CVM (Close-ended)

Based on these, the model for the study is specified as:

WTP = f (AGE, SEX, DISTANCE, EDULEVEL, HHZ, PROINCOME, GENEP, POLL, GROUP)

The variables used for fitting the regression are

(a)Willingness to pay (WTP): The amount that respondents were willing to pay for preservation of the lake in terms of per annum per household.

(b) AGE: Completed age of the respondent.

(c) SEX: Sex of the respondents coded as 0 for male and 1 for female.

(d) DISTANCE: The distance in kilometers at which the house of the respondent is situated from the lake.

(e) EDULEVEL: Education level of the respondent measured in terms of years coded as follows: 0 if illiterate, 1 if studied up to XII class, 2 for graduation and 3 for post graduation.

(f) HHZ: Number of members in each household.

(g) PROINCOME : Proportion of the income from lake related activities like farming, fishing, sheep & goat rearing and others to total household income.

(h) GENEP: Stakeholders general perception about the lake services coded as follows: 1- most important, 2 - very important, 3 - important, 4 - less important and 5 - least important.

(i) POLL: Respondents perception of pollution as a threat to the lake ranked as follows: 0 if Not at all, 1 if marginally, 2 if moderately and 3 if highly polluted,

(j) GROUP: Stakeholder groups who were dependent on the lake for their livelihood coded as 1 for farmer, 2 for fishermen, 3 for dairy farmer, 4 for duck rearer, 5 for sheep and goat rearer, 6 for input supplier and 7 for agricultural labourer.

The regression was run using SPSS 13.

Results and Discussion

Chapter IV

RESULTS AND DISCUSSION

The data collected through the survey were subjected to statistical analysis and the results are presented in five sessions. The first section deals with the stakeholder groups and their social and economic characteristics. The second section deals with stakeholder groups direct dependence on the lake and Direct Use Value (DUV) of the lake system. The stakeholder perception about the present status of lake services and the extent of pollution are presented in the third session. The stakeholders' Willingness To Pay (WTP) for preserving the lake and the factors influencing WTP is discussed in the fourth session. Last session deals with the Estimated WTP and Indirect Use Value (IUV) of the lake system.

4.1 Socio economic characteristics of Stakeholder groups

The stakeholder groups identified in the Kolleru Lake are farmers, fishermen, dairy farmers, duck rearers, sheep and goat rearers, agricultural labourers and input supply agencies. Knowledge of the social and economic characteristic of the sample stakeholders groups would be useful for understanding the implication of the analysis and its generalization. A brief description of the general socio economic feature of the respondents with respect to age, sex, education, household size and household income have been included to serve as a background of the study.

4.1.1 Age

The distribution of respondents according to the age is given in table 4.1. It was found that 33.3 percent of the total respondents were under the age group of 40-50 years. About 25 per cent each were less than 40 years age and between 50-60 year categories. The rest of the respondents (16.7%) were of more than 60 years of age. A stakeholder wise analysis showed similar trend among farmers,

fishermen, dairy farmers, agricultural labourers and input supplier categories with majority of respondents falling in the age group of 40-50 years. An equal distribution of respondents was found in the case of sheep and goat rearers (25% in each age group). Fifty per cent of the respondents among the duck rearers were in the age group of 50-60 years and only one person in this group was less than 40 years of age. The average age varied from 37 years to 44 years. Among the stakeholders, the duck rearers were older, followed by dairy farmers and sheep & goat rearers. However, the average age of their entire stakeholder group was less than 40 years. Even though duck rearing earns much higher income (Table. 4.5), only older people are engaged in it. The monotony of the duck rearing and long hours to be spent in swampy condition may be the reason for no interest among younger generation, similar reasons may be attributed for the lower involvement of younger generation in dairy farming as well as sheep rearing.

Table 4.1 Distribution of Respondents according to age

Respondents	Age					Mean Age(yrs)
	< 40 Yrs	40 - 50 Yrs	50 - 60 Yrs	> 60 Yrs	Total	
Farmer	5 (33.3)	5 (33.3)	3 (20.0)	2 (13.3)	90 (100)	37
Fisherman	24 (26.7)	31 (34.4)	23 (25.6)	12 (13.3)	15 (100)	38
Dairy Farmer	5 (25.0)	6 (30.0)	5 (25.0)	4 (20.0)	20 (100)	40
Duck Rearer	1 (10.0)	2 (20.0)	5 (50.0)	2 (20.0)	10 (100)	44
Sheep & Goat Rearer	5 (25.0)	5 (25.0)	5 (25.0)	5 (25.0)	10 (100)	40
Input Supplier	2 (20.0)	4 (40.0)	2 (20.0)	2 (20.0)	20 (100)	39
Agri Labour	3 (20.0)	7 (46.7)	2 (13.3)	3 (20.0)	15 (100)	38
Total	45(25.0)	60(33.3)	45 (25.0)	30 (16.7)	180 (100)	39

*Figures in parenthesis shows percentage to total

4.1.2 Sex

The gender wise classification of respondents presented in Table 4.2 revealed that 85 percent of the total respondents were male. Stakeholder group wise classification also pointed out that majority of respondents of dairy farmer

(60%) and sheep & goat rearer (85%) were male. All the farmers, fishermen and input suppliers were male persons. Sixty percent of the agricultural labour and seventy percent of the duck rearer were women. The male female population ratio in Andhra Pradesh is common is unfavorable to women (538:462, Census 2001). The land ownership is mostly with male and hence they are the income earners. The stakeholder groups within the radius of 5 km within the lake being fishermen, only male are engaged in the fishing activities. So there is a clear cut gender divide among the economic activities as revealed by the study.

Table 4.2 Distribution of Respondents according to sex

Respondents	Sex		
	Male	Female	Total
Farmer	15 (100)	0 (0)	90 (100)
Fisherman	90 (100)	0 (0)	15 (100)
Dairy Farmer	12 (60)	8 (40)	20 (100)
Duck Rearer	3 (30)	7 (70)	10 (100)
Sheep & Goat Rearer	17 (85)	3 (15)	10 (100)
Input Supplier	10 (100)	0 (0)	20 (100)
Agri Labour	6 (40)	9 (60)	15 (100)
Total	153 (85)	27 (15)	180 (100)

*Figures in parenthesis shows percentage to total

4.1.3 Education

The educational status of respondents is shown in Table 4.3.About 70 per cent of the total respondents were educated up to XII class, nine per cent up to graduation and one per cent had post graduation. Twenty per cent of the respondents were illiterate. Stakeholder group wise analysis revealed that majority of the respondents of fishermen, farmer, dairy farmer, duck rearer, sheep &goat rearer and agricultural labourer groups were educated up to XII and input supplier (70%) were graduates. Twenty per cent of input suppliers were post graduates. Graduates were found among the farmers, dairy farmers and input supplier

groups. The presence of educated men in farming is a welcome factor. Most of the fishermen (86%) were educated up to XII. It was revealed that none of the respondents of input suppliers were illiterate.

The average education status revealed that the respondents of fishermen, famer, dairy farmer, duck rearer, sheep &goat rearer and agricultural labourer were educated up to XII and input supplier had graduation. The average education of the total stakeholder groups was up to XII class.

Table 4.3 Distribution of Respondents according to education

Respondents	Education				
	Illterate	Upto XII	Graduate	Post Graduate	Total
Farmer	5 (33)	6 (40)	4 (27)	0 (0)	15(100)
Fisherman	13 (14)	77 (86)	0 (0)	0 (0)	90(100)
Dairy Farmer	2 (10)	13 (65)	5 (25)	0 (0)	20(100)
Duck Rearer	3 (30)	7 (70)	0 (0)	0 (0)	10(100)
Sheep & Goat Rearer	8 (40)	12 (60)	0 (0)	0 (0)	20(100)
Input Supplier	0 (0)	1 (10)	7 (70)	2 (20)	10(100)
Agri Labour	5 (33)	10 (67)	0 (0)	0 (0)	15(100)
Total	36(20)	126(70)	16(9)	2(1)	180(100)

*Figures in parenthesis shows percentage to total

4.1.4 Household size

Classification of respondents according to the number of people living in a household is presented in Table 4.4.In majority of cases family size was less than four (61%). One fourth of the respondents had five member families. Majority of the fishermen and farmer households were with four persons and less than three persons respectively. Only 8 per cent of fishermen and farmer households were bigger family size of more than five members. The average household size of each stakeholder group was around four persons.

Table 4.4 Distribution of Respondents according to household size

Respondents	Household Size(Members)					Mean Household size
	< 3	3 to 4	5	> 5	Total	
Farmer	9 (60)	1 (7)	1 (7)	4 (27)	15(100)	3.9
Fisherman	21 (23)	34 (38)	25 (28)	10 (11)	90(100)	4.2
Dairy Farmer	8 (40)	9 (45)	3 (15)	0 (0)	20(100)	3.8
Duck Rearer	4 (40)	4 (40)	2 (20)	0 (0)	10(100)	3.8
Sheep & Goat Rearer	8 (40)	6 (30)	6 (30)	0 (0)	20(100)	3.8
Input Supplier	4 (40)	3 (30)	3 (30)	0 (0)	10(100)	3.8
Agri Labour	7 (47)	4 (27)	4 27)	0 (0)	15(100)	3.7
Total	61(34)	61(34)	44(24)	14(8)	180(100)	4.0

*Figures in parenthesis shows percentage to total

4.1.5 Household income

The classification of respondents based on their household income is furnished in Table 4.5. It shows nearly half of the respondents as having household income ranging between Rs 50,000 and Rs.1, 00,000. One third were in the category of Rs 25,000 to Rs 50,000.Only 6.7 per cent and 13.9 per cent of the respondents had household income less than Rs 25,000 and exceeding one lakh rupees respectively.

It was found that majority of the respondents of fishermen (58.9%), farmer (53.3%) and dairy farmer (55%) groups were in the income group of Rs 50,000 - Rs.1, 00,000, while sheep & goat rearer and agricultural labourer groups came under income group of Rs 25,000 to Rs 50,000.The respondents of input supplier group alone had income exceeding one lakh rupees. The maximum annual household income of duck rearer was greater than one lakh.The average annual household income ranges from Rs.39,015 to Rs.14, 98,450.The annual average household income of total stakeholder groups was about Rs.1, 43,860.The average income of input suppliers was about Rs.14, 98,450 per annum.

Table 4.5 Distribution of Respondents according to household income

Respondents	Household Income (Rupees)					Mean HH Income(Rs)
	< 25,000	25,000 - 50,000	50,000 - 1,00,000	> 1,00,000	Total	
Farmer	4 (26.7)	3 (20.0)	8 (53.3)	0 (0.0)	15(100)	54186
Fisherman	6 (6.7)	30 (33.3)	53 (58.9)	1 (1.1)	90(100)	56160
Dairy Farmer	0 (0.0)	4 (20.0)	11 (55.0)	5 (25.0)	20(100)	82330
Duck Rearer	0 (0.0)	0 (0.0)	1 (10.0)	9 (90.0)	10(100)	184850
Sheep & Goat Rearer	2 (10.0)	15 (75.0)	3 (15.0)	0 (0.0)	20(100)	39015
Input Supplier	0 (0.0)	0 (0.0)	0 (0.0)	10 (100.0)	10(100)	1498450
Agri Labour	0 (0.0)	8 (53.3)	7 (46.7)	0 (0.0)	15(100)	51185
Total	12(6.7)	60(33.3)	83(46.1)	25(13.9)	180(100)	143860

*Figures in parenthesis shows percentage to total

4.2 Direct Dependence on lake

A number of people are dependent on the Kolleru Wetland for their daily livelihood. The economic activities of these people have mainly been gathered through focused group discussions. The category wise details are given below:

4.2.1 Farming

Traditionally agriculture has been one of the main occupations in the lake area. An area of 32,908 hectares of fertile land in the lakebed is used for cultivation of, the staple food, a local variety of rice –"Yerra vari". Paddy is the major *kharif* crop accounting for 95 per cent of the total cropped area, the rest being millets, sugarcane and vegetables. *Rabi* season agriculture has more diversity of crops with paddy and grams (majority green gram) accounting for 49 per cent and 40 per cent of the total cropped area respectively (CSE, 2006). Average paddy production per hectare in *kharif* and *rabi* seasons is 4.33 and 5.98 tonne respectively. The cost of cultivation of paddy is Rs.7500 per ha and about 256 man days is required for cultivating one hectare. In the bed villages, co-operative farming practices are adopted by the villagers. The villagers constitute the village council. The council, cultivate the village common areas and every male member of the village has a share in the council. There are 93 Farming

societies in the lake area, which consist of 21710 members (KLDA, 2001). These every farmer has to pay Rs 100 per annum as membership fee to the Farming Society for doing farming activity in Kolleru lake region. The annual average income from farming is Rs. 39,497, which is 62 per cent of the total household income.

4.2.2 Fishing

Fishing also is a main occupation in the study area, providing livelihood for the lake dwellers. There are 88 Fishermen Co-operative societies in the lake area, which consist of 5542 members (KLDA, 2001). Wetlands International South Asia (WISA, 2008) reported that the average yield of fish in the lake area varied from 2,500 to 3,000 kg per hectare per season, which fetches an annual income of Rs.1, 500 to 2,000 crores. The income obtained from these lands is shared by the male population of the village. Every fisherman has to pay Rs 100 per annum as membership fee to the Fishermen Co-operative Society for undertaking fishing activity in the lake. The annual average income from fishing is Rs. 36,119 and is engaged in fishing for 259 days per year. The fish catch is relatively higher during the winter in contrast to the rainy season. December to February is the most ideal season for fishing. In the month of May, the fishing activity is totally absent because the lake gets dried up.The characteristic behavior of the various types of fish in the lake is judged well by the fishermen. The fishermen have the traditional wisdom to forecast changes in the weather depending upon certain biological changes as observed in the fish. They are also capable of predicting the types of fish available in any area based on the presence of particular varieties of weeds.

Generally two types of fishing are practiced in the area; Individual fishing (Plate 1) and Group fishing (Plate 2).

(i) **Individual fishing**: The fishermen engaged in individual fishing make use of certain types of craft and gear specially designed and well suited for this purpose.

This type of fishing is done only with the help of the fish traps locally known as 'Mavulu'.Net is used for fishing only in the channels *(gaddalu)* and pools *(gundamulu)*.The common fishing craft are 'Doni' and fishing boat. The 'Doni' which is a 10-12 feet long, single person driven canoe, made by scooping out the plinth area of a palm tree of a selected (bent) shape. Rowing boats are both small and large in size. The smaller boats are 5-6 metres long with a 90cm beam width and used for transport of harvested fish and also passengers from village to village within the lake. Bigger boats are about 10 metres long and are used exclusively for transporting cargo. The fishermen also use different types and sizes of traps, locally called *mavus,* to catch different species and sizes of fish which included the basket – trap (Mavu),Gampa gari and Cast net(Visuru vala).

(ii) Group fishing : The nature and types of gear used in the group fishing activity are entirely different from the individual fishing activity. The fishing gear includes stake-net (gadisa vala), drag net etc. 'Dhadi kattu'and 'Dhoddi' fishing are the principal methods adopted in the group fishing activity. 'Dhadi kattu' is practiced in the lake from october to february when the water level and the rate of inflow are high. It involves the construction of Bamboo curtain between two land masses (villages), some of them even run to a length of over 6 km. The fish are caught by setting up the basket traps placed vertically in single rows on both the sides of Dhadi kattu along the entire length of the bamboo curtain and the yield is shared by the participants according to the traditional fishing rights in vogue (Raju, 1995). The construction of 'Dhadi kattu' to certain extent obstructs the free flow of lake waters.

Plate 1: Individual Fishing

Plate 2: Group Fishing

'Dhoddi fishing' involves temporary construction, collectively, of small bunds covering an area of 100-150 acres, locally known as 'Dhoddis' during the summer season. The village councils of the fishermen community (kula panchayats) conducts open auction for each of the 'Dhoddis' and the successful bidder of each dhoddi raises the bunds. Diesel pump sets are set up to bale out the water .As the lake bed is exposed the fish are caught by employing dragnets and some are even handpicked.

Fish farming in this region has gathered a lot of momentum and had grown into a substantial industry, stimulating the growth of a number of subsidiary industries like ice factories, hatcheries, nurseries, feed and fertilizer shops, fish disease control services etc, which has boosted the rural economy of the region with a huge potential for additional income and employment generation.

4.2.3 Dairy Farming

The Kolleru lake region is an ideal place for dairying because of the abundance of fodder and the favorable swampy environment. There are approximately 11,681 dairy farmers in the lake area (KLDA, 2001).The survey revealed that a farmer can earn a gross surplus of about Rs. 12,000 per year from a unit consisting of two milking buffaloes. The capital investment required for purchase of two buffaloes is approximately Rs.18, 000/-. Lactation period is 180 days per annum. The average milk yield per day during lactation period is 6.0 litres per buffalo and the sale price of milk is Rs.20 per litre.Dairying is thus an assured source of income especially for the marginal and small farmer households. The average annual income of dairy farmer is Rs.41, 451.

4.2.4 Duck – Rearing

Duck rearing is one of the traditional occupations of the lake dwellers. This activity is found in the lake region as well as in the peripheral villages of the lake area. Duck rearing is prevalent among weaker sections of rural population which provides them supplementary and steady income on daily basis besides providing nutritious duck eggs for family consumption. Approximately 2750 families are engaged in the activity. Duck rearers are engaged in duck rearing throughout the year (365 days) but the best periods are during November, December and May as there will be plenty of food in the fields after the harvest from the shed grains of paddy. A duck rearer can earn annual returns of Rs 1, 00,000/- from a unit consisting of 500 ducks. The annual average income is Rs.1, 56,100 household. Reduction in the duck population in the area over the years has been reported and the main factors responsible for the decline of the duck population are shortage in the fodder, water pollution and the consequent spread of various diseases (Raju, 1995).

4.2.5 Sheep and Goat Rearing

The sheep and goat population is very low in contrast to other livestock. They are raised by individuals exclusively for meeting the local demands of meat. Profitable sheep farming is largely dependent on the number of lambs weaned from an ewe in a year. An adult ewe of 8-9 months age, can fetch a price of about Rs.1, 000 /- and the males fetch a price starting from 1,500 and above based on their weight and age. The sheep rearing in the area is affected by hypothermia or loss of body weight and starvation which leads to lamb mortality. Approximately 4750 families are engaged in the activity (KLDA, 2001).The average annual income from this activity is Rs. 12,280, which constitute 32 percent of the total household income.

4.2.6 Input supply services

Input suppliers form another stakeholder group in the area. In the kolleru region, several fertilizer and pesticide shops are there. Around 5000 input supplying shops are thriving on the income from trade in and around the lake (KLDA, 2001) trading on seeds, pesticides, fertilizers, fungicides, etc. The average sale proceeds from urea is Rs 2, 50, 000 per annum, complex fertilizers Rs 4, 50,000 per annum, pesticide Rs 4, 50,000 per annum and seed 5, 00,000 per annum. The annual average income from this activity is estimated as Rs. 12, 81,369/household, which constitutes 84 percent of the total household income.

4.2.7 Agricultural labourer

Labourers form a very strong group who are having a stake in the lake area. Effective management of the labour plays a vital role in the competitiveness of agricultural production. Approximately 50,000 agricultural labourers are there in the entire lake area (KLDA, 2001).

Out of 15 sample respondents, of which 9 members are female and 6 are male. A labourer on an average gets 170 days of work per year. Hired human labour was valued at the prevailing wage rates in the area, which was Rs.100/- for female labourers and Rs.120-130/- for male. The labourer on an average earns Rs 22,001 per year.

4.2.8 Direct Use Value from lake

The direct use value of the lake related activities for stakeholders was found out by multiplying the income from lake related activity of each stakeholder group by the total number of households of the particular stakeholder group in the lake area and aggregating the values. The direct income of lake related activities is given in the Table 4.6. It was found that the duck rearers were depending on the

lake throughout the year (365 days), followed by input supplier (360 days),dairy farmer, sheep& goat rearer,fishermen and farmer. Among the stakeholders, input suppliers had high income of Rs 640.81 crores from lake.The total direct use value of the lake was estimated as Rs.940.74 crores.

Table 4.6 Direct income from lake related activities for stakeholders

S.No	Stakeholder Groups	Number of Days of dependence	Income from lake related activities(Rs/household/year)	Proportionate income(%)	Total number of households* in the lake area	Direct Use Value of the lake(lakhs)
1	Farmer	256	33497	62	21710	7272.2
2	Fisherman	259	36119	65	5542	2001.7
3	Dairy Farmer	350	41451	49	11681	4841.9
4	Duck Rearer	365	156100	82	2750	4292.8
5	Sheep & Goat Rearer	264	12280	32	4750	583.3
6	Input Supplier	360	1281639	84	5000	64082.0
7	Agri Labour	193	22001	43	50000	11000.5
Total Direct Use Value of the lake (Lakhs)						94074.3

*KLDA, 2001

4.3 Stakeholder perception on the lake status and services

As in the case of any natural resources, Kolleru Lake is also under threat due to demographic and social pressures. Large extent of the lake area has been encroached for farming, fish culture and construction. The status of encroachment in Kolleru Lake between 1999 and 2006 as given by Chatterjee (2006) is presented in Table 4.7.

The encroachments and irregular construction of fish tanks in the lake obstruct the flow of water to the ‘Upputeru’. The notified wetland under kolleru lake area also expresses severe pressure which results in qualitative and quantitative decline in services. Agriculture and fisheries which were the two major economic activities in the area exert great pressure on the system. About 62 per cent of the sanctuary area was under various types of encroachments during

the year 1999, which increased to 73 per cent in 2006, even after declaring the lake as protected resource.

Table 4.7 Status of encroachment of Kolleru lake

(Area in acres)

	The Status of kolleru lake area	As on 4/10/1999	As on 1/1/2006
Government Lands under encroachment	Fish Tanks	15899 (21)	31234 (40)
	Agricultural & Other lands	12011 (6)	5400 (7)
Private Lands under different land use	Fish tanks	6650 (9)	7210 (9)
	Agricultural & Other lands	12915 (17)	12355 (16)
Total land under encroachment / different use		**47475 (62)**	**56199 (73)**
Land available without encumbrances		29663 (38)	20939 (27)
Total Notified area of the Sanctuary		**77,138**	**77,138**

*Figures in parenthesis shows percentage to total

Source: Chatterjee, 2006

Lack of flood-flow and inundation cause water pollution and drinking water scarcity in the villages around the lake. The reduced lake spread has already affected the population of migratory birds and caused increased weed infestation clogging the lake drainage. The sewage in flow from the towns of Eluru, Gudivada and Vijayawada, industrial effluents, pesticides and fertilizers from the Krishna-Godavari delta region contaminate the lake (CESI, 2002). The Eluru municipal cooperation discharges 24 mld untreated sewage/ sullage into the drains which lead into Kolleru Lake. Eleven major industries release about 7.2 million litres of effluents into the lake every day (Rao and Rao, 2006). Andhra Pradesh Pollution Control Board report states that more than 17,000 tonnes of fertilizer wash enters the lake annually. Studies have shown the presence of organic pollutants in lake sediment and in the fast-growing weeds. The sewage and discharge from factories have also affected the growth of organisms that the fish consume.

Total agricultural land surrounding the Kolleru Wetland as well as the catchment area is 32,908 hectares. All the fertilizers and pesticides and agricultural residues used in the fields especially in the areas located between '+5' and '+7' MSL find their way as runoff into the lake waters leading to major and dangerous contamination, both to flora, fauna and human life. Residues of about 18,000 tonnes of inorganic fertilizers from paddy fields drain into the lake.Of the 25 industries located near the drains joining Kolleru Lake, 14 discharge their effluents into the drains. The Budameru River receives effluents 25, 60,000 litres per day (WISA, 2008) from different industries.

The water discharged from the fish tanks contains higher degree of concentration of nutrients (nitrogen, phosphorous and potassium), which cause high degree of water pollution. Depletion of dissolved oxygen is often observed in the lake due to obstruction to free flow of water and occasional release of metabolite-loaded wastes from fish ponds.

4.3.1 Stakeholder perception about the present status of Lake

The existing status of lake was categorized into five groups: very well preserved, moderately well preserved, less preserved, not at all preserved and no opinion. Responses are shown in Table 4.8. Nobody optioned that lake was well preserved. Forty one percent of the respondents were of the opinion that they were less preserved. Nearly 27 per cent of them supported that they were moderately preserved while four quarter of respondents were of the opinion that no efforts on preservation was there. Though Kolleru Lake Development Authority (KLDA) was constituted for the purpose of conservation and sustainable development of the area, majority of the respondents (65.5%) did not acknowledge the conservation efforts. Vasudevan and Suryaprakash (2005) also made similar attempts while estimating the existence value of sacred groves. Nobody had the opinion that these were well preserved. It was also supported by the results of the

study conducted by Samaraweera and Marothia (2007) who reported that most of the resources under investigation were in the process of degradation due to poor governance of local institution and open access of common pool resources of Chhattisgarh in India.

Table 4.8 Respondents opinion about present status of Lake

Opinion	Preservation	
	Frequency	%
No opinion	14	7.8
Not at all preserved	44	24.4
less preserved	74	41.1
moderately preserved	48	26.7
very well preserved	0	0.0
Total	**180**	100.0

4.3.2 Relative importance of lake services

Ranking of the importance of lake was done by the respondents according to the relative importance of services they enjoy (Table 4.9). Here the first preference was given for livelihood (61.4%), followed by stability of micro-climate (34.3 %) and drinking water (27.1 %). There is a wide gap between the rank for livelihood and other ranks. On the other hand least preference was given for recreation and tourism. In the study on valuation of the Bhoj wetland by Verma *et al* (2001) estimated that the maximum number of people considered drinking water to be the most important service obtained from the Bhoj Wetland. The next highly rated service was recreation, followed by stability of microclimate and employment was rated last, showing that fewer people found it important as compared to the other services. These results clearly indicate the importance of preserving the lake for the economic activities for sustaining the livelihood of the stakeholders.

Table 4.9 Respondent rating on services provided by the lake

Services	Rank-1		Rank-2		Rank-3		Rank-4		Rank-5	
	No's	%	No's	%	No's	%	No's	%	No's	%
Drinkng Water	27	16.3	34	20.1	45	27.1	50	32.7	24	36.4
Stability of Micro-climate	22	13.3	58	34.3	67	40.4	33	21.6	0	0
Livelihood	102	61.4	49	29	19	11.4	10	6.5	0	0
Recreation and Tourism	15	9	28	16.6	35	21.1	60	39.2	42	63.6
Grand Total	166	100	169	100	166	100	153	100	66	100

4.3.3 Extent of pollution

The level of pollution, according to stakeholder responses is furnished in Table 4.10. More than 50 percent of the stakeholders were concerned about the high degree of pollution. Nearly 35 per cent of the respondents thought that the pollution level was moderate. Imandoust and Gadam (2007) got similar results in respondents opinion about extent of pollution.More than 75 percent of respondents expressed that the factors of causing pollution in Pavana River are sewage from citizens, dumping of factory wastage, washing clothes and idol immersion. Rao and Rao, 2006 reported that eleven major industries release about 7.2 million litres of effluents into the Kolleru Lake every day.

Table 4.10 Respondent opinion about extent of pollution of the lake

Opinion	Pollution	
	Frequency	%
Not at all	1	0.6
Marginally	17	9.4
Moderately	71	39.4
Highly	91	50.6
Total	180	100

4.4 Willingness To Pay (WTP)

The Willingness To Pay for preservation of Kolleru Lake was elucidated from the different stakeholder groups. It was found that the majority of the respondents (71.1%) were willingness to pay Rs.100 to Rs.200 per house per annum. The results are shown in Table 4.11.It was found that majority of the farmer (66.7%), fishermen (84.4%) dairy farmer (80%) and duck rearer (80%) groups were willing to pay Rs 100 to Rs.200, while 95 percent of sheep & goat rearer group were willing to pay less than Rs.100. The income of the sheep and goat rearer group was the lowest (Table 4.6).

Table 4.11 Stakeholders WTP

Stakeholder groups	Amount (Rupees)					Mean WTP (Rs)
	< 100	100 - 200	200 - 300	> 300	Total	
Farmer	5 (33.3)	10 (66.7)	0 (0)	0 (0)	15(100)	103
Fisherman	14 (15.6)	76 (84.4)	0 (0)	0 (0)	90(100)	113
Dairy Farmer	4 (20.0)	16 (80)	0 (0)	0 (0)	20(100)	120
Duck Rearer	0 (0)	8 (80)	2 (20)	0 (0)	10(100)	143
Sheep & Goat Rearer	19 (95)	0 (0)	0 (0)	0 (0)	20(100)	66
Input Supplier	0 (0)	2 (20)	3 (30)	5 (50)	10(100)	227
Agri Labour	0 (0)	15 (100)	0 (0)	0 (0)	15(100)	119
Total	42(23.3)	128(2.8)	5(2.8)	5(2.8)	180(100)	116

*Figures in parenthesis shows percentage to total

Paddy cultivation was an important economic activity until 1969, when the cyclone damaged the protective embankments in the lake beds; since then *Rabi* crop area dwindled significantly.Eventhough paddy cultivation is legally banned in 1973, still it continues. Simultaneously, fish farming got momentum and many farmers have converted their land to fish farms. The farmers are required to pay a membership fee to the farmer/fishermen co-operative societies upon which they get the license for farming from KLDA. The WTP expressed by the farmers and fishermen were 3 per cent and 13 per cent higher than the present payment of Rs. 100. The other stake holder who currently does not pay for the services also expressed their willingness to pay.

The average WTP among the stakeholder groups ranged from Rs 66 to Rs 227 per household per annum.The duck rearers and input suppliers registered higher WTP.They were enjoying higher income from the activity. The farmer, fishermen, agricultural labourer and dairy farmer WTP were on par. Overall, the average WTP was estimated at Rs 116 per household per annum.This was about 16 per cent higher than the existing payment of Rs 100/- to KLDA. An estimation of the willingness to pay for use value of biodiversity in Yamuna river corridors of Delhi region by Babu and Kumar (2001) indicated that the majority of the respondents (27%) were willing to pay Rs.300 and more than Rs.300 per household per annum and the mean WTP was estimated at Rs.172 per household per annum.

4.5 Factors influencing WTP

The linear regression model was found to be the best among the attempted models. The R^2 value was 0.73 indicating that 73 per cent of the variations were attributed to the variables included in the model (Appendix II). Age, education proportionate income and stakeholder groups were the variables which were found to be significant. Age was found to be significant at 5 per cent level and the variables, education, proportionate income and stakeholder groups was significant at 1 per cent level respectively. It was found that, the coefficient of age on WTP was negative indicating the inverse relationship. Younger people were willing to pay more for preservation of the lake compared to old. Perhaps, the aged people were not aware of the indirect services provided by the lake and treated it as a free good. Moreover, the relatively lower level of pricing perceptions might also have influenced their statements. This was found to be in line with the findings of Imandoust and Gadam (2007) who reported that age was significant in determining the WTP for pavana river water quality.

Educated persons were willing to pay more for preservation of lake. Higher education leads to better understanding and concern for the ecosystem and

hence the result Samaraweera and Marothia (2007) also reported the significant influence of education on WTP for resource conservation. Income from lake services logically exerts significant positive impact on WTP. The higher the relative dependence on lake, the higher the WTP. The significance of income variable on WTP for resources was proved in many of the earlier studies as well Imandoust and Gadam (2007). There was significant difference between stakeholder groups in their WTP, as revealed by the significance level of this variable. Table 4.13 furnishes the estimated WTP of the stake holder group which shows a range of Rs. 83 to Rs. 196. The input suppliers WTP of Rs.196 per household per year were the highest, where as their average age was lower (39 years) and education level was higher (Post Graduation) and the proportionate dependency is more (84%). This is followed by duck rearer group and farmer who were willing to pay Rs 150and Rs 114 respectively.

Table 4.12 Results of linear regression of WTP

Variables	Std.Errors	b(Coefficients)	t
Age	0.157	-0.316	2.016*
Sex	5.431	8.398	1.546
Distance	2.549	1.364	0.535
Education	3.574	28.906	8.089**
Household Size	1.564	2.021	1.292
Proportionate Income	0.119	1.353	11.406**
General perception	1.234	1.917	1.553
Pollution perception	2.719	-1.913	0.703
Stakeholder groups	0.973	4.877	5.014**

R^2 =0.73 (N=180) Adj R^2 = 0.714

** Significant at 1 per cent level

* Significant at 5 per cent level

4.6 Estimated WTP and Indirect Use Value

The estimated WTP was found out for each stakeholder group separately by using WTP function. Fig. 3 shows the stakeholder wise estimated WTP. Table 4.13 gives the estimated WTP of each stakeholder group for Kolleru lake services.

Table 4.13 Estimated WTP and Indirect use value

S.No	Stakeholder Groups	WTP (Rs per household/year)	Total number of households* in the lake area	Indirect Use Value of the lake(Lakhs)
1	Farmer	114	21710	24.7
2	Fisherman	112	5542	6.2
3	Dairy Farmer	112	11681	13.1
4	Duck Rearer	150	2750	4.1
5	Sheep & Goat Rearer	83	4750	3.9
6	Input Supplier	196	5000	9.8
7	Agri Labour	112	50000	56.0
Total Indirect Use Value of the lake (Lakhs)				117.9

*KLDA, 2001

Fig. 3: Estimated WTP

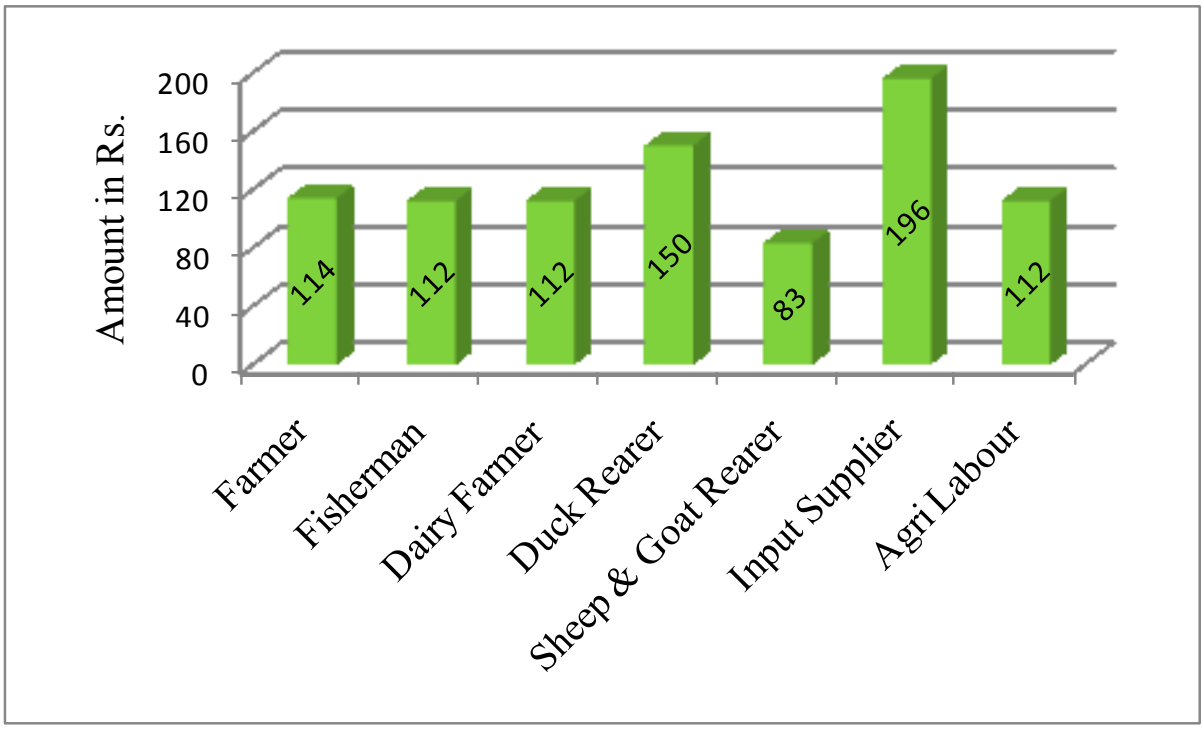
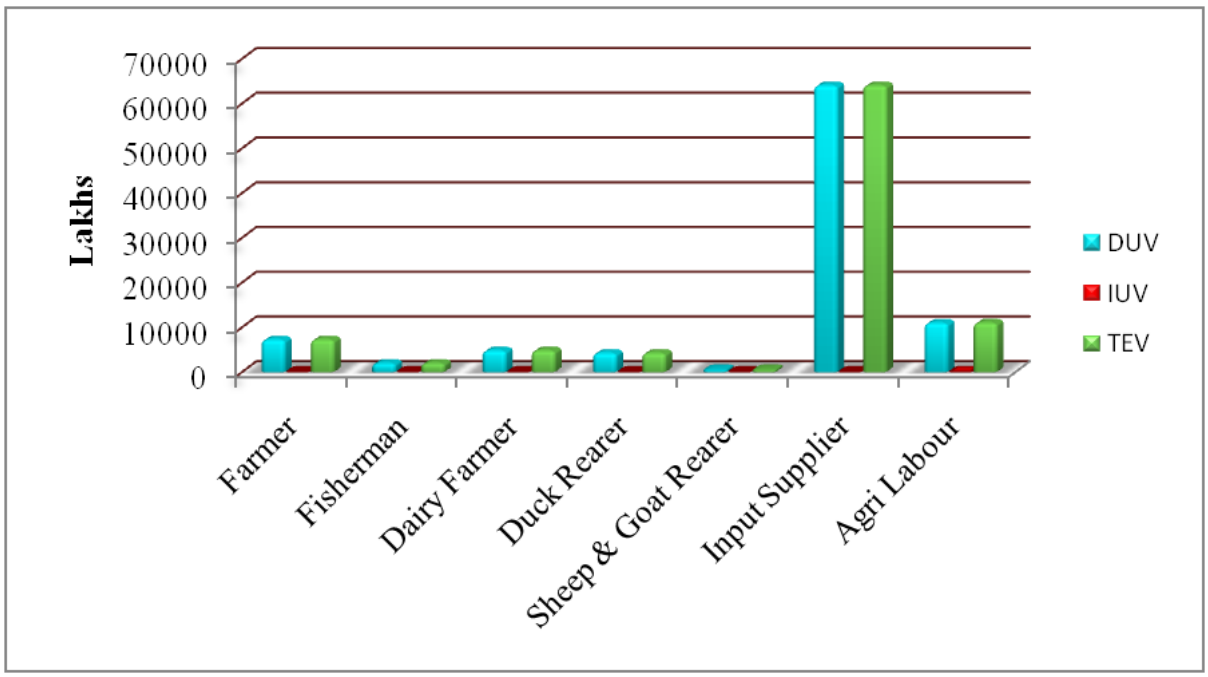


Fig. 4: Total Economic Value of the lake



The duck rearers and input suppliers were earning more income from lake related activities. They are ready to pay higher WTP as compared to other groups. The Indirect Use Value (IUV) as revealed by the WTP was estimated by the linear regression model and ranged from Rs. 83 to Rs. 196. The aggregate value of the estimated WTP was Rs. 116 per household. This was about 16 per cent higher than the existing payment of Rs. 100.

At this level, total IUV of the lake system was estimated at around Rs. 1 crore per annum.This was found to be in line with the findings of Verma *et al* (2001) who estimated that the median WTP was Rs 241/household/annum for the voluntary payment and Rs.29.50/household/annum for the compulsory tax obtained from the Bhoj wetland. Total estimated WTP per annum voluntarily and as tax amounted to Rs 48.4 million and 5.9 million respectively.

The total direct and indirect benefits of the lake were around Rs. 941 crores and around Rs 1 crore respectively. Table 4.14 shows the Total Economic Value (TEV) of lake which was around Rs. 942 crores per annum. Fig. 4 shows the TEV along with individual contributions of the DUV and IUV from each stakeholder group. Babu and Kumar (2001) estimated the total economic value of Yamuna flood plain as Rs.216.785 lakh per annum and the value of recreation and wild lives varied between Rs 155.82 to Rs.277.75 lakh per annum.

Table 4.14Total Economic Value (TEV)

S.No	Stakeholder Groups	Direct Use Value (DUV) (Lakhs)	Indirect Use Value (IUV) (Lakhs)	Total Economic Value (TEV) (Lakhs)
1	Farmer	7272.2	24.7	7296.9
2	Fisherman	2001.7	6.2	2007.9
3	Dairy Farmer	4841.9	13.1	4855.0
4	Duck Rearer	4292.8	4.1	4296.9
5	Sheep & Goat Rearer	583.3	3.9	587.2
6	Input Supplier	64082.0	9.8	64091.8
7	Agri Labour	11000.5	56.0	11056.5
Total Economic Value of the lake (Rs)				94192.2

Any investment for lake conservation less than or equal to this amount is economically justified. Further the study also suggests the scope of resource mobilization through a system of Payment for Environmental Services (PES) as all the stake holder groups expressed their WTP. The quantum of payment can be fixed as per the findings and the payment vehicle can be the existing one. The existing institutional mechanism can be effectively made use if appropriate policy decisions are taken. The results of the study can form the basis for developing an economically and socially adoptable management plan based on large scale studies for Kolleru Lake system.

Summary and Conclusion

Chapter V
SUMMARY AND CONCLUSION

Wetlands are one of the most productive ecosystems, comparable to tropical evergreen forests in the bio sphere and play a significant role in the ecological sustainability of a region. The RAMSAR Convention defines wetlands as: *"Areas of marsh, fen, peat land, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters" and may include "riparian and coastal zones adjacent to the wetlands or islands or bodies of marine water deeper than six meters at low tide lying with in*."The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

The Directory of Indian Wetlands published by World Wild Life Fund (WWF) and Asian Wetland Bureau in 1995 recorded 147 sites as important of which 68 were protected under the National Protected Area Network by the Wildlife Protection Act of 1972. Out of these wetlands, 25 sites covering a total area of 677131 hectares have been designated as Ramsar sites in India. The Kolleru Lake, situated between the Krishna and Godavari deltas in Andhra Pradesh is one of the important coastal wetland ecosystems in India. Two other wet lands are in situated in Kerala; the Ashtamudi wetland and the Vembanad- Kole wetland, together occupying an area of 212650ha.

Anthropogenic factors leading to over exploitation resulted in the gradual decline of wetlands, both in coverage and quality. At present, only 50 percent of India's wetlands remain and that they are being lost at a rate of 2 to 3 per cent every year. The ecological of wetlands are seldom understood by the people in the right perspective and they continue to be over exploited. The quantification of this value forms the basis for policy making with respect to resource allocation and

mobilisation of funds for conservation of these resources. Estimation of Total Economic Value of the natural resources for favouring decision making as well as awareness creation among general public is a challenge for economists, and a few studies are already been conducted. Following these studies an attempt was made to estimate the value of a wet land ecosystem of national importance, which is declared as a Ramsar site. The study estimates in monetary units, the indirect use value of Kolleru wetland, using Contingent Valuation Method. The specific objectives were to identify the services provided by the Kolleru Lake, in Andhra Pradesh as perceived by the stakeholders and assess the Willingness To Pay (WTP) for ecosystem services.

Kolleru lake area comprises 73 villages. Out of these, 10 villages within a radius of 5 km were randomly selected for the study. The list of the stakeholder groups dependent on the lake for their livelihood was collected from the village records, local enquiries and consultation with officials of development departments in the area. From the list, samples of 180 respondents were selected randomly. The sample respondents were post stratified into seven categories based on their economic activity. The economic activities of the population in the lake region have mainly gathered through focused group discussions. A total of seven stake holder groups were selected for this study.

Each category of stakeholder was interviewed separately. The collected data include basic information on socioeconomic characteristics of the respondents, their perception of the present status and benefits from lake and their management views. The data also included their WTP and direct benefits they derived from the system.

The Contingent Valuation Method (CVM) is a widely used non market valuation method in environmental economics. For eliciting the Willingness To Pay (WTP) for the preservation of the lake, a double bounded dichotomous choice CVM question was asked.

In Kolleru villages, co-operative farming practices are adopted by the villagers. The village council, cultivate the village common areas and every male member of the household has a share in the council. There are 93 Farming societies in the lake area, which consist of 21,710 members. An area of 32,908 hectares of fertile land in the lakebed is used for cultivation of, the staple food, a local variety of rice –"Yerra vari". Paddy is the major *kharif* crop accounting for 95 per cent of the total cropped area, the rest being millets, sugarcane and vegetables. *Rabi* season agriculture has more diversity of crops with paddy and grams (majority green gram) accounting for 49 per cent and 40 per cent of the total cropped area respectively. The annual average income from farming is Rs. 39,497, which is 62 per cent of the total household income.

There are 88 Fishermen Co-operative societies in the lake area, which consist of 5542 members. The annual average income of fishing is Rs. 36,119 and they depend on the activity for 259 days per annum and the income obtained is shared by all the male members of fishermen households. There are 11,681 dairy farmers in the lake area. The average income of the dairy farmer is Rs.41,451 per annum. Duck rearing is a round the year activity, they enjoy an annual income of Rs.1,56,100. The sheep and goat population is very low in contrast to other livestock and average annual income from this activity is Rs. 12,280, which constitute 32 percent of the total household income.

In the Kolleru region, there are 5000 input supplying shops trading on seeds, pesticides, fertilizers, fungicides, etc. The annual average income from the track is estimated as Rs. 12, 81,369, which constitutes the 84 percent of the total household income. Input suppliers are having the maximum annual income in the lake region. Approximately 50,000 agricultural labourers are there in the entire lake area with an average annual income of Rs.22, 001, constituting 43 per cent of the total household income.

The education level of stakeholders in different groups does not differ much. Most of them were educated upto XII th standard. Most of the input suppliers were graduates. Few of them post graduates as well. The average household size of each stakeholder group was around 4 persons. The annual household income ranged from Rs.39,015 to Rs.14, 98,450, with the average as Rs.1, 43,860. It was the highest for input suppliers.

As in the case of any natural resources, Kolleru Lake is also under threat due to demographic and social pressures. Large extent of the lake area has been encroached for farming, fish culture and construction. The notified wetland under kolleru lake area also expresses severe pressure which results in qualitative and quantitative decline in services. Lack of flood-flow and inundation cause water pollution and drinking water scarcity in the villages around the lake. Andhra Pradesh Pollution Control Board report states that more than 17,000 tonnes of fertilizer wash enters the lake annually. Though Kolleru Lake Development Authority (KLDA) was constituted for the purpose of conservation and sustainable development of the area, majority of the respondents (65.5%) did not acknowledge the conservation efforts. The respondents were aware of the pollution level and concerned about the conservation as they considered the lake as the main source of livelihood for them.

The Willingness To Pay for preservation of the Kolleru lake was elucidated from the different stakeholder groups. Estimated Willingness To Pay ranged from Rs 83 to Rs 196 per annum per household. The R^2 value was 0.73 indicating a fairly good explanatory power of the model. Age, education proportionate income and stakeholder groups were the variables which were found to have a significant impact on WTP. Age was found to be significant at 5 per cent level and the variables, education, proportionate income and stakeholder groups were significant at 1 per cent level. The coefficient of age on WTP was negative indicating the inverse relationship. Older people expressed lower WTP. All other variables had a positive effect. Higher education leads to better understanding and

concern for the ecosystem. It was revealed that the WTP between the stake holder groups differed significantly. The WTP expressed by the farmers and fishermen were 3 per cent and 13 per cent higher than the present payment of Rs. 100. The other stake holder who currently does not pay for the services were also willing to pay.

The DUV of the lake was estimated by the level of income enjoyed by the stake holders from lake related activities. It ranged from Rs. 12,280 to Rs. 12, 81,639 with an average of Rs. 1, 08,529 per annum per household. Extrapolating for the total population DUV of the lake system amounted to Rs. 941 crores per annum. The IUV as revealed by the WTP was estimated by the linear regression model and ranged from Rs. 83 to Rs. 196. The average WTP was Rs. 116 per annum per household. This was about 16 per cent higher than the existing payment of Rs. 100. Other stake holder groups who at present does not make any payment are also expressed this WTP, mostly higher than the existing Rs. 100. At this level, total IUV of the lake system was estimated as around Rs. 1 crore per annum. Thus the TEV of the ecosystem was around Rs. 942 crores per annum.

Any investment for lake conservation less than or equal to this amount is economically justified. Further the study also suggests the scope of resource mobilisation through a system of Payment for Environmental Services (PES) as all the stake holder groups expressed their WTP. The quantum of payment can be fixed as per the findings and the payment vehicle can be the existing one.

The management plan for resource mobilisation can adopt a differential payment regime, for different stake holder groups, depending upon their level of dependence on lake for livelihood (proportionate income and education level). The future prospects of higher resource mobilisation as younger generation are willing to pay more.

Further, the fairly good level of awareness on the current status of lake and their rating that the resource is the main source of the livelihood underlines their interest on conservation. The existing institutional mechanism can be effectively made use of appropriate policy decisions are taken. The results of the study can form the basis for developing an economically and socially adoptable management plan based on large scale studies for Kolleru Lake system.

References

REFERENCES

Ajayi, A.O.2006.An assessment of farmers Willingness To Pay for extension services using the Contingent Valuation Method (CVM): The Case of Oyo State, Nigeria. *The J. Agric. Ed. Ext*., 12 (2): 97-108.

Alvarez, S. and Larkin, S.L. 2008. Valuing recreational benefits of a National park in Andean Columbia, In: Allas, D. (ed.), *Annual meeting on Southern Agricultural Economics Association,* 2-6 February, 2008, Columbia.92p.

Anjaneyulu,Y. 2003. Assessment of Environmental quality of Kolleru Lake and strategic management plans. In Durga Prasad, M.K. and Anjaneyulu .Y (ed.), *Lake Kolleru Environmental Status (Past and Present)*, BS publications, Hyderabad, pp 12-13.

[Anonymous]. 2006. *Management Action Plan of Kolleru wild life sanctuary wetland*. Wild life management division, Eluru, Andhra Pradesh. 92p.

[Anonymous].2007.www.answers.com home page [on line]. Available: http// www.answers.com/ kolleru% 20lake. [11 May 2007]

Antonopoulou, E., Mallios, Z. and Latinopoulous, P. 2006. Willingness to pay for Wetland preservation: A case study for Lake Volvi, Northern Parts of Greece, Aristotle University of Thessaloniki, 135p.

Babu, C.R. and Kumar, P. 2001. Valuation of ecological function and benefits: a case study of wetlands ecosystems along the Yamuna river corridors of Delhi region. In: *Wetlands and Biodiversity,* World Bank Environmental Management Project, EERC Working paper series WB-6, 171p.

Bandara, R. and Tisdell, C. 2003. Does the economic value of the Asian Elephant to urban dwellery exceed their cost to the farmers? A Srilankan study. Discussion paper No. 325, School of Economics, Queensland, QIId 4072.

Bennett, R. and Larson, D. 1995. Contingent valuation of the perceived benefits of farm animal welfare legislation: An Exploratory Survey. *J. Agric. Econ.* 47(2): 224-235.

Bishop, R. C. and Heberlein, T.A. 1979. Measuring Values of Extra market Goods: Are Indirect Measures Biased? *Am. J. of Agric Econ*, pp 926-930.

Boontho, C. 2008. An economic analysis of Pru Kradueng National Park, In: *Proceedings of World Academy of Science*, 29 May, 2001, Engineering and Technology, Thailand. pp1307-6884.

Carson, R.T., Wilks, L. and Imber, D. 1993. Valuing the preservation of Australia's Kakadu Conservation Zone, San Diago. *Oxford Econ. Pap.*46:727-749.

Carson, R.T. and Mitchell, R.C. 1993. The value of clean water: The public's willingness to pay for boatable to fishable and swimmable quality water. *Water Resour. Res*., 29: 2445-2454.

Carson, R.T.,Wright,J.,Carson,N.,Alberini,A and Flores,N.1995.A *Bibliography of Contingent Valuation Studies and Papers*. In: La Jolla, Natural Resource Damage Assessment, Inc.

Census of India.2001. Homepage [on line].Available: http://www.censusindia. gov.in.[07 Dec 2001]

CESI [Centre for Economic Studies in India] 2002. Report on water supply and sanitation in Vijayawada. Centre for Economic Studies in India (Report No.2/2002).

Chatterjee, T. 2006. *The status of Kolleru lake area*, Principal Secretary of Government, EFS&T Department. Government of Andhra Pradesh, Secretariat, Hyderabad, 11p.

Chaudhry, P. 2006. Valuing recreational benefits of urban forestry- A case study of Chandigarh city, India. Ph.D. thesis, Forest Research Institute, Dehradun.55p.

Chen, W. 2005.Recreation value of Lake Wuliangsuhai Inner Mongolia, Inner Mongolia Lake Restoration Project. University of Oslo, China.105p.

Chithra, M.S. 2006. Socio economic issues on pesticide use: An analysis in bitter gourd, M.Sc (Ag) thesis, Kerala Agricultural University, Thrissur, 112p.

Chopra, K. 1997. The valuation of biodiversity within protected areas. In: Das, M.R. (ed.), *Proceedings of the World congress Environment and Resource Economists*, 25-27 January 1997, Venice, pp.311-315.

Ciriacy, W.S.V. 1947. Capital returns from soil conservation practices. *J. Farm Econ*. 29:1181-96

Cluston, E.M. 2002. Linking the ecological and economic values of wetlands: a case study of the wetlands of Hartenbay, Ph.D.thesis, School of Australian Environmental Studies, Griffith University, Australia, 396p.

CSE [Centre for Science and Environment]. 2006. Kolleru Lake is going [on line] Available: http://www.rainwaterharvesting.org/Crisis/Kolleru_etc.htm.[11 May 2006].

CSIR [Council for Science and Industrial Research] 1978. Studies on ecology and weed biology of Kolleru Lake. Council for Science and Industrial Research, 25p.

Dana, K., Thomas, J., Thomas, E.K. and Joseph, K.J.2009.Willingness to pay premium for sorganic products: case study in kerala. *The Icfai Univ. j.Environ., Econ.*7 (1):29-33.

Davis, R.K. 1963.Recreation planning as an economic problem. *Nat. Resources J.*,3(2): 239-249.

Dunffa, 1998. Estimating willingness to pay for rural water supply: The case of Ada- a-Libas District (Ethiopia), M.Sc Thesis, Addis Ababa University. 72p.

Echeverria, J., Hanrahan, M.and Solorzano, R. 1995. Valuation of non priced amenities provided by the biological resources with in the Monteverde Cloud Forest Preserve: Costa Rica. *Ecol.Econ*.13: 43-52.

Fisseha, A. 1997. Estimating willingness to pay for water: A contingent valuation study on Meki Town (Ethiopia), M.Sc thesis, Addis Ababa University, Ethiopia, 56p.

Foster, V., Bateman, I.J. and Harley, D. 1996. Real and Hypothetical Willingness to pay for environmental preservation: A non experimental comparison. *J. Agric. Econ.,*48(2):123-138.

Fu, Tsu-Tan., Liu, Jin-Jan. and Hammitt, J.K.1999. Consumer willingness to pay for low pesticide fresh produce in Taiwan. *J. Agric. Econ.* 50(2): 220-233.

Hadker, N., Sharma, S., David, A. and Muraleedharan, T.R.1997. Willingness to pay for Borivli National Park: Evidence from a contingent valuation. *J.Ecol. Econ.,* 21 (2): 105-122.

Hammitt, J.K and Liu, J.T.2001. Contingent Valuation of a Taiwanese Wetland. *J. Environ. Dev. Econ.,* 6(2): 259-268.

Hanemann, W.M., 1984, Welfare evaluations in contingent valuation experiments with discrete response. *Am. J. of Agric Econ*, 66:332-341.

Hanemann, W.M., 1994, Valuing the environment through contingent valuation. *J. of Economic Perspectives*, 8:19-43.

Hanemann, W.M., Loomis, J.B and Kanninen, B.J.1991.Statistical Efficiency of Double Bounded Dichotomous Choice Contingent Valuation. *Am. J. of Agric Econ*, 73:1255-1263.

Hanley,N., MacMilan, D., Wright, R.E., Bullock, C., Simpson, I., Pairson , D and Crabtree, B. 1998. Contingent Valuation Versus Choice Experiments: Estimating the benefits of environmentally sensitive areas in Scotland. *J. Agric. Econ.,* 49(1): 1-15.

Henn, P. 2000. User benefits of Urban Agriculture in Havana, Cuba: An application of the Contingent Valuation Method, M.Sc thesis, McGill University, Cuba, 47p.

Henson, S. 1996. Consumer willingness to pay for reductions in the risk of food poisoning in the UK. *J. Agric. Econ.,* 47(3): 403-420.

Imandoust, S.B and Gadam, S.N. 2007. Are people willing to pay for river water quality, contingent valuation? *Int. J. Environ. Sci. and Technol.,* 4(3): 401-408.

IUCN.1999.Economic Valuation of the Mangrove Ecosystem along the Karachi Coastal Areas .*The Economic Value of the Environment: Cases from South Asia*, Switzerland, 310p.

Kalpana, A., Hussain, S.A. and Badola, R. 2007. Social and Economic considerations in coserving wetlands of Indo Gangetic plains: A case study of Kabartal wetland, India. *Environmentalist* .27: 261-273.

Khan, H. 2008. The willingness to pay for recreational services: An empirical investigation with the application of multivariate analysis of two public parks in Northern Pakistan [on line]. Institute of Development Studies. Available http://ssrn.com/abstract [Accesseed on 6 October 2008].

Kishore, K.R. 1985. *Problems of Agriculture in Patta lands with in the Kolleu Lake and its peripheral areas* [Notes]. Director of Agriculture, Hyderabad, 7p.

KLDA [Kolleru Lake Development Authority].2001.*Master plan for Kolleru Lake development*, Report home page Available: www.lakekolleru.com [11 May 2001]

Kusuma, I.D. 2005. Economic valuation of Natural Resource Management: a case study of the Benuaa dayak tribe in Kalimantan. Ph.D. (Dissertation), Louisiana State University and Agricultural and Mechanical College, Indonesia, 96p.

Kwak., Yoo, S.J., Hoon, S and Ki, L.C. 2007. Valuation of the Woopo wetland in Korea – a contingent valuation study, *J. Environ. Dev. Econ.*, 12(02): 323-328.

Loomis, J., Cindy, S. and Donnelly, D. 1986. Economic losses to recreational Fisheries due to small – Head Hydro Power development: A case study of the Henry's Fork in Idaho. *J. Environ. Mgmt.,* 22: 85-94

Loomis, J., Smith, A. and Huszar, P .2005.Estimating the economic benefits of maintaining residential lake levels at an irrigation reservoir: A contingent valuation study, *Water Resour. Res.* 41: 1029-1039.

Maharana, I., Rai, S.C. and Sharma, E. 2000. Valuing ecotourism in a sacred lake of the Sikkim Himalaya, *Environ. Conserv.* 7(3): 269-277.

Mansor Abu, S., Run, D., Cyril, E., Latif and Abd, H.2005.Value of human life: Willingness To Pay for the provision of Life-Jackets at the Sarawak River. *Int. J. Bus. Soc*., 25:421-432.

Marappan, J. , Rekha, P.N., Kavitha, N. and Ravichandran, P. 2006. Assessment of impact of aquaculture on Kolleru lake using Remote sensing and Geographical Information System, *Aquaculture Res*., 37: 1617-1626.

Marie, H.2002.Water supply and sanitation in Vijayawada.CESI Report 2/2002.Center for Economic Studies in India. *J. Environ. Dev. Econ.,* 6 (3): 125-132.

Marikan, D.A.A., Radam, A. and Zakaria, S.B.B.I. 2006. The economics of recreational park conservation: A case study of Bako National Park. Staff paper 4.Faculty of Economics and Management, University of Putra Malaysia, Selangor, 140p.

McFadden, D.1994. Contingent valuation and social choice. *Am. J. Agric. Econ.,* 76: 689-708.

Michailidis, A. 2006. Impact of analysis of irrigation projects: an application of contingent valuation method, Greece. *Am. J. Agric. Biol. Sci.,* 1 (1): 17-21.

Mladenov, N., Gardner, J.R., Flores, N.E., Mbaiwa, J.E., Mmoplewa, G. and Strzepek, K, M. 2001.The value of wildlife viewing tourism as an incentive for conservation of biodiversity in the Okavango Delta, Botswana. In: Rogerson, C.M. (ed.), *Development Southern Africa*. Routledge Publisher, Colorado, 220p.

Pandurangam, T.C. 1967.*Integral development of Kolleru lake area*, Government of Andra Pradesh, Eluru, 54p.

Parid, M.M., Lim, H.F. and Woon, W.C. 2004. Economic Valuation of protected areas in Malaysia: a case study on Pulau Redang Marine Park, Terengganu Forest Research Institute Malaysia, Kepong, Selangor Darul.34p.

Pearce, D.W. and Warford, J.J. 1993. *World Without End*. Oxford University Press, Oxford.

Portney, P.R. 1994. The Contingent Evaluation Debate: Why Economists Should Care, *Economic Perspectives*. 8(4): 3-18.

Raju, K.R. 1995. Impact of socioeconomic development on the lake ecosystem – A case study of Kolleru lake region of Andra Pradesh. Ph.D.thesis, Andhra University, Visakhapatnam,235p.

Raju, P.A.R.K. , Reddy, B.J. and Raju, K.R.K. 2003. *Environmental Explosive threat to Kolleru lake and Coastal tracts of West Godavari and Krishna districts*, Civil Engineering Department, S.R.K.R. Engineering College, Bhimavaram, Amaravathi press and publications Pvt Ltd, Andra Pradesh, 7p.

Ramakrishna, E. 1980. *Integrated development of Kolleru lake area- A report*. Administrative staff college of India, Government of Andhrapradesh, Hyderabad, 32p.

Ramakrishnaiah, K.S. 1980. A case study of Kolleru lake and Upputeru river irrigation circle, Eluru, Andhra Pradesh.

Rao, A.S. 2005. *Environmental Degradation of Kolleru Lake*. Allied publishers pvt.ltd, Hyderabad, 155p.

Rao, I.S and Rao, I.N.L.2006. *Implementing sustainable development in the lake kolleru*, *India*. Department of Environmental, Social and Spatial Change (ENSPAC), Roskilde University, Sage publications, Denmark, 105p.

Rao, K.N., Krishna, G.M.and Malini, B.H. 2004. Kolleru lake is vanishing – a revelation through digital processing of IRS-ID LISS- III sensor data, *Current Sci.* 86(9): 1312-1316.

Rao, M.V., Rao,K.H., Ramana, I.V., Sasamal , S.K., Chodhary,S.B. and Bhan, S.K. Change detection studies in and around Kolleru lake using high resolution data.In : Nakamura, K.S.(ed.), *PORSEC proceedings*; 6-8 December ,2000; Goa, Oceanography group-National Remote Sensing Agency ,2: 690-694.

RSIS [Ramsar Sites Information Service].2002.Information Sheet on Ramsar Wetlands, RSIS home page [on line].Available: http://www.wetlands.org/RSDB/default.htm. [Accessed on 13 April 2002]

Samarasweera, G.C. and Marothia, D.K. 2007. User's appraisal and valuation of changes in renewable national resources states: A case study from Chhattisgarh. *Indian J. Agric. Econ.,* 63(3): 415-425.

Sarma, P.V.N. 2005. A distress call from Kolleru Lake. An enviro- legal study, *Indian J. of Aquatic plant mgmt* .22: 30-33.

Scandizzo, L.P and Ventura, M.2008.*Contingent valuation of natural resources: a case study for Sicily*, Working Paper 91. Institute for Studies and Economic Analyses (ISEA), Stampeto press, Rome, 20p.

Seshavataram, V. and Dutt. B.S.M. 1978. *Studies on ecology and weed biology of Kolleru Lake*. CSIR scheme technical report, Department of Botany, Andhra University, Waltair, 92p.

Signorello, G.1995. Valuing bird watching in a Mediterranean wetland. In: Bishop, R.C. and Romano, D. (eds.), *Environmental Resource Valuation: Applications of the contingent valuation method in Italy*. Kluwer Academic Publishers, London, 254p.

Singh, H. 1996. Contingent value measurement of coastal wetlands: A case study of New Jersey. *Middle State Geographer*, 30:50-54.

Singh, S.P and Gopal, B .2001. Integrated Management of Water Resources of Lake Nainital and its Watershed: An Environmental Economics Approach

.In: *Wetlands and Biodiversity,* World Bank Environmental Management Project Final Report, EERC working paper series WB-8, 162p.

Smith, V. K. 1993. Nonmarket Valuation of Environmental Resources: An Interpretive Appraisal. *Ld. Econ.*, 69(1): 1-26.

Srivasuki, K.P. 2002. *Information sheet on Ramsar Wetlands* .World Wide Fund for Nature, India. Available : www. wwfindia.org.[19 Aug.2002].

Streever, W.J., Callaghan- Poory, M., Searles, A., Stevens,T. and Svaboda , P.1998. Public attitudes and values for wetland conservation in New South Wales, Australia. *J. Agric. Econ.*,55: 1-14.

Terawaki, T.1997. Measuring positive and negative externalities of urban farmland. *J. Rural Planting Ass.,* 16(3): 216-227.

Thomas, W. and Smith, T.2006. From water quality to Riparion corridors: Assuring willingness to pay for conservation easements using the contingent valuation method. *J. Ext*., 44(2):234-255.

Vasudevan, R.T. and Suryaprakash, S. 2005. Estimation of the existence value of sacred groves. M.Sc (Ag) thesis. University of Agricultural Sciences, Bangalore, 175p.

Venkatachalam, L.2004.The contingent valuation method: a review, *Environment Impact Assessment Review*; 24: 89-124.

Verma, M., Bakshi, N. and Nair R.P.K. 2001. Economic valuation of Bhoj wetland for sustainable use. In: *Wetlands and Biodiversity*, World Bank Environmental Management Project Working paper series WB-9, 227p.

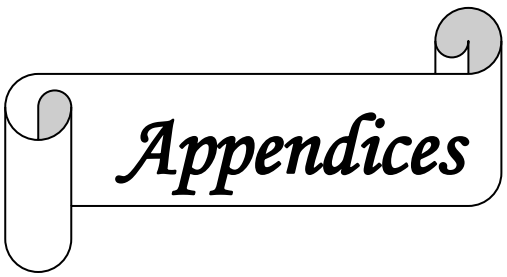
WCMC [World Conservation Monitoring Centre]. 1998. *Global Biodiversity: Status of the Earth's Living Resources*. Chapman & Hall, London.125p.

W.G [West Godavari]. 2007. WG home page [on line].Available: http// www.westgodavari.org/Kolleru % 20lake/ REHABILITATION.htm. [14 May 2007].

White, P.C.L. and Lovett, J.C. 1999. Public preferences and willingness – to- pay for nature conservation in the North York Moors National Park, UK. *J. Agric. Econ.* 55:1-13.

Whitehead, J.C., Groothuis, P.A. and Southwick, R.2006. Linking recreation demand and willingness to pay with the inclusive value: valuation of Saginaw Bay Coastal Harsh. In: *Valuation for Environmental Policy: Ecological Benefits, Arlington*, US Environmental Protection Agency Workshop paper 10,65p.

WISA [Wetlands International South Asia] .2008. *Integrated Management Plan for Kolleru Wildlife Sanctuary*, Final Report home page [on line]. Available: http//www.wetlands.org. [Accessed on 11 June 2008].


Appendices

APPENDIX-I

CONTINGENT VALUATION QUESTIONNAIRE FOR

"THE VALUATION OF ECOSYSTEM SERVICES -A CASE STUDY OF KOLLERU LAKE IN ANDHRA PRADESH"

Study conducted by: Eruva Mamatha

Date of Interview:

I. Background information on Kolleru Lake:

The Kolleru Lake region in Andhra Pradesh is the largest natural fresh water lake in India , which is unique in many aspects. Kolleru lake is one of the largest fresh water eco-systems (Wetland) of international importance recognized under Ramsar Convention. It is situated between the alluvial plains of river Godavari and Krishna due to natural geological formation. It is a shallow fresh water body. The various types of economic activities like agriculture, fishing, Sheep&duck rearing, dairying, industries, Fertilizer and Pesticide shops etc., are well developed in the lake region and provides livelihood for the people living in and around the lake region.

Pressure on the lake has led to proliferating weeds and fewer visiting birds. The catchment area has shrunk. This has led to eutrophication, loss of drinking water and declining fish catches. Obstructions on the lake's periphery lead to flooded agricultural land even during normal rainfall.The shape and area of the lake are difficult to assess because floods submerge large areas. The water spread varies from 135 sq km at +3 msl (mean sea level) level to 901 sq km at +10 msl. The average depth of the lake varies from 0.5 metres to two metres: the lake is silting gradually, raising the bed level.

Sewage inflow from the towns of Eluru, Gudivada and even Vijayawada and industrial effluents, pesticides and fertilisers from the Krishna-Godavari delta region contaminate the lake. Eleven major industries release about 7.2 million litres of effluents into the lake every day. An Andhra Pradesh Pollution Control Board report states that more than 17,000 tonnes of fertiliser wash enters the lake annually. Studies have shown the presence of organic pollutants in lake sediment and in the fast-growing weeds. The sewage and discharge from factories have also affected the growth of water-borne organisms that the fish consume.

An ecological survey conducted in 1978 by V Seshavatharam and B S M Dutt, with financial assistance from CSIR, found no evidence of algal blooms and no significant contrast between the concentration of dissolved oxygen at the surface of the lake and at the bottom. However, in 1980, a report by E Ramakrishnan of the Administrative Staff College of India stated that the weed problem in the lake was caused by high levels of pollution. In 1982, state pollution board member Rajya Lakshmi warned that a dead zone would be created if pollutants were not checked. Another board member, Ramaiah Naidu, felt the diminishing fish catch from the lake was due to depleting water levels.

The present study is conducted to identify the services provided by the kolleru Lake as perceived by the stakeholders and to assess the willingness to pay (WTP) for ecosystem services considering various aspects like resource utilization ,socio-economic and living conditions of the area.

It is being tried to place a money value to derive from the lakes. You derive a number of benefits from the wetland like drinking water facility, livelihood and microclimatic stabilization. Assuming that an independent body “Kolleru Lake Development Authority”was formulated by Government to impose a tax for doing

livelihood activities in kolleru lake area. This kind of body would require funds for operating. Suppose this body would operate only on the funds collected through voluntary contributions and through any government aid, we would like to know your contribution to such a body ……

Currently Rs.100/annum is paying as a membership fee to Kolleru Lake Development Authority for doing livelihood activities in the lake region

1.” Are you willing to pay annually Rs --------- to this fund?” This is not tax for doing any livelihood activity but for its preservation taking into account the numerous services and functions it performs and the numerous species of flora and fauna it protects. Y/N

2a. if yes to (1), “Are you willing to pay Rs ---------- for preservation of lake?

➔ Stop.

2b. If No to (1), “Are you willing to pay Rs- ---------- for preservation of lake?

➔Stop

II. <u>General attitudes</u>:

Q1. You may be aware that the Kolleru wetland provides a number of services to the people .A few of them are listed below .Kindly score them according to their importance in your opinion.

1. most important
2. very important
3. important
4. less important
5. least important

Services	Score
Drinking Water	
Stability of microclimate	
Livelihood	
Recreation and tourism	
Others specify	

Q2. Please rank the following statement:

"Important wetlands like the Kolleru Lake require special conservation measures"

Strongly agree /Agree /Neutral /Disagree / strongly disagree

Q3. To what extent is the Lake polluted in your opinion?

Marginally/Moderately/ highly / Not at all

Q4. What is your opinion regarding the present status of Kolleru Lake in Andhra Pradesh?

1. very well preserved
2. moderately well preserved
3. less preserved
4. no opinion
5. not at all preserved

Q5. How would you rank the various threats to the lakes in order of importance?

1. most important
2. very important
3. important
4. less important
5. least important

	Problem	Ranking
a	Encroachment	
b	Increasing population	
c	Agricultural waste	
d	Washermen	
e	Weeds and eutrophication	
f	Boating	
g	Effluents discharged from industries & Municipalities etc	
h	Sewage	
i	Phosphorous and pesticides effluents from fish tanks	
j	Others, please specify	

Q6. Do you support the conversion of Kolleru wetland for some other purposes like Farming, Aquaculture, Construction of houses/ roads etc?

Yes/No

III. <u>Social characteristics of the respondent:</u>

1. Name of the Respondent : Mr. / Ms ----------

2. Age (Years) : ----------

3. Sex : ---------- (M/F)

4. Marital status : ---------- (S/M/W)

5. Village : ----------

6. District : ----------

7. Religion : Hindu/ Muslim/Christian

8. Education of the Respondent : Illiterate/Upto XII/ Graduate /Post Graduate

9. Category of Stakeholder : Farmer/ Fishermen/Dairy Farmer/Duck Rearer/Sheep and Goat Rearer/Input supplier/ Agricultural Labourer

10. Experience :

11. Family Details :

S.No	Relationship with the Respondent	Sex (M/F)	Age (Years)	Education (Year of Schooling)	occupation
1					
2					
3					
4					

IV. Socio-Economic characteristics of the Farmer :

1. Total land area owned (acres) :------- leased in(acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Value of the land in that locality: ----------

5. Type of house : concrete /tiled / thatched

6. Ownership of the House : tenanted /owned / relatives

7. How far is the one-way distance to the Lake ever from your home: ----------km

8. Annual Gross Income/ household from lake activities:

(i) Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(a) Income & Expenditure :

S.NO	Crops	Area (Acres)	Season	Cost of Cultivation	Yield(Qty)	Price/Unit	Returns/ Yr

9. Net annual income/household from farming activity : ----------

10. License fee for doing farming activity in Kolleru lake area is Rs.

---

11. Percentage of Net Income is paying as License fee for farming in the

lake area ----------

IV. Socio-Economic characteristics of the Fishermen:

1. Total land area owned (acres) :------- leased in(acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Price of the land in that locality: ----------

5. Type of house : concrete /tiled / thatched

6. Ownership of the House : tenanted /owned / relatives

7. How far is the one-way distance to the Lake ever from your home: ----------km

8. Annual Gross Income/ household from lake activities:

(i) Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(i) Income :

S.NO	Season	No of days/catch/yr	Avg working hrs/day	Av. catch/day Qty Rate
1	High Catch			
2	Medium Catch			
3	Low Catch			

(ii) Expenditure:

(a) Capital Investment:

S.NO	Item	Purchase price	Year of Price	Repair Charges/Yr

(b) Recurring expenses (Fingerlings,Lime,Organic manure,insurance etc):

(c) Miscellaneous including Harvesting, Marketing expenses etc

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9. Net annual income/household from fishing activity : ----------

10. License fee for doing fishing activity in Kolleru lake area is Rs. ----------

11. Percentage of Net Income is paying as License fee for fishing in the lake area-----

IV. <u>Socio-Economic characteristics of the Dairy Farmer</u>:

1. Total land area owned (acres) :------- leased in(acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Value of the land in that locality: ----------

5. Total number of cattle owned by family: ----------

6. Type of house : concrete /tiled / thatched

7. Ownership of the House : tenanted /owned / relatives

8. How far is the one-way distance to the Lake ever from your home: ----------km

9. Annual Gross Income/ household from lake activities:

(i)Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(a) Income & Expenditure :

Experience	Maintenance Cost/Yr	Main Product Qty Price	Byproduct Qty Price	Income from main product/Yr	Income from By product/ Yr	Total Income

10. Net annual income/household from Dairy farming activity (Main & By Product): ----

11. License fee for doing Dairy farming activity in Kolleru lake area is Rs. ----------

12. Percentage of Net Income is paying as License fee for Dairy farming in the lake area: ----
--

IV. <u>Socio-Economic characteristics of the Duck Rearer</u>:

1. Total land area owned (acres) :------- leased in(acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Value of the land in that locality: ----------

5. Total number of Ducks owned by family: ----------

6. Type of house : concrete /tiled / thatched

7. Ownership of the House : tenanted /owned / relatives

8. How far is the one-way distance to the Lake ever from your home: ----------km

9. Annual Gross Income/ household from lake activities:

(i) Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(a) Income & Expenditure :

Season	No .of Working Days/Annum	Maintenance Cost	Price realized/Unit	Income/annum
On Season				
Off Season				
Total				

10. Net annual income/household from Duck rearing activity: ----------

11. License fee for doing Duck rearing activity in Kolleru lake area is Rs. ----------

12. Percentage of Net Income is paying as License fee for Duck rearing in the lake area ----------

IV. <u>Socio-Economic characteristics of the Sheep and Goat rearer</u>:

1. Total land area owned (acres):------- leased in(acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Price of the land in that locality: ----------

5. Type of house : concrete /tiled / thatched

6. Ownership of the House : tenanted /owned / relatives

7. How far is the one-way distance to the Lake ever from your home: ----------km

8. Total number of Sheep/Goats owned by family: ----------

9. Annual Gross Income/ household from lake activities:

(i)Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(a) Income & Expenditure :

Experiene	Maintenance Cost/Yr	Main Product Qty Price	Byproduct Qty Price	Income from main product/Yr	Income fromBy product/Yr	Total Income

10. Net annual income/household from Sheep& Goat rearing activity : ----------

11. License fee for doing Sheep& Goat rearing in Kolleru lake area is Rs. ----------

12. Percentage of Net Income is paying as License fee for Sheep& Goat rearing in the lake area: ------

IV. <u>Socio-Economic characteristics of the Input Supplier</u>:

1. Total land area owned (acres):------- leased in (acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Price of the land in that locality: ----------

5. Type of house : concrete /tiled / thatched

6. Ownership of the House : tenanted /owned / relatives

7. How far is the one-way distance to the Lake ever from your home: ----------km

8. Annual Gross Income / household from lake activities:

(i) Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(a) Income & Expenditure:

Experience	Expenditure	Income/Annum

9. Net annual income/household from Fertilizer and Pesticide shops : ----------

10. License fee to open Fertilizer and Pesticide shops in Kolleru lake area is Rs. ----------

11. Percentage of Net Income is paying as License fee to open Fertilizer and Pesticide shops in the lake area: ----------

IV. <u>Socio-Economic characteristics of the Agricultural labourer</u>:

1. Total land area owned (acres):------- leased in(acres):------

leased out (acres):----

2. Total area under cultivation (acres) :----------

3. Rental Value of land: ----------

4. Price of the land in that locality: ----------

5. Type of house : concrete /tiled / thatched

6. Ownership of the House : tenanted /owned / relatives

7. How far is the one-way distance to the Lake ever from your home:--km

8. Annual Gross Income / household from lake activities:

(i)Below 25,000

(ii) 25,000-50,000

(iii) 50,000- 1, 00,000

(iv) > 1, 00,000

(a) Income & Expenditure :

Experience	Avg. Days of Employment	Income/Annum

9. Net annual income/household from Agricultural Operations: ----------

10. License fee for doing the Agricultural Operations in Kolleru lake area

is Rs. ----------

11. Percentage of Net Income is paying as License fee for doing

Agricultural Operations in the lake area: ---------

APPENDIX-II

DESCRIPTIVE STATISTICS

I. DESCRIPTIVE STATISTICS OF FARMER:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	19	57	37.27	11.05
2	SEX	0	0	0	0
3	DISTANCE	1	3.50	1.97	0.77
4	EDUCATION	0	2	0.93	0.80
5	HOUSEHOLD SIZE	2	6	3.87	1.50
6	INDIVIDUAL INCOME	4800	60760	33497.27	18405.21
7	HOUSEHOLD INCOME	13500	95000	54186	28740.76
8	PROPORTIONATE INCOME	35.55	76.21	61.51	11.72
9	PERIOD OF DEPENDENCY	210	270	255.67	18.41
10	GROUP	2	2	2	0
11	WTP	50	135	102.67	25.13
12	GENERAL PERCEPTION	9	14	12.47	1.99
13	POLLUTION PERCEPTION	1	3	2.20	0.86

II. DESCRIPTIVE STATISTICS OF FISHERMEN:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	19	63	37.99	10.60
2	SEX	0	0	0	0
3	DISTANCE	1.50	4	2.10	0.61
4	EDUCATION	0	1	0.85	0.35
5	HOUSEHOLD SIZE	2	6	4.22	1.02
6	INDIVIDUAL INCOME	11800	78400	36119.10	15182.42
7	HOUSEHOLD INCOME	19540	125000	56159.61	21952.94
8	PROPORTIONATE INCOME	38.46	87.43	64.73	11.97
9	PERIOD OF DEPENDENCY	213	275	258.75	13.43
10	GROUP	1	1	1	0
11	WTP	50	150	113.44	15.43
12	GENERAL PERCEPTION	9	17	13.15	1.56
13	POLLUTION PERCEPTION	1	3	2.34	0.67

III. DESCRIPTIVE STATISTICS OF DAIRY FARMER:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	21	57	39.90	10.81
2	SEX	0	1	0.40	0.50
3	DISTANCE	1	5	2.30	1.00
4	EDUCATION	0	2	1.15	0.59
5	HOUSEHOLD SIZE	3	5	3.75	0.72
6	INDIVIDUAL INCOME	11100	93000	41450.50	21463.50
7	HOUSEHOLD INCOME	32410	165000	82330	35521.24
8	PROPORTIONATE INCOME	34.24	68.89	48.84	7.27
9	PERIOD OF DEPENDENCY	270	360	349.50	26.25
10	GROUP	3	3	3	0
11	WTP	85	150	119.50	17.91
12	GENERAL PERCEPTION	11	15	13.70	0.98
13	POLLUTION PERCEPTION	0	3	2.40	0.82

IV. DESCRIPTIVE STATISTICS OF DUCK REARERS:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	25	57	44.20	9.91
2	SEX	0	1	0.70	0.48
3	DISTANCE	1.50	2	1.70	0.26
4	EDUCATION	0	1	0.70	0.48
5	HOUSEHOLD SIZE	3	5	3.80	0.79
6	INDIVIDUAL INCOME	60000	310000	156100	83950.32
7	HOUSEHOLD INCOME	85000	335000	184850	84942.15
8	PROPORTIONATE INCOME	66.66	93.33	81.92	9.38
9	PERIOD OF DEPENDENCY	365	365	365	0
10	GROUP	4	4	4	0
11	WTP	125	155	143	11.35
12	GENERAL PERCEPTION	11	17	14.20	1.62
13	POLLUTION PERCEPTION	2	3	2.70	0.48

V. DESCRIPTIVE STATISTICS OF SHEEP AND GOAT REARERS:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	24	56	39.85	10.66
2	SEX	0	1	0.15	0.37
3	DISTANCE	1.5	4	3	0.61
4	EDUCATION	0	1	0.6	0.50
5	HOUSEHOLD SIZE	2	5	3.75	1.07
6	INDIVIDUAL INCOME	3900	25500	12280	6305.44
7	HOUSEHOLD INCOME	19560	65000	39014.50	10979.40
8	PROPORTIONATE INCOME	11.50	64.29	31.68	14.78
9	PERIOD OF DEPENDENCY	240	270	264	12.31
10	GROUP	6	6	6	0
11	WTP	30	110	66	23.37
12	GENERAL PERCEPTION	9	14	11.85	1.90
13	POLLUTION PERCEPTION	2	3	2.50	0.51

VI. DESCRIPTIVE STATISTICS OF INPUT SUPPLIERS:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	27	55	39.10	9.89
2	SEX	0	0	0	0
3	DISTANCE	2	5	2.70	0.95
4	EDUCATION	1	3	2.10	0.57
5	HOUSEHOLD SIZE	2	5	3.80	1.03
6	INDIVIDUAL INCOME	533256	2379500	1281639	619262.50
7	HOUSEHOLD INCOME	650000	2579500	1498450	653339.40
8	PROPORTIONATE INCOME	69.43	93.57	84.10	7.22
9	PERIOD OF DEPENDENCY	360	360	360	0
10	GROUP	5	5	5	0
11	WTP	120	350	227	69.00
12	GENERAL PERCEPTION	14	16	14.40	0.70
13	POLLUTION PERCEPTION	2	3	2.70	0.48

VII. DESCRIPTIVE STATISTICS OF AGRICULTURAL LABOURERS:

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	23	56	38.53	10.62
2	SEX	0	1	0.6	0.51
3	DISTANCE	1	2	1.4	0.39
4	EDUCATION	0	1	0.67	0.49
5	HOUSEHOLD SIZE	2	5	3.73	0.96
6	INDIVIDUAL INCOME	17600	26520	22001.33	2505.14
7	HOUSEHOLD INCOME	38250	65500	51185.33	6105.22
8	PROPORTIONATE INCOME	32.07	54.48	43.39	5.97
9	PERIOD OF DEPENDENCY	170	200	192.67	10.47
10	GROUP	7	7	7	0
11	WTP	110	130	119.33	4.95
12	GENERAL PERCEPTION	11	16	14.07	1.03
13	POLLUTION PERCEPTION	1	3	2.4	0.74

DESCRIPTIVE STATISTICS OF TOTAL STAKEHOLDER GROUPS

S. No	VARIABLE	MIN	MAX	MEAN	SD
1	AGE	19	63	38.8	10.53
2	SEX	0	1	0.15	0.36
3	DISTANCE	1	5	2.16	0.77
4	EDUCATION	0	3	0.91	0.57
5	HOUSEHOLD SIZE	2	6	4	1.04
6	INDIVIDUAL INCOME	3900	2379500	108528.90	319549.70
7	HOUSEHOLD INCOME	13500	2579500	143860.10	363033.70
8	PROPORTIONATE INCOME	11.5	93.57	59.28	17.82
9	PERIOD OF DEPENDENCY	170	365	275.18	49.35
10	GROUP	1	7	2.75	2.16
11	WTP	30	350	116.39	39.20
12	GENERAL PERCEPTION	9	17	13.22	1.65
13	POLLUTION PERCEPTION	0	3	2.40	0.68

VALUATION OF ECOSYSTEM SERVICES – A CASE STUDY OF KOLLERU LAKE IN ANDHRA PRADESH

By

ERUVA MAMATHA

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement

for the degree of

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Faculty of Agriculture

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ABSTRACT

Wetlands are one of the most productive ecosystems, comparable to tropical evergreen forests and play a significant role in the ecological sustainability. They are facing rapid decline in coverage and quality. The present study on "Valuation of ecosystem services- A case study of Kolleru Lake in Andhra Pradesh" was taken up with the objectives of identifying the services provided by the lake as perceived by the stakeholders and assessing the Willingness To Pay (WTP) for ecosystem services. It was conducted in one of the important wetland systems in India, Kolleru Lake in Andhra Pradesh, which is declared as a RAMSAR site.

The data for the study was drawn from primary and secondary sources. The respondents for primary data were selected by multistage random sampling (180 samples) and data was gathered through personal interview method using pretested structured schedule. The major tool for the analysis was Contingent Valuation Method (CVM), following dichotomous choice questions.

The stake holders depending on the Kolleru wetlands were farmers, fishermen, dairy farmers, duck rearers, input suppliers and agricultural labourers. Though Kolleru Lake Development Authority (KLDA) was constituted for the purpose of conservation and sustainable development of the area, majority of the respondents (65.5%) did not acknowledge the conservation efforts. The respondents were aware of the pollution level and concerned about the conservation as they considered the lake as the main source of livelihood for them.

The Total Economic Value (TEV) of the system constitutes of both Direct Use Value (DUV) and Indirect Use Value (IUV). The DUV of the lake was estimated by the level of income enjoyed by the stake holders from lake related activities. It ranged from Rs. 12,280 to Rs. 12, 81,639 with an average of Rs. 1, 08,529 per annum per household. Extrapolating for the total population DUV of the lake system amounted to Rs. 941 crores per annum. The IUV as revealed by the WTP was estimated by the linear regression model and ranged from Rs. 83 to Rs. 196. The average WTP was Rs. 116 per annum per household. At this level, total IUV of the lake system was estimated as around Rs. 1 crore per annum. Thus the TEV of the ecosystem was around Rs. 942 crores. Age, education and level of dependence on the lake were the important factors that influenced the WTP and it varied significantly among stakeholder groups.

Findings suggested the economic rationality of the investment of Rs. 942 crores for the conservation of lake. It also shows the possibility of the resource mobilisation through a system of Payment for Environmental Services (PES). The study can form the basis for the development of a management plan for the sustainable use of the lake system which is socially acceptable.