ECONOMIC VALUATION OF ECOSYSTEM SERVICES PROVIDED BY WETLAND; CASE STUDY OF KOLE WETLAND, RAMSAR SITE

By

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(2019-17-016)

THESIS

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DECLARATION

I, hereby declare that the thesis entitled "Economic Valuation of Ecosystem Services Provided by Wetland; Case Study of Kole Wetland, Ramsar Site" is a bonafide record of research done by me during the course of research and that this thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other University or Society.

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Certified that the thesis, entitled "**Economic Valuation of Ecosystem Services Provided by Wetland; Case Study of Kole Wetland, Ramsar Site**" is a record of research work done independently by **Neha Tamhankar (2019-17-016)** under my guidance and supervision and that it is not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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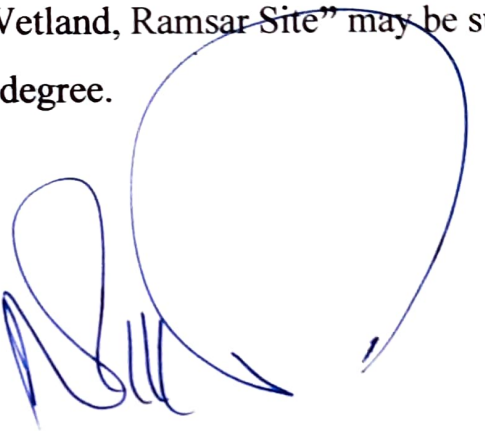

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Dedicated to.....

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Introduction

1. Introduction

"Healthy wetlands are imperative for a healthy earth."

Wetlands are one of the most productive ecosystems on earth and described as "the kidneys of the landscape", because of the infinite functions they perform in the hydrological and chemical cycles as well as they are termed as "biological supermarkets" because of the enormous food webs and treasure of biodiversity they support (Mitch and Gosselink, 1993). Globally wetlands are considered as one of the most diverse and life supporting ecosystems. Wetlands occupy 12.1 million km^2 and account for 40.6 percent of the overall value of global ecosystem services (SAC, 2011).

The significance of the wetland was first brought to the notice of the world by the convention on wetlands which held at the Iranian city Ramsar, signed on 2nd February 1971. The convention on wetlands (Ramsar convention) is the only international legal treaty primarily focused on wetlands. It works globally to promote their conservation and wise use, ensuring that wetlands play a key role in delivering the sustainable development goals, Aichi biodiversity targets, the Paris agreement on climate change and other related commitments. There are presently 171 contracting parties to the convention, with 2,392 wetland sites, totalling 253 million hectares, designated for inclusion in the Ramsar list of wetlands of international importance. The total number of Ramsar sites in India is 46, the highest in south Asia. In case of Kerala, the state is blessed with three important Ramsar sites namely Vembanad-kole, Sasthamkotta lake and Ashtamudi wetland.

Wetlands are dynamic systems, undergoing natural change due to subsidence, drought, sea-level rise, or infilling with sediment or organic material. The direct and indirect activities, development projects, industrialization, urbanisation has considerably altered the nature of wetland. Despite of it plays an extremely essential role in maintaining ecological balance and providing livelihood

for the local communities. Wetland did not receive the conservation attention that they deserve, it has been underestimated from decades.

Wetland loss has been faster (3.7 times) in the twentieth and early twenty-first centuries, with 64–71 percent of wetlands lost since 1900 AD (Davidson, 2014). Inland natural wetlands have suffered more losses and at a faster rate than coastal natural wetlands. Large area of wetland is converted to the agriculture, industrial developments or residential uses. Thus, descriptions made it easier to exploit for economic activities. Increased population, development projects, increased pollution have led to more destruction of wetland globally. The havoc created by frequent floods has created progressive attitude and awareness about the importance of wetlands. The conversion of wetlands to other land uses is a main cause behind frequent floods. People residing near wetlands are heavily dependent on wetland for various goods and services. If humans did not influence with wetland ecosystems, the planet would have around 29.83 million km^2 of wetlands (Hu, 2017). Researchers discovered that as of 2009, at least 33 percent of global wetlands had been lost, including 4.58 million km^2 of non-water wetlands and 2.64 million km^2 of open water wetlands, by merging datasets relevant to global wetlands (Hu, 2017). Besides of all this, no efforts are being made to conserve wetland. It has been noted that the main reason for the excessive depletion and conversion of wetland resources is the failure to properly account their values, particularly, the non-use and functional values (Barbier *et al.,* 1993). It is widely acknowledged that the ‘‘true’’ economic value of wetlands is underestimated because most valuation studies cover only marketed resources such as agriculture and fishery benefits (Turpie *et al*., 2010).

By providing a means for measuring and comparing the various benefits of wetlands, economic valuation can be a powerful way to aid and improve wise use and management of global wetland resources. Valuation plays an important role in creating markets for the conservation of biodiversity and ecosystem services (Engel *et al*., 2008). Economic valuation provides us with a tool to assist with the difficult decisions involved in conservation (Barbier, 1994). Understanding of the TEV

(Total Economic Valuation) of the ecosystem is required for economically justifiable decisions.

Total economic value (TEV) framework is increasingly used to assess the value of ecosystem services by combining both monetary and non-monetary aspects of overall value (Ledoux and Turner, 2002). Within the Millennium Ecosystem Assessment (MEA) the Total Economic Value (TEV) is stated as the widely used framework to identify and quantify the contribution of ecosystem services to human wellbeing. TEV is composed of use values, non-use values and option values (Adger *et al.,* 1995). There has been attempts on the economic valuation of wetland ecosystem in different parts of the globe. Such attempts are very limited in India. Economic valuation of priceless ecosystem services is tough task but extremely essential for the conservation of wetland ecosystem.

Economic activity, the standard indicator of success, always reigns supreme. However, criticisms of the Gross Domestic Product (GDP) as a metric that only measures economic growth and ignores both social and human welfare have entered the global debate. This conflict illustrates the need for improved progress metrics that can inform various policies and public expectations (Fioramonti, 2017).

Thrissur Kole Wetlands is a one of the important Ramsar sites lying in Thrissur district of Kerala, India. It contributes majorly to Kerala's rice requirement. The Kole Wetlands is one of largest, highly productive and threatened wetlands in Kerala and it comes in Central Asian Flyway of migratory birds. Due to anthropogenic interventions, Kole lands are now facing loss of species richness, decrease in agriculture production, scarcity of portable water, variation in flooding pattern and depletion of aesthetic value (Jyothi and Suresh Kumar, 2014).

Historically, Kole wetlands are the flood plains, who have played main role in the rural economy of the region, providing fertile land for agriculture supporting large population. Water that observed through floodplains recharges the underground reservoirs, which supply water to wells, beyond flood plain area. As this flood water levels reduces, arable crops are grown, and some quantity of soil moisture persists to the other season that is dry season providing essential grazing

for migrant and domestic herds. They also yield valuable supplies of fish, food, fodder, timber, medicines and provide crucial habitats for wildlife, especially for migratory birds (Maltby and Acreman, 2012).

No comprehensive study has been done in recent past with respect to the economic valuation of Kole wetland ecosystems. As it is very important for management and policy-decisions, attempt is being made to find out the value of ecosystem services by the Kole wetlands.

Objective:

- To estimate the Total Economic Value (TEV) of Ecosystem Services provided by Kole Wetlands

Limitations of the study:

1. Since the study is mainly a component of a postgraduate programme, time and financial resources are constrained
2. The study seeks to assess a wetland ecosystem that had been subjected to a large-scale alteration to undertake ecologically unfriendly but economically profitable activities based on stakeholders' perceptions of its importance
3. Given the current state of knowledge and awareness concerning the significance of the wetland ecosystem among stakeholders, the WTP is the perfect suited. If we can raise wetland occupants' consciousness, the WTP will certainly rise. As a result, the current study's findings may only be seen as a sign of a greater issue

To make the study results as valid as feasible, the researchers took all conceivable care to eliminate response biases and cross-verified the facts and figures to the extent possible.

- **Plan of the thesis**

The thesis is divided into five chapters, which are listed below. The first chapter is an introduction that discusses the study's aims, scope, and limitations. The second chapter examines relevant studies in context of the present study. The third chapter looks into the specifics of the research field as well as the technique employed during the examination. The fourth chapter summarizes the results and discussions, while chapter five has the study's summary and conclusion, as well as references, appendices and an abstract.

Review of Literature

2. Review of literature

In order to properly comprehend the principles, study design, and method of analysis in any research programme, a thorough examination of previous studies is required. As a result, this chapter includes a review of previous research that are relevant to the goal of study.

2.1. Wetlands

Wetlands are defined as 'Lands transitioning between terrestrial and aquatic eco-systems where the water table is usually at or near the surface or the land is covered by shallow water (Prasad *et al*, 2002). Wetland is a distinct ecosystem that is flooded by water for all the year or for few months. It is a vital ecosystem on the planet that offers incalculable benefits to humanity (Adger *et al.,* 1995). Wetlands are characterised as areas of swamp, fen, peatland, or stream, whether natural or artificial, permanent or temporary, with water that is stagnant or flowing, fresh, brackish, or salt, including areas of marine water with a depth of less than six metres at low tide (Ramsar convention, 1971). This ecosystem is considered as the most biologically diverse of all ecosystem, providing habitat to a wide number of plant and animal species (Mitsch and Gosselink, 1993). They play a critical role in local and global water cycles, as well as the they are the link between water, food, and energy; their protection is a challenge for our community in the sense of long-term sustainability (Clarkson *et al*., 2013).

India has a wealth of wetlands, that support a wide range of ecosystem services. It maintains numerous and distinctive wetland ecosystems due to its varied terrain and climate regimes (Bassi *et al.,* 2014). SAC's National Wetland Atlas 2011 is the most recent inventory of Indian wetlands. The entire country was assessed, and a total of 201,503 wetlands were discovered and mapped at a scale of 1:50,000 (SAC, 2011). Out of this, area under inland wetlands accounts for 69%, coastal wetlands 27%, and other wetlands (smaller than 2.25 ha) 4% (SAC, 2011). In terms of average area under each type of wetland, natural coastal wetlands have the largest area.

2.2. Kole wetland: Case of present study

The Kole wetland is one of the largest and most productive wetlands of Kerala, as well as one of the most endangered ecosystems. The etymology of "Kole" refers to a unique form of paddy cultivation that takes place from December to May, and this Malayalam word denotes a bumper crop with high returns if the crops are not damaged by floods. Agriculture is the main source of income for the residents of the Kole wetlands, about 90% of the population engaged in paddy farming (Panikkaveettil, 2020).

2.3. Functions of Kole wetland

Wetlands provide a variety of ecosystem services, including habitat, reduction in pollution, floodwater storage, microclimate control etc. The importance of wetlands is explained by Mitsch and Gosselink (2000) at three levels of ecological hierarchy, namely population, environment, and global. At the population level, wetlands include services such as paddy fields, fishing, vegetables, lotus farming etc which are typically harvested as a food. Wetlands include flood protection, drought mitigation, good quality water and enrichment of groundwater at the ecosystem scale. These are known as ecosystem values because the ecosystem delivers them most efficiently when the abiotic and biotic components are in sync. Then there are values such as climate regulation, carbon sequestration etc. at the biosphere scale. The Millennium Ecosystem Assessment (2005) introduced a new classification of ecosystem services, such as provisioning services (food, water, fibre, and fuel); regulating services (water control and purification); and regulating services (water regulation, climate regulation, erosion control and purification), Cultural facilities (spiritual and recreational); Supporting services (such as soil formation and nutrient recycling) are also essential.

Wetlands offer important economic, environmental, social, and cultural benefits to local residents, and they play an important role in planning and investment decisions. The estimation of economic value of different natural wetland ecosystem services is a difficult and complex process, but it is necessary for rational management of wetland (Costanza *et al*., 1989).

2.4. Importance of economic valuation of wetland:

In the sense of the environment, economic valuation refers to determining desires of people for a "public good" (that is the WTP, to conserve biodiversity). The valuation method is inherently anthropocentric (Randall, 1988).

The attempt to assign quantitative values to the products and services offered by environmental resources is known as economic valuation. The economic value of any good or service is usually determined by how much we are willing to pay for it, minus the cost of production (Babu *et al.*, 2002). Where an environmental resource merely exists and provides us with goods and services at no expense, the value of the resource in delivering those resources is defined solely by our ability to pay, regardless of what we pay for it.

According to Barbier (1993), Economic valuation of tropical wetlands is an important field for furthering our understanding of the role of natural systems in economic growth. Too frequently, planning decisions are taken without considering the economic consequences of wetlands modification and conversion. The costs of such decisions are always visible, with irreversible effects, and they are borne by those in developed economies who can least afford them.

The Millennium Ecosystem Assessment (2005) defines valuation as the process of expressing a value for a specific good or service in terms of something that can be counted, most commonly money, but also by methods and measures from other disciplines.

The values of people and society are reflected in economic valuation, and these values are often partial and imperfect. The scarcity of markets for many environmental goods and services is gradually changing, and people now have more opportunities to express their desires through market forces. Donations to conservation organisations, land purchases with unique environmental attributes, fees for environmental services, ecotourism trip purchases, and demands for more environmentally friendly goods are examples of these actions (Clarkson *et al*., 2013).

Disciplines that evaluate biophysical processes, such as ecology, biogeochemistry, and hydrology, play a central role in moving from identification

to quantification (Jenkins *et al*., 2010), while economics provides the connection from service quantification to monetization. As per Pascual and Muradian (2010), valuation exercises should preferably accept the existence of alternative, sometimes contradictory valuation paradigms and be clear about the valuation paradigm and assumptions used.

Economic valuation of ecosystem resources is one of the most promising ways to put aquatic environments on the water agenda. Ecosystem services can then be compared to those in other industries and factored into decision-making processes. In addition to attempt to internalise externalities and to protect effective decisions, economic valuation of ecosystems serves a variety of other purposes (Korsgaard and Schou, 2010).

Now the world is also aware about the environmental goods and the concept of EDP is introduced (Environment Adjusted GDP). Value of EDP is found by using formula, EDP = GDP + Value of Environment. To find value of environment TEV (Total Economic Value) framework is used.

2.5. Total economic valuation:

Natural ecosystem conservation initiatives in developing nations are limited by the lack of resources and imbalance of information. Furthermore, the distribution of public funds is usually insufficient since the economic value of these resources is not taken into account when making decisions. Economists face a challenge in determining the Total Economic Value (TEV) of natural resources in order to aid decision-making and raise public awareness (Adger *et al.,* 1995). Total economic value (TEV) is a commonly used and widely accepted method for classifying and attempting to incorporate wetland economic benefits into decision-making (Emerton, 2016). TEV's main breakthrough is that it considers subsistence and nonmarket values, ecological functions, and non-use advantages in addition to industrial and extractive values. TEV is used to solve the issues that have plagued traditional economic analysis and decision-making due to the undervaluation of wetland benefits (Jenkins *et al*., 2010).

The word "TEV" first became popular in the late 1980s and early 1990s (Pearce *et al*., 1989). TEV recognises not only commercial or extractive values, but also nonmarket and subsistence values, ecological functions, and non-use benefits. Looking at a TEV wetland entails considering all of its characteristics as an interconnected system – its resource stocks or properties, flows of environmental resources, and the ecosystem's overall attributes (Barbier, 1994).

Environmental values can be divided into two categories: use values and non-use values. The direct use of a wetland goods, such as the use of fish for food, the use of trees for fuel wood or as a building material, and the use of water for drinking, cooking, and washing, recreation, agriculture etc. (Schuyt and Brander, 2004). Indirect uses of a wetland include, carbon sequestration potential, nutrient cycling, flood control, groundwater recharge, micro climatic stabilization, erosion control, water filtration etc.

Using the Total Economic Valuation method, value provided by ecosystems can be classified as direct use value, indirect use value, Option value, bequest value and existence value (Turpie *et al*., 2010)

2.6. Review of Selected Wetland Studies

The review has been undertaken under three classifications namely,
1. International case studies 2. Indian scenario 3. Status of Kerala

2.6.1. International studies

Davidson (2011) re-estimated the global monetary values of natural wetland ecosystem services in 2011 using fresh data on the extent of various coastal and inland wetland classifications, as well as estimates for forested wetlands. Natural wetland ecosystem services are presently valued at Int$47.4 trillion per year, accounting for 43.5 percent of the total value of all natural biomes. Coastal wetlands were predicted to supply 43.1 percentile (Int$20.4 trillion a year) of the total

worldwide ecosystem services monetary value of all natural wetland classes, despite accounting for only 15% of global natural wetland area.

The annual economic value of 63 million hectares of wetland around the world is projected to be US$3.4 million. With a yearly economic value of US Dollar 1.8 billion, wetlands of Asia are noted as the most valuable (TEEB, 2010).

Choe *et al*., (1996), studied the economic value of improved water quality of the river and sea in Davao, Philippines. He used Revealed Preference Method as well as Stated Preference Method. The Contingent Valuation and Travel Cost estimates were found to be very similar and to be very low, both in absolute terms and as a percentage of household income. Water pollution management was not a high priority for Davao residents, according to the study. It also backed up the claim that people's willingness to pay for environmental benefits like better water quality is poor.

Fearnside (1996) conducted a survey in the Amazon Forest to estimate deforestation rate. The green income accounting and TEV frameworks were merged in this situation, and the new method is applied to Brazil in order to measure the foregone economic benefits as a result of Amazonian deforestation. The rate of deforestation is very high in most nations, and the Amazon Forest is being destroyed at a faster rate than ever before. The findings back up call for a stronger policy emphasis on the protection of rare and irreplaceable habitats.

In Dulac, California, Cardoch *et al*. (2000) evaluated the economic benefits of using wetlands for wastewater assimilation. Both traditional onsite waste water treatment plants and wetland treatment were compared in the study. It was discovered that wetland treatment costs just 25% of the cost of on-site waste water treatment, saving USD 150,000 per year.

Contingent Valuation Method was used by Loomis *et al*. (2000) for study. The authors used a ‘dichotomous preference Willingness to Pay' question to ask the sample stakeholders about the prospect of buying increased ecosystem resources by paying a higher water bill. The findings showed that households were willing to pay an average of USD 21 per month or USD 252 annually for additional ecosystem services, based on responses from 100 samples.

Lupi *et al.* 2003, has developed and used a method for calculating the relative economic values of wetland habitats in a case study of Michigan, USA. Through Choice Experiments, a utility theoretic model covering three major dimensions of wetlands, namely (i) Form, (ii) Function, and (iii) Services, was developed for estimating wetlands ecosystem values. The findings of the study revealed that stakeholders' understanding of wetland functions is unequal.

Tong *et al*. (2006) studied potential conservation work in the Sanyang wetland, a deteriorated permanent river wetland near the centre of Wenzhou city, China, over the course of a year. The main goal was to plan the restoration using structural indices as well as a valuation of the wetland ecosystem services, thereby connecting research to human welfare. They estimated the potential and current values of the key ecosystem resources based on field surveys and analysis into the study area's past. The results revealed that the Sanyang wetland have a potential value of 55,332-yuan ha^{-1} yr^{-1}, while the actual value was only 5807-yuan ha^{-1} yr^{-1}.

The monetary value of service functions for the Linghe river estuarine wetland was calculated and analysed in order to achieve sustainable use of Linghe estuarine wetland ecosystems resources. The monetary value of a service functions of wetland is equal to its direct, indirect, and non-use value. Nine key functions of wetland ecosystem services were defined using a method of map data visual analysis and the classification of functional zones. After visual interpretation, the monetary value is determined based on the functional zones and map data. The monetary value of the service functions of the Linghe estuarine wetland is measured

as 87.07108 yuan, which includes direct use value, indirect use value, and non-use value (Qian and Linfei, 2012).

Study conducted by Camacho-Valdez *et al*. (2013) introduced a spatial aspect for classifying wetland types and assessing their current distribution and extent using standardised remote sensing techniques for wetland mapping, as well as further evaluating their ecosystem services (ES). With the wetlands of northwest Mexico as a case study, a value transfer approach was used to generate baseline estimates of the ecosystem services provided by wetlands, which were then validated through a meta-analysis of a database of wetland estimates. Study found that saltmarshes were the most important wetland types in all terms. According to the findings, the adjacent wetlands offered a value of one billion dollars per year in facilities and benefits to the local citizens in 2003. The present approach emphasises the importance of wetlands to community well-being in a spatially explicit manner.

The Sundarbans Reserve Forest in Bangladesh, which covers 6000 sq.km. and is home to the world's largest mangroves, offers a wide range of ecological services. The aim of this study was to provide an economic estimate of the provisioning and cultural services provided by Sundarbans forest. The official of Forest Department revenue reports were the sources of information used in the forest's economic valuation. The Sundarbans' main provisioning services had been identified as timber, fuel wood, fish, thatching materials, honey, and waxes. Tourism is the most important cultural service. During the financial years 2001–2002 to 2009–2010, the Sundarbans' provisioning and cultural services contributed an average of US$ 744,000 and US$ 42,000 per year to the income of Forest Department (Uddin *et al*.,2013).

Sharma *et al*. (2015) used a mix of market-based and value transfer approaches to determine the economic values of the Koshi Tappu Wildlife Reserve's selective ecosystem services. According to the findings of the report, the reserve generates an annual economic gain of USD 16 million, or USD 982 per

household. Provisioning services provided about 85 percent of the total economic profit. While non-use principles and some components of regulatory services were not included in the report, the results clearly demonstrate the critical importance of the economic gain of reserve to the local well-being of community.

The overall economic value of the Jagadishpur Reservoir was calculated using direct, indirect, and non-use values. Direct products derived from wetland were tourism, agriculture, carbon sequestration, biodiversity protection, and conservation for potential use were among the six main values prioritised by the study. The overall economic value of the reservoir was estimated using market and nonmarket based valuation techniques. To gather information, a household survey, focus group discussions, and interactions with tourism entrepreneurs and district stakeholders were conducted. The overall annual economic value of the reservoir was calculated to be NRs 94.5 million (Baral *et al*., 2016).

The study conducted in China develops a non-monetary accounting structure for Environmental Service Value that divides the ES into three categories: direct services (directly linked to stock and flow), indirect services (produced by ecosystem processes that generate direct services), and existence services (cultural services and global benefit). The new structure proposed by Yang *et al*. (2018) aims to (1) construct a system energy flow diagram and a merging calculation method to prevent double counting; (2) propose new methods for biodiversity and climate regulation; and (3) link non-monetary and monetary values. Using the forest ecosystem in the Jing-Jin-Ji urban agglomeration as an example, the study calculated 9 ecosystem services in detail and compared to economic values using the Energy Money Ratio. The findings show that energy can be used to track environmental debt and create a balance sheet that reflects economic factors as well as environmental contributions to economic growth.

Indonesia has the most mangroves in Asia (and the world), accounting for roughly half of the total mangrove area in the region. The work was done with the

aim of determining the importance of the use-driven economy and the non-use value of the existing economy, estimating the overall economic value of mangrove resources, and making suggestions and recommendations based on observations in Timbulsloko, Sayung, and Demak (Perdana *et al*., 2018). Economic valuation using the total economic value approach was done. Fisherman, fish pond growers, branjang catchers, oystercatchers, trap makers, shop owners, grilled fish makers, and shrimp chip makers all used the direct use value of mangroves. Breakwater, beach belt, and hybrid engineering functions had indirect usage benefit. The overall economic benefit per year was Rp. 63,61,430,639 or Rp. 202,335,580 per hectare (Perdana *et al.,* 2018).

A functional value evaluation framework was created for the Xi'an Chan-Ba wetland to analyse the service feature value of urban wetland ecosystems. Such values were translated into economic value using market value method, carbon tax law and afforestation cost method, alternative cost method, travelling cost method, and so on, and a description of the same was made for comparison. The Chan-Ba wetland ecosystem had a total service feature value of 3,87,108 Y (Zhou *et al.*, 2018).

The TEV study was conducted for watershed system, a combination of market and non-market-based valuation methods were used to assess the value of ecosystem services in the Begnas Watershed System, including household surveys, multiple focus group meetings and stakeholder consultation. In-depth interviews, as well as a combination of market and non-market-based valuation methods including market price method, travel cost method, revealed price method, contingent valuation method, and benefit transfer method were used. The economic benefit provided by the wetland was estimated to be worth US$ 3.91 million per year, or US$ 650.67 per household and US$ 799.79 per hectare (Thapa *et al*., 2020). The most profitable service was the direct non-consumptive (recreational) service, which accounted for around 85 percent of the overall value.

Forest products were rated as the most important ecosystem service provided by the Ghodagadi wetland in Nepal, followed by edible foods and tourism, according to the study's priority ranking report. Since the wetland is a complex of lake clusters with surrounding tropical forest, offering the most needed provisioning facilities, local people rated usage value as the highest priority. According to the Aryal *et al*., (2021) current ecosystem services assessment, the annual net economic return from the Ghodaghodi wetland was expected to be 0.67 million US dollars, with usage value accounting for 96% of the amount.

2.6.2. Indian scenario

The services given by the Bhitarkanika mangrove ecosystem in India, as well as the estimated cyclone damage prevented in three selected villages, were valued by assessing the socio-economic status of the villagers, cyclone damage to buildings, livestock, fisheries, trees, and other properties owned by the residents, and the extent and length of flooding, using the cyclone of 1999 as a reference point. The study found that the village that was not sheltered by mangroves but had an embankment suffered the greatest loss per household (US$ 153.74), followed by the village that was neither in the shadow of mangroves nor on the embankment (US$ 44.02), and the village that was covered by mangrove forests (US$ 33.31) (Badola and Hussain, 2005).

Brown *et al*. (2006) described ES as those that were derived from ecosystem functioning and have direct meaning for humans. The two main forest ecosystems in the western Himalayan region (India's Uttarakhand State) are oak (*Quercus leucotrichophora*) and pine (*Pinus roxburghii*). The study's goal was to quantify the various provisioning services that local people derive from oak and pine forests in the western Himalayan region, as well as to evaluate perceptions of local people of the regulating services of forests. A standardised questionnaire was used to conduct the research in 11 villages (665 households). In comparison to pine forests, oak forests have a wider range of provisioning facilities (Joshi and Negi, 2011). Oak

forests (Rs. 5676/person/year) offered more useful provisioning resources such as fuelwood, fodder, and natural fertilisers than pine forests (Rs. 4640/person/year) (Joshi and Negi, 2011).

The research was conducted in the village of Thittu, which is located near the Pichavaram mangroves in the Indian state of Tamil Nadu. The goals of the study were to assess the current state of mangroves in Tamil Nadu, investigate perceptions of fishermen about mangrove importance to their livelihoods, calculate the economic value of mangroves as a case study, and recommend policy measures for mangrove conservation, security, management, and growth. The required information was gathered at random from 41 experts and 120 villagers. The values were divided into direct use values, indirect use values, and willingness to pay figures, and the total economic value of the concerned mangrove area was calculated Rs. 353,52,31,312 (DebRoy and Jayaraman, 2012).

Manda *et al*. (2004) used the contingent valuation method and the individual travel cost method to estimate the public and non-public good portion values of Kaziranga National Park (KNP), a World Heritage Site in the north-eastern part of India. In the fiscal year 2010-11, real usage charges accounted for just 5.87 percent of overall conservation spending. Excludable and semi-rival amenities OF KNP are significantly undervalued.

Inland open water fisheries facilities in India include 14 large rivers, 44 medium rivers, 1.2 million ha of floodplain wetlands, and more than 3.0 million ha of reservoirs (including 8253 km of riverine length and 41600 ha of lakes and reservoirs in the cold-water fisheries sector) (Pandit *et al*., 2015). However, since the majority of the programmes are provided for free, their worth is often underestimated. Valuation can be a powerful tool for recognising the true values of valuable natural resources, which can help shape policies governing their conservation and sustainable use. The research attempted to value a 22-kilometer stretch of the Bramhaputra River in Assam. Throughout 2012, primary and

secondary data was collected from various stakeholders. Depending on the case, the market price system, revenue generation, and travel cost method were considered for valuation of goods and services. The minimum annual value of these six goods and services was calculated to be Rs 47.8 crores (Pandit *et al*., 2015).

In several nations, the use of national parks for recreational purposes has risen dramatically in recent years. The leisure importance of a site can be estimated using a variety of methods. The travel cost form is one of them (TCM). Narkar *et al.* (2016) conducted a study at Borivali National Park to investigate the recreational importance and demand for recreation. Data was obtained from 150 visitors at random. The results of the study revealed that as travel costs rise, the number of visits by tourists decreases. Age and park value were found to have positive estimated coefficients, while education level, employment status, gender, and monthly income of visitors were found to have negative estimated coefficients.

Verma *et al*. (2017) assessed the economic value of ecosystem resources in six Indian tiger reserves. The six tiger reserves studied were Corbett Tiger Reserve (CTR), Kanha Tiger Reserve (KTR), Kaziranga Tiger Reserve (KZTR), Periyar Tiger Reserve (PTR), Ranthambore Tiger Reserve (RTR), and Sundarbans Tiger Reserve (STR) based on screening criteria (STR). The benefit transfer approach is used to count importance based on a literature review. According to the findings, the annual monetary value of flow benefits produced by selected tiger reserves ranges from US$ 128 million to US$ 271 million.

The study used data from 301 visitors from various parts of the world to estimate the value of the economic benefits provided by sustainable management of Dachigam National Park in Jammu and Kashmir. Count data models were used to analyse the data, and the results show that the travel cost method was suitable for valuing various use values provided by environmental resources such as national parks. According Bhat and Bhatt (2019), user surplus per tourist per visit in the

study was Rs. 12,470 (US$197), equating to a monetary recreational value of Rs. 247,614,828 (approximately US$3,930,395) per year.

Research was undertaken to determine the economic benefits of historical monuments Taj mahal in relation to conservation issues. The Taj Mahal is one of the world's 100 most endangered sites (WMF, 1996), and it is threatened by a variety of factors. For the study, total of 200 households were surveyed (Sadia, 2021). The proposed bid prices for Taj Mahal conservation were considered to be appropriate by 70.50 percent of the 200 sample respondents, while the remaining 29.50 percent rejected the proposed bid prices. The study found that the mean willingness to pay (WTP) derived from the Single Bounded Dichotomous Choice model was Rs. 109.92 (US$1.50) per month per household.

Khecheopalki, a lake in the west district of Sikkim state, India, offers recreational, biodiversity, and sacredness qualities (Maharana *et al.,* 2000). With lower travel costs and distances for Sikkimese visitors, the demand function for recreation grew. WTP for lake upkeep and preservation by all sorts of visitors ranged from US $0.88 for local residents to US $7.19 for international/sacredness values linked to biodiversity protection and pilgrimage (Maharana *et al.,* 2000).

Chopra (1997) undertook an economic assessment study of India's Kailadeo National Park, a Ramsar site of national importance. She had underlined the significance of tourism and hence used the Travel Cost Method (TCM). The consumer surplus, calculated using local cost estimates, was Rs. 427.04 for an Indian and Rs. 432 for a foreigner per visit. She determined a total value of Rs. 42.5 million by estimating the total number of tourists between 1992-93 and 1995-96.

2.6.3. Studies from Kerala-

Bulow and Lundgren (2007) conducted research to determine the recreational importance of Periyar National Park in India. Research employs travel

cost method for study. The survey was performed on 129 visitors to the National Park using a pre-tested interview schedule. According to the findings of the report, Periyar National Park's consumer surplus was projected to be worth $15 billion USD.

The results of CVM studies according to Binilkumar (2010) in the Kole wetlands of Thrissur showed that almost all of the respondent households expressed support and willingness to participate in the CVM survey for the better protection of the wetland. They were able to donate a portion of their annual profits to WTP in order to improve conservation (97 percent of the respondents of CVM study were willing to contribute a part of their income annually for the better conservation of the wetland). The total annual WTP for all stakeholders in the Thrissur Municipal Corporation was calculated to be INR 13,365,400. The sum suggested that the improved protection of Kole wetland has a high perceived monetary value among urban households.

Rice production, which accounts for 99 percent of the state's total food grain production, peaked at 9.88 lakh tonnes in 1960-61 but dropped to about 5.98 lakh tonnes by 2009-10, a drop of around 47% over the same period (Government of Kerala, 2010). Kole wetlands contributes majorly to the Kerala’s rice requirement. To find out the economics of Kole wetland paddy fields study was conducted by Shrinivas (2012). Paddy cultivation yielded an average net value of Rs. 11,142 per hectare. For small padasekharams, this was as low as Rs. 2,335. Small holder cultivators have a net return of Rs. 27,736 per hectare, while marginal holders have a net return of Rs. 10,279 per hectare.

Kerala's coast, which covers 10% of the country's coastline, currently has less than 1% of India's total mangrove ecosystem. Mangroves can be found in large numbers in the districts of Kannur (44%) and Ernakulam (24%). Study was conducted in two districts of Kerala. The research was carried out in the Ernakulam and Kannur districts of Kerala. The research was focused on both primary and

secondary sources of information. The primary data was collected from 480 respondents who were randomly selected from four different stakeholder groups (residents, fishermen, paddy growers, and the general public). Data was gathered through personal interviews and direct observation using an organised, pretested interview schedule. The TEV of the mangrove ecosystem was thus 117,947 million, or 0.14 percent of the GSDP (2011-12) (Hema and Devi, 2015).

Kuttanad is located in the Alappuzha district of Kerala, India, in the heart of the backwaters. The sum that the citizens of Kuttanad are willing to pay for pure and potable water was calculated using the contingent valuation method. People are willing to pay USD 0.671 per kilolitre of water (Antony, 2019). According to the report, a family of four members was willing to pay about USD 5.64 per month if they could get potable water through a pipeline at home.

The Ashtamudi ecosystem is an estuarine wetland ecosystem in Kerala's southern region. The economic value and current status of 11 important ES supported by this wetland were examined (Joy and Paul, 2020). Fish, clam, shrimp/prawn larvae production, inland navigation, coir production, carbon sequestration and erosion prevention offered by mangroves, flood control, cooling impact, tourism, and potential use-value are all considered resources. The methods used were market price methods, replacement cost method, travel cost method and contingent valuation method. By considering the aforementioned facilities, the overall economic value of the wetland was 424 million US$ (in 2017 International $ value), and each hundred square metres of the wetland has an economic production of approximately 820 US$ per year.

Aswathy (2015) carried out an Ecosystem Valuation Study of Vellayani Lake. Replacement method, market value method, travel cost method, willingness to pay methods were used. By summing the value of products and services offered by the lake, the Overall Economic Value, which was the total value of ecosystem service use of the Vellayani lake, was calculated to be Rs. 672.28 crore $year^{-1}$.

Materials and methods

3. Material and methodology

3.1 Materials

For a research study to be successful, it must have an appropriate research design. The goal of study on the valuation of ecosystem services in Kole wetlands is to determine the services offered by the wetlands as recognised by stakeholders and to calculate the total economic worth of ecosystem services. The part includes a brief summary of the research area as well as a detailed discussion of the research methods.

3.1.1 The Study Area

The Kole lands, a rice granary in Kerala, are part of the Vembanad-Kole wetland ecosystem, which was designated as a Ramsar site in 2002 and covers 1,51,250 ha. According to the Ramsar, the Vembanad-Kole Wetland System is India's largest brackish, humid tropical wetland ecosystem in southwest India. About ten rivers feed the Vembanad-Kole system and all these rivers flow westward from the Western Ghats and into the Arabian Sea. The study area is a Kole lands, which is part of the Vembanad-Kole wetland ecosystem, cover an area of around 13,632 ha in the Thrissur and Malappuram districts. Kole is a term used to describe a unique form of farming activity that takes place on these lands. Kole means bumper yield or high returns in the Malayalam language, assuming the crop was not damaged by floods (Shrinivas ,2012).

3.1.2 Location

The Kole lands stretch from the northern bank of Chalakudy River to the southern bank of Bharatapuzha river in the north. Around 10 20' and 10 40' N latitude and 75 58' to 76 11'E longitude, they are low-lying tracts 0.5 to 1 m below mean sea level. The fields are located in the taluks of Mukundapuram, Chavakkad and Thrissur in the Thrissur district. The ‘Thrissur kole' covers the area between Velukkara in the south on the Chalakudy river bank in Mukundapuram Taluk and

Mullassery in Chavakkad Taluk, as well as the Tholur-Kaiparama areas of Thrissur Taluk.

Kole is a low-lying region of alluvium deposits carried down by the rivers Kechery and Karuvannur. It is a saucer-shaped basin with laterite hills on the western and eastern sides. Some parts of the Kole region have a lacustrine climate, with black carbonaceous clay (Johnkutty and Venugopal,1993). The Thrissur kole spread over 12082 ha area covering 8 blocks in Thrissur district. Block wise area of Thrissur Kole is given in table 1.

Table 1: Block wise geographical area of Kole wetlands, Thrissur, Kerala

Name of Block	**Area ha**
Anthikadu	2985
Puzhakkal	2299
Cherpu	1501
Mullassery	1293
Irinjalakuda	1665
Chowannur	922
Chawakkad	845
Vellangallore	572
Total	12082

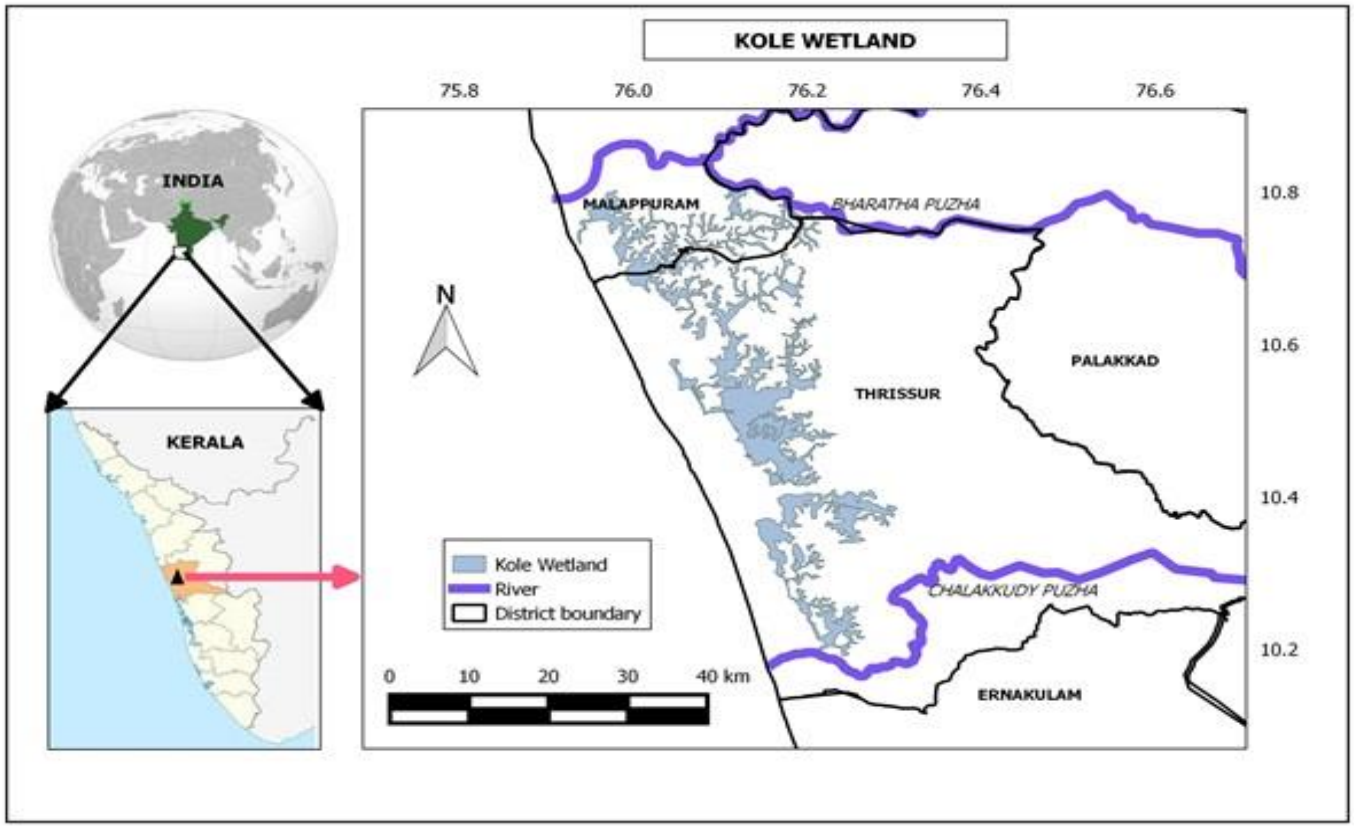

Plate 1: Map of Kole Wetlands, Thrissur, Kerala

3.1.2 Hydrology

The Kole lands are immersed in floodwater for around six months of the year, and this seasonal change gives it both terrestrial and water-related properties that decide ecosystem structure and processes, which in turn give rise to a variety of provisioning services. Kole lands are under water from Month of June to almost September to November.

The two rivers Kechery and Karuvannur, which eventually drain into the sea, are the key sources of floodwaters in this district, which runs parallel to the sea. External drainage is provided by a network of main and cross canals that links the various regions of Kole to the rivers.

The Thrissur Kole is divided into two parts: north and south. From the Karuvannur River in the south to Kaiparamba in the north, the Thrissur North Kole is a stretch of low-lying lands. The Enamakkal and Idiyanchira regulators are the key exits for flood water entering the Kole fields. These regulators also act as salt barriers, diverting a portion of the floodwaters from northern Kole to the backwaters via Kanoli canal, and then to the sea via Chettuva azhi (Johnkutty and Venugopal,1993). The key water discharge into the South Kole field, on the other hand, is via Thuppanthodu, which enters the Kole land from the Villichira regulator. Another stream, Nedumthodu, flows through this area, draining Thommana and other parts of Irinjalakuda town to the east and northeast. Panoli canal passes through Irinjalakuda's north and north-west, eventually draining into the Chemmanda kayal. During the monsoon, the Thamaravalayam canal from the Muriyadu region flows into the Karuvannur River, which is used to transport irrigation water from the river during crop seasons (Srinivasan, 2010).

3.1.3 Climate

Summer lasts from March to May, whereas winter begins in November and lasts until February. The monsoon season occurs twice yearly. The main rainy season is the southwest monsoon, which lasts from June through August. In October-November, the Northeast monsoon, also known as the retreating monsoon,

arrives. In most parts of the region, overall temperature remains cool between the two monsoon seasons. It is a land with a pleasant environment in general. The annual rainfall averaged 3,200 mm, with temperatures ranging from 28°C to 31°C.

3.1.4 Flora and Flora

After Chilika Lake in Orissa and Amipur Tank in Gujarat, the Thrissur Kole Wetlands are India's third largest in terms of bird population. BirdLife International has designated it as one of India's Important Bird Areas.

From the Kole wetlands, 140 species of plants were found, divided into 23 Dicotyledon families, 11 Monocotyledon families, and 5 water fern families (Sujana and Sivaperuman, 2008). A total of 44 species of Odonata,30 dragonflies and 14 damselflies, belonging to eight families were recorded from the Kole wetlands in the study conducted by Chandran *et al*., 2021. 167 species of birds belonging to 16 orders and 39 families were recorded from wetlands by Sivaperuman and Jayson (2000)

According to Sarath *et al.,* (2017) total 58 butterfly species from five families were identified from Kole wetlands including Sahyadri birdwing which is endemic to western ghats. In the Kole wetlands, a census for various taxa is conducted every year. It is a biodiverse region with an abundance of biodiversity.

Kole is home to a total of 12 species of herpetofauna, including seven amphibian species and five reptile species. *Hoplobatrachus tigerinus* was the most plentiful and frequently encountered amphibian in the Kole Wetlands, while *Xenochrophis piscator* was the most plentiful reptile in the Kole Wetlands. The study found two endemic amphibian species: *Hylarana malabarica*, which is endemic to the Western Ghats, and *Hylarana aurantiaca*, which is unique to Sri Lanka and the Western Ghats.

3.1.5 Kole Development Authority

On 30 June, the Government of Kerala established the Kole Development Authority (KDA) in Thrissur City for the development of Kole farming in order to

carry out the project. The initiative will be implemented by the Thrissur District Collector as a special officer. The Indian government has approved a Rs 425-crore project for the development of the Thrissur Kole fields. The money will be utilised for infrastructure development in Kole fields, such as the construction of bunds, canals, and roads, as well as farm mechanisation. A research unit worth Rs 15 crore would be established to investigate the Kole land development.

3.2. Methodology

This chapter explains the methods used in the present research under the following headings:

3.1. Nature and sources of data

3.2. Scheme of analysis

3.3. Analytical techniques and techniques applied

3.2.1. Nature and sources of data-

The research was focused on both primary and secondary data. Direct personal interviews are the most efficient method for gathering data and obtaining reliable information. Kole lands provides a variety of services to a variety of individuals, so a personal interview is the most suitable approach for data collection (Fromm, 2000). To collect primary data from different stakeholders, standardised pretested interview schedules were used. In December 2021, a pilot survey was conducted in Puzhakkal, Adat, and Pullu to test and finalise the questionnaire.

The questionnaire, which is divided into two parts, is used to gather information about the various aspects. The first section covers the socioeconomic status of respondent and basic information, which is shared by all respondents. Stakeholder-specific schedules were created for each category in the second section. The responses from the respondents were collected in a descriptive manner

to capture the qualitative aspects. Tourist interview schedule was created to collect information of tourists.

Secondary data and necessary values were gathered from various universities and government departments. Different published reports were also referred.

1.Kerala Water Authority

2. Kerala Fisherman's Welfare Fund Board

3. Fisheries Department Kerala

4. Department of Agriculture Development and Farmers' Welfare

5. Kole Wetland Development Authority

6. Thrissur Municipal Corporation

3.2.2. Scheme of analysis

The study was initiated by holding focus group discussions with local residents, officials of the agriculture department and people in the locality**.** Major stakeholders who were directly reliant on the wetland ecosystem were identified. They were classified as Kole wetlands inhabitants who rely on the wetlands for their livelihood. The majority of them were paddy farmers. There were only a few lotus farmers, fishermen and duck rearers identified. Residents are important respondents because they benefit directly by the Kole wetlands in the form of ground water recharge. Nearly 40 tourists were interviewed. A total of 215 participants were questioned for the survey. Figure 1 shows how the sample respondents were sorted into distinct categories.

People who reside inside Kole and folks who reside outside Kole are divided into two categories. Paddy farmers, farmers who engage in fishing operations, and residents involved in other occupations are among those who live inside Kole area. People who reside outside of Kole and visitors make up the second category. Eight major locations from Thrissur Kole were selected for study. They are Thommana,

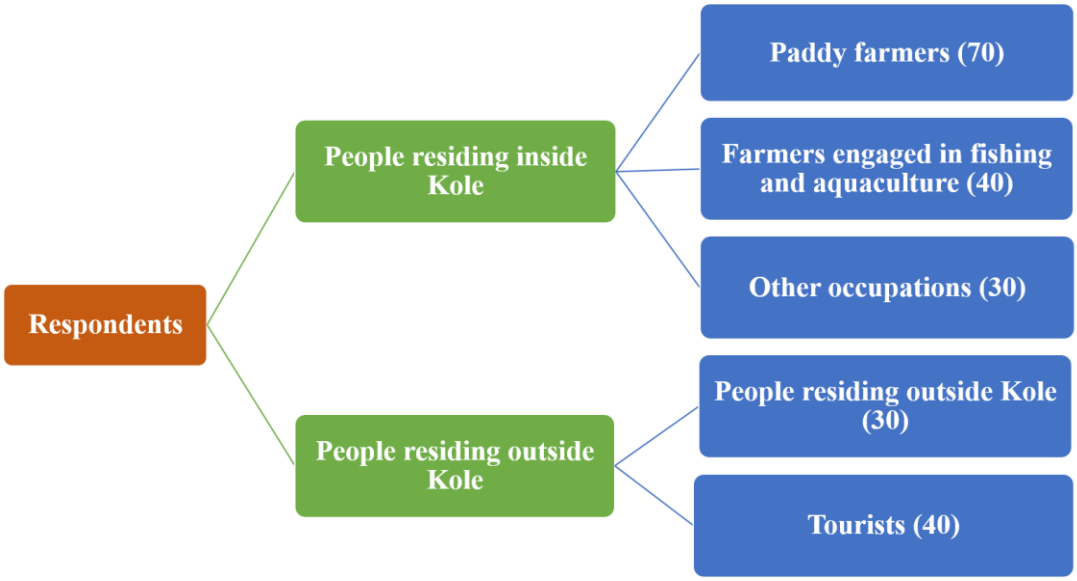

Fig 1: Selection of sample respondents for survey

Pullu, Enamav, Kanjani, Pulazhi, Nedupuzha, Aranattukkara, Kodannur and Adat. The list of farmers was collected from the *padasekharam samiti* and random sampling of 70 was identified. People undertake fish catching and pisciculture operations prior to rice production. Forty farmers engaged in natural fishing and pisciculture were interviewed. The list of residents along with the study area was gathered from respective grama panchayat office and 30 residents from list were selected randomly. Lotus farming is not much popular in Thrissur Kole land area. There were very few farmers engaged in Lotus farming and duck rearing.

The tourist those who are visiting Kole wetlands for the purpose of sight-seeing, boating, birding etc. are involved in this group. The randomly 40 respondents were selected from Kole tourism sites. This group represents the people who are not receiving any benefit from Kole wetlands. People 10 km apart from Kole were selected randomly from Vellanikkara, Pandiparamb, Chirakkekod and Thanikudam. Randomly 40 samples were collected from above different locations.

3.2.3. Analytical tools and techniques

The overall economic value of the Kole wetland ecosystem was estimated using primary data obtained from various stakeholders and analysed using appropriate techniques. The study identified different resource users of the Kole wetland ecosystem, classified them according to the type of resource usage, categorised the related sets of prices and costs that decide the economic trajectories of their production activities and estimated the monetary values using a set of common valuation taxonomy established by various environmental economists (Barbier, 1994). Surrogate markets and a contingency valuation survey were employed to estimate economic values where there were no observable markets for such resources. The cumulative economic value of wetlands is calculated by adding these figures together.

TEV stands for Total Economic Valuation, and it is a framework for valuing the various ecological services that ecosystems offer to humanity. TEV is divided into use and non-use categories depending on the characteristics of the products and

services received. Kole wetlands include 12 essential ecosystem services, which were selected after discussions with experts, farmers and residents. Different valuation approaches were used for different values. Table 2 shows the various values discovered and the various approaches used to analyse them in present study.

Table 2: Ecosystem services and valuation approaches used for valuation

SL No.	Ecosystem service	Valuation approach
1	Paddy	Market Value method
2	Fishing	Market Value method
3	Pisciculture	Market Value method
4	Lotus farming	Market Value method
5	Duck rearing	Market Value method
6	Cattle rearing	Market Value method
7	Tourism	Travel Cost Method
8	Reservoir of water	Replacement Cost Method
9	Carbon sequestration	Benefit transfer method
10	Groundwater Recharge	Alternative/ substitute method
11	Non-use value	Contingent Valuation Method

3.2.3.1. Tabular analysis:

To illustrate different demographic characters of respondents, chi-square test results and t-test results tabular analysis was employed. The software R is used for statistical computing and graphics.

3.2.3.2. Valuation approaches

The various valuation approaches were used for valuation of different ecosystem services. The different approaches used for study are explained below:

3.2.3.2.1 Market value method

Kole wetlands provide various direct products to mankind. Market prices of these direct outputs produced were used to monetize economic values of products.

Costs associated with various crops and fishing were gathered from various stakeholders and market sources. The profits from direct activities were measured using the market price of the produce and the net returns from farming and fishing. The total value from direct uses, and fishing was measured using average net returns per acre.

Total value of wetlands from farming;

$V^i = \sum_{i=1}^{n} PiQi - Ci$

Where,

V^i =Net returns from the resource (₹)

P^i = Price of the i^{th} resource (₹/kg)

Q^i = Quantity of i^{th} resource (kg)

C^i = Expenditure (₹)

3.2.3.2.2 Travel cost method

The Travel cost model was used to estimate the tourism and recreational benefits of the Kole wetlands. It was thought that an individual's usefulness is determined by the amount of time spent at the location, the site's efficiency, and the amount of private goods purchased other than travel (Willis and Garrod, 1991; Bockstael, 1995; Turpie *et al*., 2001; Turpie and Joubert, 2001).

In present study, the Individual Travel Cost Method (ITCM) is used. Visitors to sites are asked to provide details about their trip (cost, duration, intention, other sites visited, etc.) as well as other socioeconomic factors (income, age, sex, etc.). The visitor rate is then specified as the dependent variable (the number of visits made by the individual in a period).

Opportunity cost - The potential gains that an individual, investor, or business misses out on when choosing one option over another are referred to as opportunity costs.

Opportunity cost and total expenses per trip were calculated. The total number of tourists on week days and weekends was observed. The following formulae was used to evaluate economic value of tourism service.

VT= (OC + E) x Tn

Where,

VT =Value of tourism services (₹)

OC = Opportunity cost per visitor (₹)

E = Expenses per visitor (₹)

Tn =Number of visitors per annum

3.2.3.2.3. Replacement cost method

This approach considers the cost of providing a substitute good (or surrogate) that has a similar function to a given ecosystem goods or service (Basnyal *et al*., 2012).

Kole wetland perform important function in flood storage by storing huge amount of water. To calculate the economic value of this function cost of substitute good method is used (Zhou *et al*., 2018). As a result, the gross water storage of Kole wetland during the wet season is estimated. Flood storage function value is determined by the money which would be spent to build a tank to store the estimated quantity of water. Tank construction costs were obtained from the Irrigation Department of Kerala.

3.2.3.2.4. Benefit transfer method

The benefit transfer method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/ or context (Baral *et al*., 2016). Thus, the basic goal of benefit transfer is to estimate benefits for one context by adapting an estimate of benefits from some other context. The method was used to estimate carbon sequestration of Kole wetland.

The social cost of carbon (SCC) is the economic cost of climate damage (or benefit) caused by an additional tonne of carbon dioxide released into the atmosphere (tCO2) (Nordhaus, 2017). India's country-level social cost of carbon emission was estimated to be the highest at $86 per tonne of CO2 (Ricke *et al*., 2018). To calculate economic value of carbon sequestration social cost of carbon per ton in India for the year 2020 was used (Gallant *et al*., 2020; Ganguly *et al*., 2018).

3.2.3.2.5 Alternative/ Substitute method

The alternative/ Substitute method was used to estimate the economic value of the groundwater recharge service provided by the Kole wetlands. Data on water requirement of the households were gathered. The economic value of domestic water supply was used as an alternative estimate for the economic value of groundwater recharge ecosystem service provided by the Kole wetland. Water charges charged by Thrissur corporation and Kerala Water Authority were used.

Economic value of groundwater recharge ecosystem service was calculated by,

VG= IWR x F x H x WS x WC

Where,

VG= Value of groundwater recharge

IWR= Individual water requirement per day

F =Average family size

H=Number of households

WS= Water scarcity period

WC= Water charges

3.2.3.2.6 Contingent valuation method

Non- use values of any ecosystem are complicated to analyse. Different values like bequest, altruism and existence values for which market is not available Contingent valuation approach can be used (Mitchell and Carson, 1989). Willingness to Pay (WTP) is important value in CVM method. The amount of money a person is willing to pay for any good or service is referred to as willingness to pay. It has to do with the usefulness of the particular product or service. We provided a scenario and a hypothetical market that ensures a better management policy and enhanced ecosystem services offered by wetlands to the respondents in order to estimate the consumer's willingness to pay for the non-use values of Kole wetlands (Katar and Anil, 2007). The mean WTP was calculated and get non-use value of Kole wetland the number of households residing inside Kole wetland area was used.

Economic value of non-use value was calculated by,

NUV= WTP x NH

Where,

NUV= Non-use value

WTP= Mean willingness to pay amount per household

NH= Total number of households in Kole wetland area

Results and Discussion

4. Results and discussion

The results of the study and statistical analysis of the data acquired through the survey are presented in four sections. The stakeholder groups and their socio-economic features are discussed in the first section. The second section deals with stakeholder direct dependence on the Kole wetlands and Direct Use Value of the wetland ecosystem. The multiple benefits of wetlands are addressed in the third session of the topic, as well as the economic appraisal of indirect values. Stakeholder perspectives on the current situation of wetland ecosystem services and the many concerns are presented in the fourth session.

4.1 Socio-economic characteristics of stakeholder group

The stakeholder groups identified in Kole wetlands are farmers, farmers engaged in fishing activities, residents of Kole wetlands engaged in other occupations, tourists and people residing outside Kole wetlands. Understanding the implication of the research and its applicability would benefit from knowing the social and economic characteristics of the sample stakeholder groups. Respondent are classified as respondents residing inside Kole wetlands and respondents from outside Kole wetlands. To serve as a context for the study, a brief summary of the respondents' general socio-economic characteristics in terms of age, gender, education and family size has been included.

4.1.1 Respondent residing inside Kole wetlands

The respondents residing inside Kole wetlands are classified in three stakeholder groups. Paddy farmers, farmers engaged in fishing and aquaculture and people from Kole who work in other occupations are the three stakeholder groups. The following are the descriptive statistics and demographic characteristics for three categories:

Descriptive statistics

Table 3: Descriptive statistics of three respondent groups

Particulars	**Age**	**Family size**	**Homestead area(cents)**	**Wetland area (acre)**
Paddy farmers	57.5 (9.6)	4.3 (1.7)	40 (60)	3.5 (5.8)
Farmers engaged in fishing and aquaculture	48.53 (7.32)	5.02 (1.3)	22 (21)	3.2 (3.5)
Other occupation	47.5 (13.61)	4.4 (1.1)	20 (10)	1.2 (3.2)

*Figures in the parentheses shows standard deviation

Table 3 shows descriptive statistics for three respondent categories based on age, family size, and homestead area. The average age of farmers is 57.5 years, with a standard deviation of 9.6 years. Because the majority of them began farming after their retirement. Farmers involved in fishing and aquaculture have an average age of 48.53 years, while those in other occupations have an average age of 47.5 years. Fishing farmers have a family size of five, while paddy farmers and other occupations have a family size of four. This was discovered to be similar to the state's average family size of 4.4 individuals (Census, 2011). Paddy farmers have an average homestead size of 40 cents, whereas the category other occupations and farmers engaged in fishing and aquaculture have an average homestead area of 20 and 22 cents, respectively.

1. Age

The table 4 gives details about three respondent groups inside Kole and their distribution based on age classes. There are three age groups: under 45 (young people), 45 to 60 (middle age), and over 60 years (elder people). Fourteen percent of paddy farmers belong to the age group below 45. Forty-seven paddy farmers are in 45-to-60-year age class and eleven farmers are above 60 years. Thirteen farmers who are engaged in fishing activities are in below 45 years. The third respondent group is distributed like 4 below 45, 23 in-between 45 to 60 and three respondent

above 60. Among the all respondents, 27 belongs to young category, majority of respondents are in 45 to 60 age class and 17 respondents are aged above 60.

Table 4: Distribution of respondents based on their age

Particulars	**Below 45**	**45-60**	**Above 60**	**Overall**
Paddy farmers	10 (14.70)	47 (69.13)	11 (16.17)	68 (100)
Farmers engaged in fishing and aquaculture	13 (32.50)	24 (60.00)	3 (7.50)	40 (100)
Other occupation	4 (13.36)	23 (76.44)	3 (10.00)	30 (100)
Total respondents	27 (19.56)	94 (68.1)	17 (12.31)	138 (100)

* Figures in the parentheses indicates percentage to total

2. Gender

The gender wise classification of respondents is given in table 5 revealed that nine females are involved in paddy farming and seven are in other occupations. Males account for 86.7 percent of paddy farmers, 87.5 percent farmers involved in fishing activities and 76.6 percent from other occupation category. Farming and fishing are physically demanding activities in which few women participate. There are 138 respondents in total, 15.2% of whom are female and 84.7 percent are male.

Table 5: Distribution of respondents based on gender

Particulars	**Female**	**Male**	**Total**
Paddy farmers	9 (13.23)	59 (86.77)	68 (100)
Farmers engaged in fishing and aquaculture	5 (12.50)	35 (87.50)	40 (100)
Other occupation	7 (23.33)	23 (76.67)	30 (100)
Total respondents	21 (15.22)	117 (84.78)	138 (100)

*Figures in parentheses indicates percentage to total

3. Family size

Table 6 shows a classification of respondents based on the number of individuals living in a household. A ten of paddy farmers have a modest family. In addition, 4 of farmers engage in fishing activities, while 6 of respondents in other occupations have small families. About seventy-seven percent of paddy farmers as well as farmers engaged in fishing activity and 63.4 percent from other occupation are belong moderate family size. Each five from each category belong to group large family size. All together 14.4 percent of respondent have small family size, 74.63 percent respondent have medium family size and 10.8 percent of respondent have large family size. Majority of them were with medium family size.

Table 6: Distribution of respondent's categories based on their family size

Particulars	**Low**	**Moderate**	**High**	**Overall**
Paddy farmers	10 (14.7)	53 (77.9)	5 (7.3)	68 (100)
Farmers engaged in fishing and aquaculture	4 (10)	31 (77.5)	5 (12.5)	40 (100)
Other occupation	6 (20)	19 (63.4)	5 (16.6)	30 (100)
Total respondents	20 (14.4)	103 (74.63)	15 (10.8)	138 (100)

*Figures in parentheses indicates percentage to total

4. Education

The educational status of respondents is shown in Table 7. Four paddy farmers, 2 farmers from fishing activity group and no one from other occupation were illiterate. According to the research, the literacy rate is around 95%, which is comparable to literacy rate of Kerala. Eight paddy farmers, 14 farmers involved in fishing activities and ten people from other occupations groups have completed secondary education. Higher secondary education has been completed by 15 paddy farmers, four fishermen, and seven people from various occupations. Eleven paddy farmers, four from each second and third category are graduated. The average education of participants is found to be up to the seventh grade, which is considered primary education.

Table 7: Distribution of respondents according to education

Particulars	Illiterate	Primary	Secondary	Higher secondary	Graduate	Overall
Paddy farmers	4 (5.91)	30 (44.11)	8 (11.76)	15 (22.05)	11 (16.17)	68 (100)
Farmers engaged in fishing and aquaculture	2 (5.00)	11 (27.50)	14 (35.00)	9 (22.50)	4 (10.00)	40 (100)
Other occupation	0 (0)	9 (30.00)	10 (33.34)	7 (23.34)	4 (13.32)	30 (100)
Total respondents	6 (4.36)	50 (36.24)	32 (23.18)	31 (22.46)	19 (13.76)	138 (100)

*Figures in parentheses indicates percentage to total

5. Homestead area

Table 8 depicts the distribution of respondents by homestead area. Most of paddy farmers (94%) belong to medium homestead area and 4 belong to large homestead area. Total 82.5 percent of farmers engaged in fishing activity and 85.7 percent of respondents from other occupation category have medium home stead area. Five respondents from farmers involved in fishing activities respondent group and one from other occupations group belong to large homestead areas. All together majority of them (89 %) of respondent belong to medium homestead area.

Table 8: Distribution of respondent based on their homestead area

Particulars	Small	Medium	Large	Overall
Paddy farmers	0 (0)	64 (94.10)	4 (5.90)	68 (100)
Farmers engaged in fishing and aquaculture	2 (5)	33 (82.50)	5 (12.50)	40 (100)
Other occupation	3 (10)	26 (86.70)	1 (3.30)	30 (100)
Total respondents	5 (3.62)	123 (89.13)	10 (7.25)	138 (100)

*Figures in parentheses indicates percentage to total

6. Wetland area

The table 9 illustrates the distribution of respondents by wetland area. According to the distributions, about 57 percent of respondents have a marginal land holding of less than 1 hectare. Twenty-two paddy farmers, sixteen farmers engaged in fishing activities and four from other occupations group have wetland areas ranging from one to two hectares. One paddy farmer has a vast wetland, which is more than 10 hectares in size. All together there are 80 respondents in category marginal wetland holding.

Table 9: Distribution of respondent based on wetland area

Class	**Classes in Ha**	**Paddy farmers**	**Farmers involved in fishing and pisciculture**	**Other occupations**	**Overall**
Marginal	Below 1.0 ha	38 (55.88)	18 (45.00)	24 (80.00)	80 (57.97)
Small	≥ 1.0 and ≤ 2.0 ha	22 (32.35)	16 (40.00)	4 (13.33)	42 (30.43)
Semi-medium	≥ 2.0 to ≤ 4.0 ha	2 (2.94)	4 (10.00)	2 (6.67)	8 (5.79)
Medium	≥ 4.0 ha and ≤ 10 ha	5 (7.35)	2 (5.00)	-	7 (5.07)
Large	10 ha and above	1 (1.48)	-	-	1 (0.72)

*Figures in parentheses indicates percentage to total

4.1.2. Cross tabulation of demographic variables

1. Annual income and gender

Table 10: Result of cross-tabulation of income and gender

Income class (₹)	**Gender**	
	Female	Male
Low (<50,000)	1	8
Medium (50,000-3,00,000)	10	75
High (>3,00,000)	3	13
χ^2	0.61^{NS}	

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of income and gender is given in table 10. Chi square value (0.61) indicates that there is no association between income and gender.

2. Annual income and age

Table 11: Result of cross-tabulation of demographic variable income and age

Income class (₹)	**Age classes**		
	Below 45	45-60	Above 60
Low (<50,000)	0	7	2
Medium (50,000-3,00,000)	14	57	14
High (>3,00,000)	3	11	2
χ^2	2.03^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross- tabulation of income class and age classes are given in table 11. The chi-square value shows that there is no relationship between income categories and age classes.

2. Annual income and family size

Table 12: Results of cross-tabulation of income and age groups

Income class (₹)	Family size		
	Small (<3)	Moderate (3 to 6)	Large (>6)
Low (<50,000)	0	8	1
Medium (50,000-3,00,000)	13	63	9
High (>3,00,000)	2	13	1
χ^2	1.97^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 12 shows the results of a cross-tabulation of income and age groups. The value of 1.97 indicates that there is no linkage between income levels and age groups.

3. Annual income and homestead area

Table 13: Results of cross-tabulation of income and homestead area

Income class (₹)	Homestead area		
	Small (<10 cents)	Moderate (10 to 50 cents)	Large (>50)
Low (<50,000)	1	7	1
Medium (50,000-3,00,000)	58	24	3
High (>3,00,000)	6	9	1
χ^2	14.65**		

\

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

A cross-tabulation of annual income (generated by farming in Kole lands) and house plot area is shown in the table 13. The $\chi 2$ value 14.65, indicates a link between income and homestead area.

4. Annual income and wetland holding

Table 14: Cross-tabulation of variable annual income and wetland

Income class (₹)	**Wetland holding(acre)**		
	Small (<2)	Moderate (2-8)	Large (>8)
Low (<50,000)	2	6	1
Medium (50,000-3,00,000)	59	25	1
High (>3,00,000)	6	7	3
χ^2	18.46**		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 14 shows a cross-tabulation of variable annual income and farm land ownership. The chi-square value indicates that two variables are significant.

5. Annual income and farming category

Table 15: Distribution of respondents based on category and income class

Farming category	**Homestead area**		
	Low (<50,000)	Medium (50,000-3,00,000)	High (>3,00,000)
Farmers	1	57	8
Farmers engaged in fishing and aquaculture	8	22	9
Lotus farmers	0	3	0
Farmers leasing land for duck rearing	0	2	0
χ^2	18.21**		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Paddy farmers, lotus farmers, farmers leasing land for duck rearing and farmers engaged in fishing activities are represented in the table 15 by different revenue categories. The chi-square test results indicates that these two variables are associated with each other.

6. Farming category and gender

Table 16: Distribution respondents based on gender and category

Farming category	Gender	
	Female	Males
Farmer	9	57
Farmers engaged in fishing and aquaculture	5	35
Lotus farmers	0	2
Farmers leasing land for duck rearing	0	1
χ^2	0.94^{NS}	

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 16 shows the distribution of males and females in various categories. The chi-square test result indicates that these two variables are not significant.

7. Farming category and homestead area

Table 17: Classification respondents based on their homestead area

Farming category	Homestead area		
	Small (<10)	Moderate (10 to 50)	Large (>50)
Farmers	59	7	0
Farmers engaged in fishing and aquaculture	6	34	0
Lotus farmers	2	0	0
Farmers leasing land for duck rearing	1	0	0
χ^2	87.92**		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 17 above demonstrates how respondents were classified into different categories based on their homestead area. The chi-square value 87.92 indicates that there is a relationship between category and homestead area.

8. Farming category and wetland holding

Table 18: Respondent's classification based on the category and wetland holding

Farming category	Wetland holding (acre)		
	Small (<3)	Moderate (3 to 8)	Large (>8)
Farmers	63	3	2
Farmers engaged in fishing and aquaculture	34	6	0
Lotus growers	2	0	0
Farmers leasing land for duck rearing	1	0	0
χ^2	89.15**		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 18 demonstrates how respondents were classified into different categories based on their farm land area. The chi-square test result value 89.15 indicates that there is a relationship between these two variables.

4.1.3. Respondent from outside Kole wetlands

The respondent group outside Kole is classified in two categories. One is people residing outside Kole and other one is tourists. The socioeconomic characteristics of both groups, as well as descriptive statistics are shown below:

Descriptive statistics table

The following table 19 describes mean and standard deviation of age for both respondent groups. The first category of people residing outside Kole has average mean age 43 years and for the second group of tourists the average age is 33 years. Average family size of both the respondent category is 4. For the category of people residing outside Kole the average distance is 15.4 and standard deviation 4.3 kilometres. The second category is tourist for which average distance is 12.9 kilometres and standard deviation is 10.8 km.

Table 19: Descriptive statistics of respondents

Particulars	Average age	Family size	Average distance
People residing outside Kole	43(9.5)	4.3(1.21)	15.4(4.23)
Tourist	33(10)	4.6(1.46)	12.9(10.8)

*Figures in the parentheses shows the standard deviation

1. Age

The distribution of respondents residing outside Kole according to their age is given in table 20. Age classes are made like below 45(young people), 45 to 60(middle age people) and above 60 years (elder people). About 46 percent people residing outside Kole belong to age group below 45. Thirteen people are in 45-to-60-year age class and four people are above 60 years age. Majority of tourists (62 %) are in below 45 years; 30 percent are in 45 to 60 years group and three are above 60. All together there are 39 respondents in young category, 26 are in 45 to 60 age class and 7 are in above 60 age class.

Table 20: Distribution of respondents according age

Respondent group	Below 45	45-60	Above 60	Overall
People residing outside Kole	14 (46.66)	13 (43.34)	3 (10.00)	30 (100)
Tourist	25 (62.50)	12 (30.00)	3 (7.50)	40 (100)
Total respondents	39 (55.71)	25 (35.71)	6 (8.58)	70 (100)

*Figures in parentheses indicates percentage to total

2. Gender

The respondents were classified based on their gender. Distribution of respondents based on gender is shown in table 21. There are 17 ladies and 13 men in the first respondent group and 18 females and 22 males are in a group of tourists. There seem to be 50 percent females and 50 percent males all together.

Table 21: Classification of respondents based on their gender

Particulars	Female	Male	Overall
People residing outside Kole	17 (56.66)	13 (43.34)	30 (100)
Tourist	18 (45.00)	22 (55.00)	40 (100)
Total respondents	35 (50.00)	35 (50.00)	70 (100)

*Figures in parentheses indicates percentage to total

3. Family size

The distribution of respondents based on the size of their families is shown in Table 22. The majority of respondents (80%) from persons living outside had a medium-sized family. Tourists make up the second response category, with 9 percent having a small family, 50 percent having a medium family and 11 are with large family. All together about 62 percent respondents are with medium family size.

Table 22: Distribution of respondents based on family size

Particulars	Small (<3)	Moderate (3 to 6)	Large (>6)	Overall
People residing outside Kole	2 (6.66)	24 (80.00)	4 (13.34)	30 (100)
Tourist	9 (22.50)	20 (50.00)	11 (27.50)	40 (100)
Total respondents	11 (15.71)	44 (62.85)	15 (21.44)	70 (100)

*Figures in parentheses indicates percentage to total

4. Education

Education categories are made as illiterate, primary (up to seven grades), secondary (up to matriculation), higher secondary (up to 12^{th} class) and graduation. One respondent from group residing outside Kole and 2 from group of tourists were illiterate. About 30 percent of people residing outside Kole and 20 percent from second category have taken primary education. Eleven people and eight tourists

have completed secondary education. Graduate category includes four from the first group and 10 from the second tourists. According to the study, the literacy rate is around 96 percent which equal to Kerala's literacy rate. The table 23 illustrates the distribution respondents based on their education.

Table 23: Distribution of respondents based on education

Particulars	Illiterate	Primary	Secondary	Higher secondary	Graduate	Overall
People residing outside Kole	1 (3.33)	9 (30.00)	11 (36.66)	5 (16.66)	4 (13.35)	30 (100)
Tourist	2 (5.00)	8 (20.00)	8 (20.00)	12 (30.00)	10 (25.00)	40 (100)
Total respondents	3 (4.28)	17 (24.28)	19 (27.16)	17 (24.28)	14 (20.00)	70 (100)

*Figures in parentheses indicates percentage to total

5. Distance from Kole wetlands

The table 24 describes distribution of respondents based on distance from Kole wetland. People residing outside Kole are divided like five in less than 10 km distance, 16 in 10 to 18 km and 9 are in class more than 18 km. Tourists are classified as 3 in less than 10 km, 32 are in between 10 to 18 kilometres away and 5 are more than 18 kilometres away class.

Table 24: Distribution of respondents based on distance from Kole wetland

Particulars	Less than 10 km	10 to 18 km	More than 18 km	Overall
People residing outside Kole	5 (16.66)	16 (53.34)	9 (30.00)	30 (100)
Tourist	3 (7.50)	32 (80.00)	5 (12.50)	40 (100)
Total respondents	8 (11.43)	48 (68.57)	14 (20.00)	70 (100)

*Figures in parentheses shows percentage to total

4.1.4. Cross tabulation of demographic variables of respondent group tourist

1. Number of visits and age

Table 25: Distribution of respondents by age and number of visits

Number of visits	Age class		
	Below 45	45 to 60	Above 60
1 to 8	22	2	10
More than 8	2	3	1
χ^2	4.32^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 25 depicts the tourist distribution based on the number of visits and the age class interval. The chi square test result shows that there is no associati on in two variables.

2. Number of visits and gender

Table 26: Results of a cross-tabulation of income and gender

Number of visits	Gender	
	Females	Males
1 to 8	18	16
More than 8	1	5
χ^2	1.4^{NS}	

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of income and gender is given in table 26. Chi square value (1.4) indicates that there is no association between income and gender.

3. Number of visits and family size

Table 27: Distribution of respondents based on the family size and number of visits

Number of visits	Family size		
	Small (<3)	Medium (3-5)	Large (>5)
1 to 8	7	17	10
More than 8	1	4	1
χ^2	0.61^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

The table 27 depicts the distribution of tourists based on the size of the family and the number of trips. Chi-square value 0.61 indicates that they are not significant.

4. Time spent on site and age

Table 28: The cross-tabulation of time spent on site with different age groups

Time spent on site(hours)	Age classes		
	Below 45	45-60	Above 60
Less than 1	3	5	2
2 to 3	14	1	7
More than 3	0	6	2
χ^2	6.28^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Table 28 illustrates the cross-tabulation of time spent on site with differe nt age groups. The chi square test is carried out and value shows there is no associ ation between time spent on site and age.

5. Time spent on site and gender

Table 29: Classification of respondents based on time spent on site and gender

Time spent on site(hours)	Gender	
	Female	**Male**
Less than 1	7	3
2 to 3	7	15
More than 3	5	3
χ^2	4.92^{NS}	

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Table 29 describes two variables one is time spent on site and other gender. The chi-square test results shows that there is no association between them.

6. Time spent on site with Income

Table 30: Results of a cross-tabulation of income and gender

Time spent on site(hours)	Income classes (₹)		
	Low (<1,50,000)	**Moderate (1,50,000-4,00,000)**	**High (>4,00,000)**
Less than 1	2	7	1
2 to 3	4	13	5
More than 3	0	2	6
χ^2	10.42*		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of income and gender is given in table 30. Ch i-square value (10.42) indicates that there is association between income and gend er.

7. Time spent on site with opportunity cost

Table 31: Distribution respondents based on time spent and opportunity cost

Time spent on site(hours)	Opportunity cost (₹)		
	Low (<128)	Moderate (128-548)	High (548)
Less than 1	10	0	0
2 to 3	0	22	0
More than 3	0	2	6
χ^2	67.5**		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Table 31 gives description about time spent on site with opportunity cost of individual. The chi-square test results shows that there is linkage between them.

8. Purpose of visit with gender

Table 32: Cross tabulation of two variables: the purpose of the visit and gender

Purpose of visit	Gender	
	Female	Male
Sight-seeing and birding	16	15
Boating and park	3	6
χ^2	0.34^{NS}	

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Table 32 shows the cross tabulation of two variables one is purpose of vi sit and other is gender. The chi-square value (0.34) shows that there is no relations hip between purpose of visit and gender.

9. Purpose of visit with age

Table 33: Cross tabulation of variable purpose of visit and age

Purpose of visit	Age classes		
	Below 45	45-60	Above 60
Sight-seeing and birding	4	17	10
Boating and park	0	8	1
$\chi 2$	3.58^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Table 33 shows the cross tabulation of variable purpose of visit and age. The result of chi-square test shows that there is no association between two variabl es.

10. Purpose of visit with income

Table 34: Cross tabulation of variable purpose of visit and income groups

Purpose of visit	**Income classes (₹)**		
	Low (<1,50,000)	**Moderate (1,50,000-4,00,000)**	**High (4,00,000)**
Sight-seeing and birding	9	17	5
Boating and park	1	7	1
$\chi 2$	0.16^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Table 34 shows the cross tabulation of variable purpose of visit and inco me classes. Chi- square test result value for these variables is 0.16 shows there is n o association in between them.

11. Purpose of visit with opportunity cost

Table 35: Results of a cross-tabulation of visit purpose and opportunity cost

Purpose of visit	Opportunity cost (₹)		
	Low (<128)	Moderate (128-548)	High (>548)
Sight-seeing and birding	5	17	9
Boating and park	1	5	3
$\chi 2$	1.62^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of purpose of visit and opportunity cost is giv en in table 35. Chi-square value 1.62 indicates that there is no association between income and gender.

4.2. Direct dependence on Kole wetlands

Kole wetland is home to a number of individuals that rely on it for their daily sustenance. Literature and a survey were used to compile the economic activities of wetlands. The following is an overview of each economic activity:

4.2.1. Paddy farmers

In the Kole land, paddy is the most important economic activity. The flourishing paddy fields are shown in plate 2. The following are the crop seasons in the Kole lands: Virippu is commonly grown in higher rice fields near the Kole land, where floods only persist a few days. Virippu is known for cultivating varieties that can tolerate floodwater for a few days. Mundakan is grown in fields at a medium elevation around the Kole lands, where flood water collects around in August. The Kole lands must, however, be safeguarded by bunds in order to carry out Kadumkrishi. Pumping out of water will take 10 to 15 days, and it starts once the floodwaters in the Kole fields start to recede towards the end of the South West monsoon season. Petti and para, an indigenous pumping gear created for emptying the Kole fields, are often used for dewatering. In recent decades, Jyothi, Uma, and

Jaya have become the most popular rice varieties. Farmers like ‘Jyothi' because it sells for a higher price and has a better flavour. Thrissur Kole wetland is divided into eight blocks and 33 Krishi bhavans. Anthikadu, Puzhakkal, Cherpu, Mulassery, Irinjalakuda, Chowannur, Chawakkad, and Vellangallur are the different blocks.

Farmers organise Padasekharam samithis to do some farming operations cooperatively and retain government records. In Thrissur, there are around 219 padasekharam Samithi. The total area under paddy cultivation in Thrissur Kole is approximately 10,974 hectares.

People that reside inside the Kole wetlands have at least one acre of land. One acre of paddy yields around 3,000 kg on average. The harvested paddy is shown in plate 3. The pricing for paddy in most of the area is 28, but it varies according to quality, market, season, and other factors. In Kole, the average per hectare output is 5,114 kg. The average expenditure per hectare is Rs. 50,271, and the price per kg is Rs. 28.

Farmers rely on straw for a significant portion of their income. Only a few farmers have their own cattle, and therefore rely on straw for their daily needs. The majority of farmers sell this straw to customers on a private basis. In a rare circumstance, Samithi collects all of the straw and sells it all at once. In this situation, they offer the farmer a set sum per acre. Cultivation begins late in some regions due to water storage, and hence some areas do not receive straw yield. The average output per hectare from straw is Rs. 12,014.

The net returns from paddy cultivation per hectare is ₹ 1,04,935. According to Shrinivas (2012), small holder cultivators have a net return of Rs. 27,736 per hectare, while marginal holders have a net return of Rs. 10,279 per hectare. The present study found the net returns from paddy cultivation around 1 lakh which is significantly higher than the previous study. Total area under paddy cultivation is 10,974 hectares and 1,108 hectares is a non-cultivated land. The actual total economic value of paddy cultivation is ₹ 115 crores per annum. The estimated economic value of paddy cultivation is 126 crores (Table 36).

Table 36: Estimated economic value of paddy farming in Kole wetland, Thrissur

Particulars	
Area under paddy cultivation (Ha)	10,974
Area of cultivable fallow wetland (Ha)	1,108
Paddy yield per hectare (kg)	5,114
Market price of paddy per kg (₹)	28
Revenue from paddy per hectare (₹)	1,43,192
Revenue from straw per hectare (₹)	12,014
Cost of cultivation per hectare (₹)	50,271
Net returns from paddy cultivation per hectare (₹)	1,04,935
Total economic value from paddy cultivation (₹)	1,15,15,56,690
Estimated economic value from paddy cultivation (₹)	1,26,78,24,670

4.2.2. Farmers engaged in fishing and aquaculture

In the Kole wetlands, fishing is one of the important sources of income, especially during the monsoon season. The marsh provides a wide range of indigenous fish species. During the three months of monsoon, intensive fishing takes place. These fishing activities are done for leisure or as a part-time business that is only limited to their own family (Plate 4). In the Kole wetland and nearby surroundings, there are roughly 40 different fish species.

In the Kole wetlands, fish farming is another important economic sector. It is done by Padasekharam Samithi jointly in several places. A few Padasekharam Samithi auction their land for leasing for 3 years. Some Padasekharam do their own fish farming along with marketing. Catla (*Labeo catla*), Rohu (*Labeo rohita*), and common carp (*Cyprinus carpio*) are the most common fish species cultivated in Kole wetlands. Seeds, fertilisers, food, and a portion of a nursery budget are provided by the government as subsidies.

The farmers engaged in fish farming are getting average ₹ 9,902 per hectare. Area under farming is 291 hectares. The area currently not utilised for pisciculture is 10,683 hectares. The estimated total economic value from fishing activity is ₹ 28,81,482 (Table 37).

Due to exceptionally high rainfall during the monsoon season, major floods hit the south Indian state of Kerala on August 16, 2018. Kerala had seen its worst flood in nearly a century. Kerala was also hit by catastrophic floods on August 8, 2019, due to heavy rains during the monsoon season. This has had a significant impact on the Kole wetlands area, and many individuals have lost their fish farming produce as a result. Since 2018, the government has stopped providing subsidies to fish farming. As a result, many farmers have abandoned fish farming. Only 2 to 3 people are involved in fish farming on an individual basis. Only a few padasekharam Samithi are now investing in fish farming.

Table 37: Returns from pisciculture per annum from Kole wetland, Thrissur

Particulars	
Area under pisciculture (ha)	291
Unutilised area (ha)	10,683
Net return per hectare (₹)	9,902
Total economic value from pisciculture (₹)	28,81,482
Estimated economic value from pisciculture (₹)	11,96,35,964

Plate 2: Paddy cultivation in Pullu, Kole wetland, Thrissur, Kerala

Plate 3: Harvested paddy from Erinjalakuda, Kole wetland, Thrissur

Plate 4: Individual natural fish catching in Kole wetlands, Thrissur

4.2.3. Lotus farming-

Lotus (*Nelumbo nucifera Gaertn*, also known as *Nelumbium speciosum* Wild. From India to Australia, the Nymphaceaceae family is native to the region. It is revered by Hindus in India. Tamara is the Malayalam name for the national flower of India. It is a giant perennial erect water herb with massive spherical floating leaves that range in size from 20 to 80 cm in diameter. The lotus farm is shown in plate 6 and plate 5 is shot during harvesting of flowers.

In the Thrissur district, 6.8 hectares of land is under lotus farming. Lotus farming is practised by about three farmers. Flowers are picked by labourers in the morning using tiny boats. On alternate days, about 145 flowers are picked from a one-acre plot. Farmers are paid Rs. 3 per flower. These flowers are taken to nearby temples such as Guruvayoor, Vadakkenath and others. The cost per acre for lotus is around Rs. 35,000. Fertilizers, herbicides and insecticides are all employed. Because birds pose a hazard to lotus farming, the fields must be encased in netting to protect them from various birds.

The annual net return from lotus farming is Rs. 2,19,175 per hectare (Table 38). Total area under lotus cultivation is 6.8 hectares. The total economic value from lotus cultivation is ₹ 14,90,390.

Table 38: Returns from lotus cultivation per annum from Kole wetland, Thrissur

Particulars	Values
Area under lotus cultivation (ha)	6.8
Cost of cultivation per hectare (₹)	87,500
Yield of lotus in numbers per hectare per year	1,02,225
Market price per flower (₹)	3
Revenue per hectare (₹)	3,06,675
Net return per hectare from lotus cultivation (₹)	2,19,175
Total economic value from lotus cultivation (₹)	14,90,390

Plate 5: Labour engaged in lotus collection in Kole wetlands, Thrissur, Kerala

Plate 6: Lotus farms in Kole wetlands, Thrissur, Kerala

4.2.3. Farmers leasing land for duck rearing

Ducks from Tamilnadu and other parts of Kerala are brought to the Kole paddy fields after being harvested. They release them on farms to devour weed seeds and leftover seeds. The farmer receives some money in exchange for these duck rears. This is a less well-known behaviour, yet it occurs in a number of sites throughout the Kole wetlands. The plate number 7 and 8 shows the ducks grazing around Kole.

In some locations, padasekharam Samithi handles this business on behalf of the entire Samithi area. There are only a few occasions where this is done privately. Duck reares pays farmers an average of Rs. 673.9 per hectare. And total area under duck rears activity is almost 461 hectares. The total economic value from land leasing for duck rearing is ₹ 3,10,667.90. The estimated economic returns from land leasing for duck rearing is 73 lakhs (Table 39).

Table 39: Returns from leasing land for duck rearing per annum from Kole wetlands, Thrissur

Particulars	
Money received by farmer for one hectare (₹)	673.9
Total area under activity (ha)	461
Unutilised area (ha)	10,513
Total economic value from land leasing for duck rearing (₹)	3,10,667.90
Estimated economic returns from leasing land for duck rearing (₹)	73,95,378.60

Plate 7: Ducks resting in water bodies in Kole wetlands, Thrissur, Kerala

Plate 8: Ducks grazing around harvested paddy fields of Kole wetlands, Thrissur, Kerala

4.2.4. Tourism

The beautiful Kole fields near Thrissur, with its lush foliage and abundant of birds and fish, are destined to become a popular tourist destination. The whole Kole wetland has potential to become tourist destination. Kole wetlands provide a crucial utility in the form of recreation. Its outstanding scenic value draws a large number of visitors. It indirectly produces jobs by allowing people to open hotels, soft drink stalls and small enterprises. Boating is another popular pastime in Kole, which runs from July to February. Pullu and Vilangan hills are two major tourist attractions in the Kole area. Both are well-known, and a large number of people visit them on a daily and weekend basis. Panoramic view of Kole wetlands from Vilangan hills is refreshing (Plate 9). The tourist also dvisits Pullu to see beautiful sunset (Plate 10). The Kole scenario is well-known for their pre-wedding photoshoots. The scenery for photoshoots includes boating and lotus farming. The Pullu-Manakkody Kole wetlands are the subject of an ecotourism project being developed by the Thrissur district administration.

4.2.5.1 Purpose of visit:

The Table 40 displays the reasons given by the interviewees for visiting the Kole wetland. The main motive for visiting the Kole, according to all of the respondents, was to admire its aesthetic magnificence. Six percent of those who visited wetlands did so for the purpose of boating. Over 21% of tourists came to the wetlands because it features a children's park, snack stands and other amenities. About 10 percent of respondents visit Kole wetlands to watch bird especially migratory birds in December to February.

Table 40: Respondents distribution based on purpose of visit

Purpose of visit	Frequency	Percent
Sight-seeing and Boating	27	68
Bird watching	4	10
Park and others	9	22

Plate 9: Panoramic view of Kole wetlands from Vilangan hills

Plate 10: Beautiful Sunset at Pullu, Kole wetlands, Thrissur

4.2.5.2. Opportunity cost and expenses per visitor

The potential gains that an individual, investor, or organisation misses out on when choosing one option over another are referred to as opportunity costs. Individuals and businesses can make more profitable decisions by considering the value of opportunity costs.

Tourists were questioned about their monthly earnings and the amount of time they spent in the area. This data is used to evaluate the prospective cost of each visitor. It was discovered that the average cost of a tourist opportunity cost was Rs. 245. The average guest spends Rs. 92 on their visit. The entire potential cost and expenses per visitor are Rs. 337.

4.2.5.3. Weekdays and weekends and holidays:

The number of tourists on weekdays and weekends is different. In the year 2020 there were 248 weekdays and 117 weekends and holidays together. The number tourist visiting Pullu and Vilangan hills are different. Table 41 below illustrates average number of tourists on weekdays, weekends and economic value of tourism. The total number of tourists visiting Kole per annum is 25,200 to Pullu and 2,56,610 to Vilangan hills. The total economic value of recreation is Rs. 9,49,69,970. Using the travel cost technique, research conducted in the Ramsar site in Massa (Morocco) discovered a consumer surplus of $ 65.36 per person and an estimated value of leisure service of $1.96 million US dollars (El-Bekkay *et al*., 2013). Because the tourism site is more developed than the Kole wetland region, the values are significantly higher. However, according to the analysis, the Ramsar site has the potential to earn money through developed tourism. In the Chitwan national park and buffer zone, the average willingness to pay of domestic, South Asian country, and foreign visitors was estimated at NRs 3370, NRs 6960, and NRs 7500 (KC *et al*., 2012), respectively, while tourism expenditure of visitors was estimated at Rs 7,667, NRs 16,120, and NRs 23,173 for domestic, South Asian country and foreign visitors in the Bardia National Park (Basnyat *et al*.,2012). In compared to two protected areas, the value of tourism in the wetland appears to be

substantially smaller, as the location is popular in Kerala but not a popular international tourist destination. This is primarily due to the poor tourism amenities of Kole wetland and services. Guests provide little or no value to local populations, with the exception of a few hotels where tourists eat largely local food. Bulow and Lundgren (2007) conducted research to determine the recreational importance of Periyar National Park in India. Consumer surplus of Periyar National Park is expected to be approximately $15 billion USD because the park is already well-known in the country and has advanced facilities.

Table 41: Economic value from tourism per annum from Kole wetland, Thrissur

Name of location	**Pullu-Manakkody**	**Vilangan hills**
Average number of tourists on week days	45	445
Average number tourist on weekends and holidays	120	1250
Total number of tourists in year	25,200	2,56,610
Tourism value of location **(₹)**	84,92,400	8,64,77,570
Total value **(₹)**	9,49,69,970	

4.2.6. The actual Economic value from direct benefits Kole

The returns per hectare of wetland through different activities of each stakeholder group and total area under activity were used to calculate the direct use value of wetland. The table shows the direct benefits from wetland-related activities. Paddy farmers are a high-income category among the stakeholders, highlighting the importance of the service.

Paddy cultivation has the largest overall economic value (Rs. 1,15,15,56,690), highlighting its significance. Fishing has an economic value of Rs. 28,81,482 and lotus cultivation has an economic value of Rs. 14,90,390. Leasing land for duck rearing is another major but lesser-known activity. Land leasing has an economic worth of Rs. 3,10,667.9. Recreation is another important direct asset

of the Kole wetland. The recreation service has an economic value of Rs. 9,49,69,970. The actual direct usage of Kole wetland is 125 crores (Table 42).

Table 42: The direct use value of Kole wetland per annum

Category	**Net return per annum per ha (₹)**	**Total area (ha)**	**Economic value (₹)**
Paddy Farmers	1,04,935	10,974	1,15,15,56,690
Farmer engaged in fishing and aquaculture	9,902	291	28,81,482
Lotus farmer	2,19,175	6.8	14,90,390
Farmers leasing land for duck rearing	673.9	461	3,10,667.9
Tourism (₹)			9,49,69,970
Total (₹)			1,25,12,09,199.9

4.3. Indirect use value of Kole wetland

Flood storage, carbon sequestration, and groundwater recharge are among of the indirect benefits of Kole wetlands. The following is a description of the economic worth of each service:

4.3.1. Flood storage function:

The replacement cost method, which has been used by numerous authors, indirectly helps to measure the worth of the ecosystem. The approach estimates the value of the environmental good by using the cost of a perfect substitute (Bartik, 1988; Sundberg, 2004). The cost of replacing an ecosystem function (Flood plain) with a man-made equivalent (tank) is used to calculate its economic value.

Kole wetlands serve as a flood storage area. It serves as a natural buffer between the Western Ghats and the Arabian Sea. The most essential function of the Kole wetland is flood storage. The wetlands of Thrissur Kole can store a total of 241,640,000,000 litres of water. The economic valuation of flood storage function is determined using the replacement cost method. Kole wetlands provide natural

storage and an artificially constructed tank can provide the same service. As a result, an overall estimate for the construction of a tank capable of holding 241 billion litres of water should be determined.

The formation of a new reservoir in Kannankottai and Thervaikandigai, Thiruvallur District, Tamilnadu, for the purpose of augmenting drinking water supply to Chennai City is proposed, with a water storage capacity of 1 TMC. The estimated cost of project is 330 crores (Veerappan and Lakshmipathy, 2018). The water storage capacity of Kole wetland is 8.5 TCM. The life cycle analysis says the life span of tank is 15 years. The cost of flood storage capacity per year is calculated as shown in table 43.

Table 43: Details of Kole wetland area and water storage capacity

Particulars	**Values**
Kole lands area (ha)	12,082
Volume for 2m avg. depth of water ($m^{3)}$	241,640,000
Volume in litres (L)	241,640,000,000
Volume in TMC	8.533
Estimated cost of tank in crores (₹)	187.73

4.3.1. Carbon sequestration

Carbon sequestration is the long-term removal, capture, or storage of carbon dioxide from the atmosphere in order to prevent or reverse CO_2 pollution and climate change. Biological, chemical, and physical processes naturally collect carbon dioxide (CO_2) from the atmosphere. Carbon sequestration is a critical function of wetlands. The benefit transfer method was used to estimate carbon sequestration of wetland. The average sequestration rate of tropical wetlands is 1.29 t-C ha^{-1} $year^{-1}$(Mitsch *et al*., 2013). The area under Thrissur Kole wetlands is 12,082 hectares. India's country-level social cost of carbon emission was estimated to be the highest at $86 per tonne of CO2 (Ricke *et al*., 2018). One ton of carbon equals to 3.67 tons of carbon dioxide (Baral *et al*., 2016). The estimated economic value of carbon sequestration is 36.44 crores (Table 44).

The total benefits of carbon sequestration in wetlands in Nova Scotia are roughly \$124–\$373 ha^{-1} yr^{-1}, and range from \$5105 to \$39,795 ha^{-1} in total. The wetland ecosystem stored nearly three times higher carbon than forests ecosystem. The total carbon stock value of the Jagadishpur reservoir is NRs 1.0 million per year (Baral et al.,2016) by using replacement cost method. The economic value of carbon sequestration of Jagadishpur site and present study is comparatively same as there is difference in area in between two study sites.

Table 44: Economic valuation of carbon sequestration per year from Kole wetland, Thrissur

Particulars	**Values**
Average carbon sequestration rate (t ha^{-1})	1.29
Carbon dioxide (t ha^{-1})	4.73
Total area of Thrissur Kole	12,082
Total carbon dioxide sequestered in Kole wetlands(tons)	57,147.9
Social cos of carbon per ton (₹)	6,377
Estimated economic value of carbon sequestration in crores (₹)	36.44

4.3.2. Groundwater recharge function

Rain and snowmelt replenish groundwater, and surface water replenishes it to a lesser level (rivers and wetlands). Kole wetlands aid in maintaining the water table's level and exerting control over the hydraulic head. Groundwater recharging and discharge to other bodies of water are both aided by this. Soil, vegetation, site, perimeter to volume ratio and water table gradient all influence the amount of groundwater recharged by a wetland. People who live near a Kole wetland have their daily water requirements evaluated and compared to people who live far away from a Kole wetland. The daily water requirement of both respondent group is discussed below:

4.3.2.1.Daily water requirement of Kole residents-

Residents of the Kole wetlands are asked about their daily water requirements and sources of water during the study. Everyone has access to clean water. This

group's average water need was discovered to be 882 litres per household. The table 45 demonstrates the variation of residents according to their daily water needs. The amount of water required is determined by the number of family members and the size of the home garden or property. The majority of people require between 500 and 1100 litres of water every day.

Table 45: Distribution respondent based on daily water requirement

Class	**Low (<500)**	**Intermediate (500-1100)**	**High (>1100)**	**Total**
Frequency	5	56	9	70
Percent	7.14	80.00	12.85	100

4.3.2.2. Daily water requirement of people residing outside Kole wetlands-

People who live outside of the Kole wetlands are also questioned about their daily water needs. Canals and wells are the most common sources of water for most people. Water scarcity is present in a few localities around Thanikudam, Madathara, and Wadakkechery for two months in March and April. This group's average daily water consumption was discovered to be 793 litres per household. The table 46 shows the distribution of responders based on their daily water requirement. Around 73% of households have daily water requirements ranging from 600 to 1000 litres. Water consumption is less than 600 litres per day in 22% of households. The amount of water required on a daily basis is entirely dependent on the number of family members.

Table 46: Distribution of respondents based on daily water requirement

Class interval	**Low (<600)**	**Intermediate (600-1000)**	**High (>1000)**	**Total**
Frequency	10	33	2	45
Percent	22.25	73.33	4.42	100

4.3.2.3. T-test result

Mean scores		t- value
People residing inside Kole	People residing outside Kole	-3.2998**
206.5909	197.7465	

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Two sample t-test is carried out in between two variable water requirements inside Kole wetland and outside Kole wetland of individuals. The result says that it is significant at 1 percent level.

4.3.2.4.Water charge

The Table 47 shows the water charges for the city of Thrissur. The minimum payment is Rs 23 for up to 5000 litres. Then, as shown in the table, a certain quantity will be added to each 1000 litres.

Table 47: Additional charge for each 1000 litres as per Thrissur corporation

Interval	Additional charges
5-10	5
10-15	5.5
16-20	6.30
21-25	7.25
26-30	9.41
31-40	12.60

4.3.2.5. Economic valuation of groundwater recharge function

Individual water requirements for individuals living in Kole was 206.5 litres per day, while those living outside the Kole was 197.7 litres per day. Kole wetland has an average household size of four people. The average home requires 824 gallons of water. The overall number of households in the Thrissur Kole wetlands area is 3,45,673 (Census 2011). The water charge for month of march and April is Rs. 286. Economic value of groundwater recharge function is ₹ 9,90,35,314.50 (Table 48).

Table 48: Economic value of groundwater recharge per annum from Kole wetland, Thrissur, Kerala

Particulars	
Average water requirement per person per day inside Kole (litres)	206
Average water requirement per person per day outside Kole (litres)	197
Average family size inside Kole	4
Water requirement of family staying inside Kole per day (litres)	824
Water requirement for one month (litres)	24,720
Water charge for one month **(**₹)	143.25
Water charge for 2 months per household **(**₹)	286.5
Number of households in Kole wetlands	3,45,673
Estimated economic value of groundwater recharge function in crores **(**₹)	9.94

4.4 Non-use value

The non-use values of ecosystem include altruism, bequest and existence value. The contingent valuation method is only method to count non-marketed goods. The valuation techniques are based on the calculation of a household's 'Willingness to Pay' (WTP) for non-use ecosystem services, either directly or indirectly (Constanza *et al*., 1997). The amount of money a person is willing to give in exchange for a commodity or service is known as willingness to pay. It has something to do with the usefulness of that particular product or set of services. It is associated with the utility of that particular commodity/services.

4.4.1. Willingness To Pay

These are the wetlands' non-values. People who are intimately tied to the Kole wetlands are chosen for this merit. Farmers, fishermen, citizens, and other business people make up this group. People were asked how important Kole was to them, and money were requested. The results of contingent valuation method are discussed below:

4.4.1.1.Respondents support for the conservation of Kole wetlands

The responses of the respondent group revealed that they were well-informed on the importance of the Kole wetlands. In a yes-or-no manner, they were asked if

they support Kole conservation. Eighty-six percent of those said yes to the question. Thirteen percent of were negative (Fig 2).

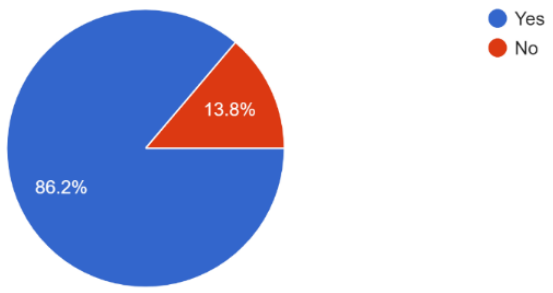

Fig 2: Participants' responses towards conservation of Kole wetlands

4.4.1.2. Perspective of respondents

Individuals place an altruistic value on the availability of an ecological resource in present scenario. The majority of folks replied enthusiastically. Almost 66% of people said they were willing to pay towards conservation. Only 33% of respondents were opposed to monetary contributions. Figure 3 shows the distribution of based on their responses.

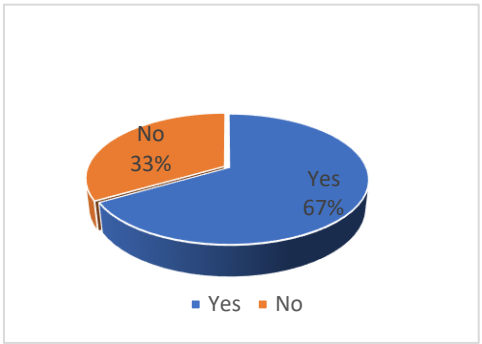

Fig 3: Distribution of respondents based on responses towards conservation Kole wetland, Thrissur

Approximately 5 persons were willing to donate Rs. 50. The majority of folks were content with Rs. 100. A few of them were really enthusiastic, and they were willing to donate somewhere between Rs. 1000 and Rs. 2000.

Range (Rs.)	50	100	200-500	1000-2000
Numbers	5	11	2	2
Percent	25	55	10	10

4.4.1.3.Reasons for willing to pay

People were also questioned about why they were willing to pay. The conservation of the Kole wetland is vital, the quantity is appropriate, and the third argument is that the amount affordable. All of the respondents (about 85%) were aware of the importance of the Kole wetland and were willing to donate because the price was acceptable. Only 15% of respondents were willing to donate since the amount was within their means.

4.4.1.4.Opinion of respondents about the developmental projects in Kole wetlands

1. **Roads**

Almost everyone expresses support for the construction of roads. Because the bund road is Kole's only mode of transit, farmers rely on it for a variety of purposes. In Kole, about 86 percent of residents demanded road improvements (Fig 4).

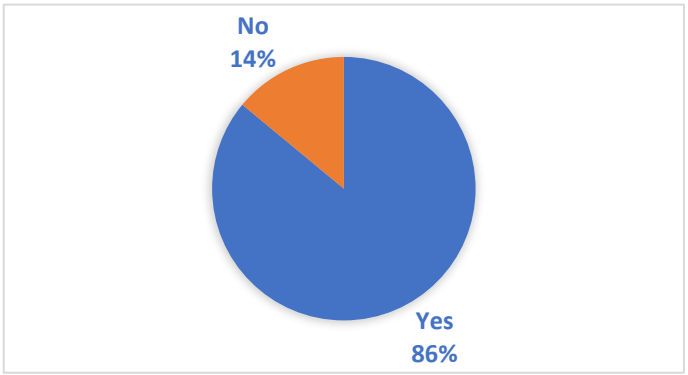

Fig 4: Distribution of respondents based on their opinion about the construction of roads in Kole wetlands, Thrissur

2. **Home or any construction project**

The development of any structure in the Kole wetlands was viewed unfavourably by about 66 percent of respondents. Sixteen percent of people

thought the construction of a home or building was a good idea. Figure 5 shows distribution respondents based their opinion.

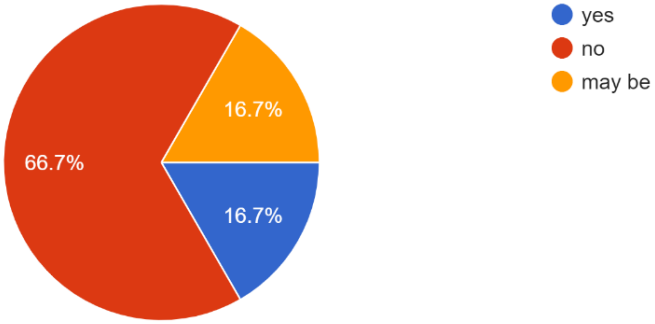

Fig 5: Distribution of respondents based on their opinion about construction project at Kole wetlands, Thrissur

3. Developmental project

The opinion of respondents was sought on the construction of developmental projects in the Kole wetlands. Seventy percent of participants expressed negative response to the development project (Fig 6). In the Kole wetlands, just 20% of the population is ready for any development endeavour.

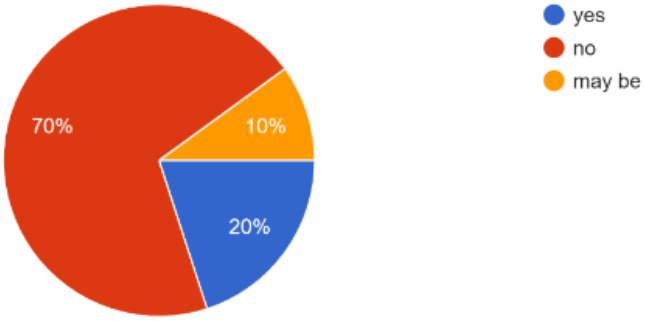

Fig 6: Distribution of respondents based on their opinion about developmental project at Kole wetlands, Thrissur

4.4.1.5.Economic value of non-use values

The average willingness to pay amount is found Rs. 212 from the study. It is considered as standard willingness to pay amount by all the respondents. A recent study from Kole wetland discovered that the mean maximum WTP value for the

total sample of 100 families is 476, with a standard deviation of 414 (Aravindh *et. al*, 2019). The amount discovered during this study is significantly less than that discovered in previous studies. The total number of respondents from Kole wetlands is 3,45,673. The economic value of non-use services is Rs. 7.3 crores. The following table 49 explains economic value of non-use services. Another attempt is done by Binilkumar (2010) to find out non-use value of Kole wetlands. In the Thrissur Municipal Corporation, the total yearly WTP for all stakeholders was calculated to be INR 13,365,400. The total indicated that increased conservation of the Kole wetland had a high monetary worth in the eyes of urban dwellers. Value found by Binilkumar was 1.3 crores, which is much smaller than the value discovered in the current study. This is because the researcher focused on the population of the Thrissur corporation, but the current study is focused on the whole population of the Kole wetlands.

Table 49: Economic value of non-use values from Kole wetlands, Thrissur

Particulars	**Values**
Mean WTP	212
Total number of households in Kole wetlands	3,45,673
Economic value of non-use values (Rs.)	7,32,82,676

4.4.2. Cross tabulation of demographic variables

1. Gender and WTP

Table 50: Results of a cross-tabulation of gender and WTP

Family size	**WTP (₹)**		
	Low (<100)	**Moderate (100-500)**	**High (>500)**
<4	1	7	0
5-6	5	4	1
>6	1	1	0
χ^2	1.26^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of gender and WTP cost is given in table 50. Chi square value 1.3 indicates that there is no association gender and WTP.

2. Age and WTP

Table 51: Results of a cross-tabulation of age and WTP

Annual income	**WTP (₹)**		
	Low (<100)	**Moderate (100-500)**	**High (>500)**
<1,00,000	2	2	0
1,00,000-2,50,000	4	7	1
>2,50,000	1	4	0
χ^2	1.2^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of age and WTP cost is given in table 51. Chi-squ are value 2.8 indicates that there is no association between age and WTP.

3. Family size and WTP

Table 52: Results of a cross-tabulation of family size and WTP

Gender	**WTP (₹)**		
	Low (<100)	**Moderate (100-500)**	**High (>500)**
Male	4	9	1
Female	3	2	1
χ^2	1.3^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of family size and WTP cost is given in table 52. Chi square value 1.2 indicates that there is no association between family size and WTP.

4. Annual income and WTP

Table 53: Results of a cross-tabulation of annual income and WTP

Distance from Kole wetlands (km)	WTP (₹)		
	Low (<100)	Moderate (100-500)	High (>500)
<1	2	2	0
1-5	4	7	1
>5	1	4	0
χ^2	1.1^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of annual income and WTP cost is given in ta ble 53. Chi-square value 1.2 indicates that there is no association between annual i ncome and WTP.

5. Distance from Kole wetlands and WTP

Table 54: Results of a cross-tabulation of distance from Kole and WTP

Age	WTP (₹)		
	Low (<100)	Moderate (100-500)	High (>500)
<45	1	4	0
45-60	3	6	1
>60	3	3	0
χ^2	2.8^{NS}		

Note: NS = Not Significant

*** = Significance at 5 percent level**

**** = Significance at 1 percent level**

Results of cross-tabulation of distance from Kole wetlands and WTP cos t is given in table 54. Chi square value 1.1 indicates that there is no association bet ween distance from Kole wetlands and WTP.

4.5. Total economic value of wetland

The estimated total economic is composed of all together direct use value, indirect use value and non-use values. Some of the locations in India had already been studied for TEV. The total annual economic value of the Jagadishpur reservoir was estimated to be NRs 94.5 million in the study, with option/existence value accounting for the majority of the value, followed by direct use value such as wetland goods and tourism, and indirect use value such as carbon sequestration, biodiversity conservation, and irrigation. The TEV of Kole wetland is attempted to be counted, with gross annual WTP projected to be INR 13,365,400 for all stakeholders in Thrissur Municipal Corporation together (Binilkumar,2010). According to the study, the amount reflects a high perceived monetary value placed on enhanced Kole wetland conservation by urban households. However, the study only looked at non-use of wetlands, and the respondents were all from the Thrissur Corporation. Another attempt is undertaken to determine the Kole wetland's non-use value (Aravindh et al., 2020). The median WTP value was assessed to be 300 per person, with the wetlands' overall economic worth estimated to be at 25 crores. Whereas, according to present study mean WTP is Rs. 212, which are relatively close. The total estimated economic value of Kole wetland is found 389 crores including all direct, indirect and non-use value of the wetland. The total economic value of all direct use, indirect use and non-use values is explained in table 55.

Table 55: Estimated total economic value of Kole wetland

Values	**Ecosystem services**	**Estimated Economic value per year (Rs)**	**In lakhs (Rs) per year**
Direct use value	1. Paddy cultivation	**1,26,78,24,670**	**12,678**
	2. Farmers engaged in fishing activities	**11,96,35,964**	**1,196**
	3. Lotus farming	**14,90,390**	**14**

	4.Farmers leasing land for duck rearing	**73,95,378.60**	**73**
	5.Tourism	**9,49,69,970**	**949**
Total direct use value		**1,48,42,31,661**	**14,842**
Indirect use value	6.Flood storage	**1,87,73,33,333**	**18,773**
	7.Carbon sequestration	**36,44,32,158**	**3,644**
	8.Groundwater recharge function	**9,90,35,314**	**990**
Total Indirect use value		**2,34,08,00,805**	**23,408**
Non- use value	9. Non-use value	**7,32,82,676**	**732**
Estimated total economic value (Rs)		**3,90,53,99,855**	**39,053**

4.6. Perception of respondents to various ecosystem services

A person's opinion on preserving the Kole wetlands is based on what they consider to be the most positive part of it. During the interview, respondents were asked to express their opinions on how much they value the various ecological services provided by Kole wetlands. Literature and field research were used to identify several ecological services. The table 56 below lists the many ecosystem services with their associated numbers.

Eleven different ecosystem services were presented to gauge respondents' attitudes on the conservation of the Kole wetlands. The respondents were asked to label their reaction as strongly disagree, disagree, neutral, agree, or strongly agree on a five-point scale. Each of these replies was scored on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, with all other values falling somewhere in between. The following are the eleven statements with response of respondents that were posed to respondents as part of the study. Depending on score the services are ranked from 1 to 10.

Table 56: Ecosystem services provided by Kole wetlands, Thrissur

Number	Ecosystem services
S1	Kole wetlands serve as a source of groundwater replenishment.
S2	The marsh of Kole serves as a floodplain.
S3	Kole wetland as source of food.
S4	The Kole Wetland is home to a diverse range of plants and fauna
S5	Wetlands play an important role in global climate regulation by storing carbon.
S6	Kole wetland as potential tourism site.
S7	Availability of fish
S8	Kole wetlands provide a shelter for migrating birds.
S9	Kole has spiritual and cultural importance.
S10	Fodder source

4.6.1. The respondent's opinion about different ecosystem services

The table 57 depicts the responses provided by 100 people. Six of the ten statements were agreed by overwhelming majority, according to their responses. The tone of comments was different, however, when it came to local stakeholders' participation in conservation operations and the impact of urbanisation.

Respondents agreed that kole wetlands serve as a source of groundwater replenishment, a floodplain, and a source of food. Tourism and fish availability are two more major services mentioned by respondents. Another popular service supplied by Kole wetlands is the provision of fodder. Biodiversity, migratory bird habitat, and carbon sequestration are not particularly popular among people (Fig 6).

Table 57: Respondents' reactions to a variety of ecological services

Service	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
S1	76	16	8	0	0
S2	71	17	12	0	0
S3	83	15	2	0	0
S4	66	16	18	0	0
S5	52	15	30	3	0
S6	76	15	9	0	0
S7	75	20	5	0	0
S8	55	30	14	1	0
S9	2	6	20	2	0
S10	72	21	7	0	0

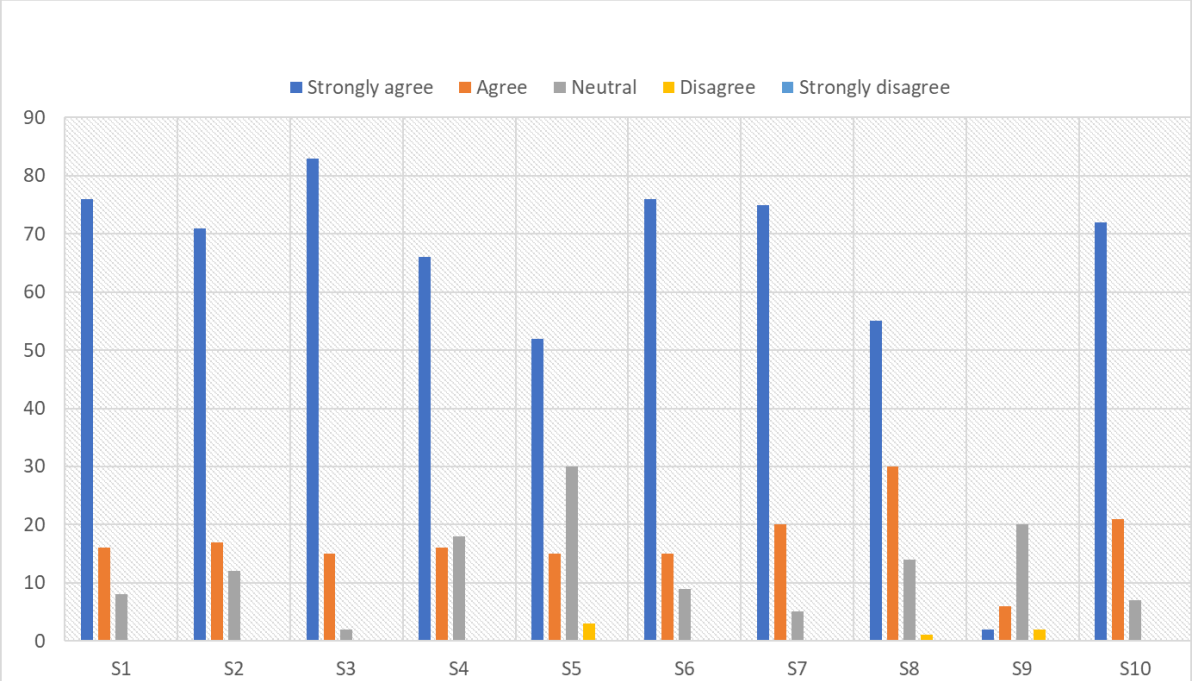

Fig 6: Perception of respondents towards various ecosystem services

4.6.2. Perception of respondents to various conservation questions

Five statements were used to assess respondents' perceptions of the people about problems in Kole wetlands. The respondents were asked to label their reaction as strongly disagree, disagree, neutral, agree, or strongly agree on a five-point scale. Each of these replies was scored on a scale of 1 to 5 in the order listed above, with 1 being strongly agree and 5 being strongly disagree, and all other values in between. The following are the eight assertions that were posed to respondents (Table 58):

Table 58: Different problems in Kole wetlands

Code	Statement
P1	Encroachment in Kole wetlands
P2	Pollution of canals and rivers draining into the Kole wetlands
P3	Unauthorized hunting of migratory bird species
P4	Climate change and drought, flood
P5	Crop raiding by birds

Respondents were questioned on their perceptions of various issues in the Kole wetland. The following table 59 summarises people's responses. Kole residents are dealing with encroachment, wetland degradation, uncontrolled hunting, and crop raiding by birds, are major issues among other issues (Fig 7).

Encroachment and degradation are serious issues that every ecosystem is now dealing with. Crop raiding is a common occurrence in most paddy fields of Kole. Grey headed swamphens (*Porphyrio poliocephalus*) is a bird species that wreak havoc on paddy and lotus farming. The streaked weaver (*Ploceus manyar*), tricoloured munia (*Lonchura malacca*), and scaly-breasted munia *(Lonchura punctulate*) are other granivorous bird species that reduces yields. Damage to seedlings is indicated by Great egrets (*Ardea alba*), Asian openbills (*Anastomus oscitans),* Grey herons (*Ardea cinerea*), and other birds. Another issue causing skin diseases in the area surrounding Aranattukkara and Nedupuzha is pollution. This problem is caused by untreated medical waste from Thrissur hospitals being dumped directly into running water. Pollution is partly to blame for the poor quality of drinking water in some areas.

Table 59: Participant responses towards various problems in the wetlands

Problems	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
P1	24	10	29	32	5
P2	35	20	21	22	2
P3	27	29	31	11	2
P4	54	19	10	7	10
P5	52	29	11	8	-

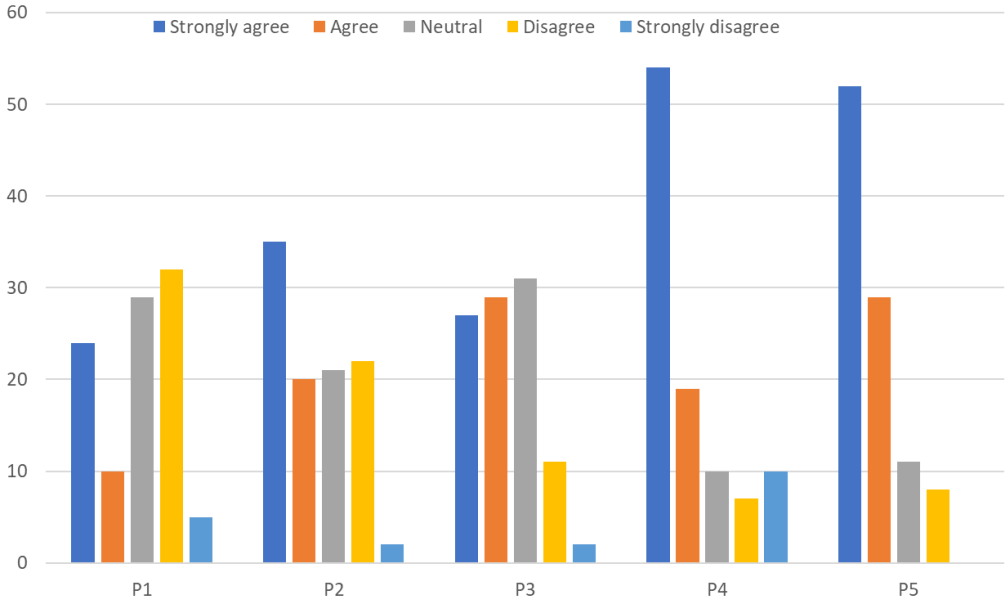

Fig 7: Perception of respondents towards various problems

Summary

Summary

Wetlands are one of the most productive ecosystems on the planet, termed "the kidneys of the landscape" for the endless tasks they perform in the hydrological and chemical cycles, as well as "biological supermarkets" for the vast food webs and biodiversity treasures they support. The importance of wetlands was first brought to the world's attention by the Ramsar Convention on Wetlands, which was signed on February 2, 1971 in the Iranian city of Ramsar. As a result, February 2nd is designated as World Wetland Day. The Ramsar Convention on Wetlands is the first international legal treaty dedicated only to wetlands. It strives to promote their conservation and sensible use around the world, ensuring that wetlands play an important part in achieving the Sustainable Development Goals, the Aichi Biodiversity Targets, the Paris Climate Agreement, and other relevant commitments. The convention currently has 171 contracting parties, with 2,392 wetlands totaling 253 million hectares designated for inclusion in the Ramsar list of wetlands of international importance. India has the biggest number of Ramsar sites in South Asia, numbering 46. The state of Kerala is home to three key Ramsar sites: Vembanad-kole, Sasthamkotta Lake, and Ashtamudi Wetland.

Wetlands have historically been thought of as wastelands. A large portion of the wetlands has been converted to agricultural, industrial, or residential purposes. As a result, descriptions made it easy to exploit for commercial purposes. Globally, growing population, development projects, and pollution have resulted in more wetland loss. Flooding has produced a progressive attitude and understanding about the value of wetlands as a result of the devastation caused by regular floods. Flooding is caused in part by the transfer of wetlands to other land uses. People who live near wetlands rely greatly on wetlands for a variety of commodities and services.

Economic valuation may be a useful tool for assisting and improving sensible use and management of global wetland resources by offering a way to

measure and compare the diverse benefits of wetlands. The function of valuation in the creation of markets for biodiversity protection and environmental services is critical. Economic valuation supplies us with a tool to help us make challenging conservation decisions. For economically justified actions, an understanding of the ecosystem's TEV (Total Economic Value) is essential.

The Thrissur Kole Wetlands are a major Ramsar wetland in Kerala, India, and are located in the Thrissur District. It provides a significant portion of Kerala's rice needs. The Kole Wetlands are one of Kerala's largest, most productive, and most vulnerable wetlands, and they are part of the migratory bird's Central Asian Flyway. Kole lands are today experiencing a loss of species richness, a decline in agriculture production, a scarcity of portable water, variations in flooding patterns, and a depletion of aesthetic value as a result of anthropogenic actions. No comprehensive study has been done in recent past with respect to the economic valuation of Kole wetland ecosystems. As it is very important for management and policy-decisions, attempt is being made to find out the value of ecosystem services by the wetlands.

Both primary and secondary data are employed in the study. Direct personal interviews are the most effective way to gather data and obtain trustworthy information. Kole lands provides a variety of services to a variety of people, thus a personal interview is the best method for gathering information. Standardised pretested interview schedules were utilised to acquire primary data from various stakeholders. A pilot survey was conducted in Puzhakkal, Adat, and Pullu in December 2021 to test and finalize the questionnaire.

The farmers involved in paddy farming**,** fishing activities, lotus farming, and those leasing land for duck rearing are the stakeholders relying on the Kole wetlands. Another key economic activity in the Kole wetlands is tourism, accounting additional income to the farmers. Flood storage, groundwater recharge, and carbon sequestration are some of the additional indirect benefits. The economic worth of various ecosystem services was estimated using a variety of methodologies. The market value method was used to assess direct ecological

benefits. For indirect benefits, the replacement cost method, benefit-transfer method, and alternative cost method were utilized. The contingency valuation approach was used to estimate the non-use value of wetlands. And to estimate economic worth of recreation service individual travel cost method was used.

The non-use value of wetland is also estimated with WTP approach. The Kole wetland has a non-use value of Rs. 7.3 crores. Residents were asked to rate their level of agreement with ecosystem services and other challenges on a scale of strongly agree, agree, neutral, disagree, and strongly disagree. Respondents value the majority of services, indicating that they are environmentally conscious. Kole as a source of food is the most appreciated service, while Kole as a source of medicine is the least well-known. Kole's difficulties are centred in a few areas. Crop raiding by birds, climate change, and flooding are all major issues. In places like Nedupuzha and Arattukkara, pollution and deterioration of groundwater are also problems. Farmers must also battle with weeds such as weedirice. Crop raiding by birds, pollution, floods, and poor wetland management are important issues that the farmers have facing at Kole wetlands.

The Total Economic Value (TEV) of the system is composed of direct use value, indirect use value and non-use value. The level of income generated by wetland-related activities was used to calculate the direct use value of the wetland. Paddy cultivation worth Rs. 126 crores per year, highlighted as most important service provided by the Kole wetland. It has a direct usage value of Rs. 148 crores and the flood storage function of Rs. 187 crores, whereas the groundwater recharge function is worth Rs. 9.9 crores per annum.

According to the findings, wetland ecosystem services have an estimated economic worth of Rs. 390 crores per year which highlights its enormous importance. The findings of the study can be used to construct a socially acceptable management strategy for the conservation of long-term viability of Kole wetland.

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Economic Valuation of ecosystem services: A Case Study of Kole Wetlands, Ramsar Site

By

NEHA TAMHANKAR

(2019-17-016)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Forestry

Faculty of Forestry

Kerala Agricultural University

DEPARTMENT OF WILDLIFE SCIENCES

COLLEGE OF FORESTRY

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ABSTRACT

Wetlands are one of the most productive ecosystems on the planet, equivalent to tropical evergreen forests, and they play an important role in ecological sustainability. The quality and extent of these wetlands are rapidly deteriorating. The purpose of our study, was to determine the services offered by the wetland as regarded by stakeholders and to quantify the economic value for various ecosystem services. It was held in one of most important wetland systems in Kerala, the Kole wetlands, which has been designated as a Ramsar site.

The data used in this study was collected from both primary and secondary sources. Primary data respondents were chosen using a multistage random sampling method (200 samples), and data was collected using a personal interview method with a pretested organised schedule. The obtained data was analysed by using market value approach, travel cost method, replacement cost method, benefit transfer method, and contingent valuation method.

The farmers involved in paddy farming**,** fishing activities, lotus farming, and those leasing land for duck rearing are the stakeholders relying on the Kole wetlands. Another key economic activity in the Kole wetlands is tourism, accounting additional income to the farmers. Flood storage, groundwater recharge, and carbon sequestration are some of the additional indirect benefits. The relevance of wetland ecosystem services was recognised by the respondents. Crop raiding by birds, pollution, floods, and poor wetland management are important issues that the farmers have facing at Kole wetlands.

The Total Economic Value (TEV) of the system is composed of direct use value, indirect use value and non-use value. The level of income generated by wetland-related activities was used to calculate the direct use value of the wetland. Paddy cultivation worth Rs. 126 crores per year, highlighted as most important service provided by the Kole wetland. It has a direct usage value of Rs. 148 crores

and the flood storage function of Rs. 187 crores, whereas the groundwater recharge function is worth Rs. 9.9 crores per annum. It has a non-use value of Rs. 7.3 crores.

According to the findings, wetland ecosystem services have an estimated economic worth of Rs. 390 crores per year which highlights its enormous importance. The findings of the study can be used to construct a socially acceptable management strategy for the conservation of long-term viability of Kole wetland.

Appendices

APPENDIX - I

COLLEGE OF FORESTRY

KERALA AGRICULTURAL UNIVERSITY (KAU)

Economic Valuation of Ecosystem Services; A Case Study of Kole Wetlands, Ramsar Site

Socio-economic questionnaire

Name of the panchayat: **Date:**

Personal details

1) Name of person respondent:
2) Age:
3) Sex: Male ☐ Female ☐ Transgender ☐
4) Contact No.:
5) How long have you been living in this location? _____

   Less than 5 year ☐ 5-10 years ☐ 10-20 years ☐ more than 20 years ☐
6) Family details:

   No of family members: ☐

Sl No.	Sex	Age	Education	Main occupation

7) What is your occupation?

☐	Agriculture	☐	Fishing
☐	Pisciculture	☐	Duck Rearing
☐	Poultry	☐	Tourism
☐	Others- specify: _____		

8) Land holding details

Sl No.	House plot	Wetland	Location	Gram-panchayat

9) What is a source of water for your family?

Well	☐
Stream	☐
Bore well	☐
Piped water supply (KWA)/ LSG	☐

10) How much is your daily water requirement?

☐

11) Annual income ☐

If Pisciculture/ fishing,

12) Natural fishing ☐ Pisciculture ☐

13) Distance of fishing ground from your home:

14) In which season the fish harvesting is done?

Period	**Days/ month**	**Number of species**	**Number of Species found in wetland**
Jan- March			
April – June			
July- Sept			
Oct- Dec			

15) Fish and Income

Species	**Quantity/day**			**Average Market price**
	≤ 10 kg	10-25	≥ 25	

16) Expenses for natural fishing

Sl. No	**Item**	**Amount**
I	Equipment (Mention year of purchase)	
Ii	Labour	

17) Expenditure for pisciculture

Inputs	**Cost**
Startup cost/Fixed Cost (Year)	
Labour charges	
Harvesting charges	
Marketing charges	
Total	

If farming,

18) How long you have been doing rice farming?

☐ Less than 5 yrs. ☐ 5-10 yrs. ☐ 10-20 yrs ☐ 20 to 30 yrs ☐ ≥30 yrs.

19) Land use

Crop	**≤ 1 acre**	**1-2.5 acre**	**≥ 2.5 acre**
Paddy			
Coconut (no)			
Banana (no)			
Vegetables			
Pulses			
Others			

20) Average yield from various crops

Crop	**Yield per year**	**Average rate**	**Total**
Paddy			
Coconut			
Banana			
Vegetables			
Pulses			
Others			

21) Expenses for each crop

Paddy

Item	**Amount**
Seeds	
Fertilizers	
Pesticides	
Machinery	
Labour cost	
Transportation	
Land Lease Charges	
Others	
Total	

Coconut

Item	**Amount**
Seeds	
Fertilizers	
Pesticides	
Machinery	
Labour cost	
Transportation	
Land Lease Charges	
Others	
Total	

Item	**Amount**

Seeds	
Fertilizers	
Pesticides	
Machinery	
Labour cost	
Transportation	
Land Lease Charges	
Others	
Total	

Item	**Amount**
Seeds	
Fertilizers	
Pesticides	
Machinery	
Labour cost	
Transportation	
Land Lease Charges	
Others	
Total	

22) Yield in tones

Item	**Quantity**	**Family consumption**	**Quantity marketed**	**Market rate**	**Returns**
Rice					
Straw					
Coconut					
Banana bunch					

21) Benefits of Kole wetland

- Ranking of goods and services provided by Kole wetland

No	Goods/services	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	Flood plain					
2.	Groundwater recharge					
3.	Providing special condition for paddy fields					
4.	Fish availability					
5.	Nutrient cycling					
6.	Carbon sequestration					
7.	Potential tourism site					
8.	Provides habitat for birds					
9.	Spiritual significance					
10.	Fodder source					
11.	Medicinal plants					
12.	Sources of thatching materials for roofs, baskets, mats, paper etc.					

22) Are birds causing any threats to paddy cultivation?

Very often ☐ Often ☐ Sometimes ☐ Rarely ☐ None ☐

23) If yes, which are the birds?

If Lotus farming / water lily

24) How long have you been practicing lotus farming?

Less than 5 yr ☐ 5-10 yr ☐ 10-20 yr ☐ more than 20 yr ☐

25) Season of Lotus farming

January- March ☐ April- June ☐ July- September ☐ October- December ☐

26) Area under lotus cultivation

≤ 1 acre ☐ 1-2.5 acres ☐ 2.5 acres ☐

27) Expenditure

Input	**Quantity**	**Rate**
Seeds		
Manures		
Pesticides		
Labour		
Storage		
Transportation		
Others		

28) Daily yield

Item	Quantity	Average Rate	Total

If Duck rearing

29) Participation

Duck rearing ☐ Providing land on lease ☐

30) Season of duck rearing

January- March ☐ April- June ☐ July- September ☐ October- December ☐

31) Number of Ducks: _____

Less than 100 ☐ 100-500 ☐ 500-1000 ☐ more than 1000 ☐

32) Expenses for Duck rearing

Inputs	**Amount**
Medicine	
Food	
Water	
Labour	
Land lease charges	
Maintenance	
Other	

33) Fixed capital for Duck rearing

34) Land on lease for Duck rearing

1 acre ☐ 1-2.5 acre ☐ 2.5 acres ☐

35) What is the rate of lease?

36) period of lease for Duck rearing

0-3 Month ☐ 3-6 months ☐ 6-9 months ☐ 9-12 months ☐

Remarks

……

……

……

……

……

…… **Signature**

APPENDIX - II

COLLEGE OF FORESTRY

KERALA AGRICULTURAL UNIVERSITY (KAU)

Economic Valuation Of Ecosystem Services; A Case Study of Kole Wetlands, Ramsar Site

Tourist interview schedule:

1. Name
2. Age
3. Sex
4. Education
5. Occupation
6. Length of vacation
7. Family size
8. Daily income foregone for visit
9. How many times in a year you are visiting Kole wetlands?
   Average time spent on each visit
10. What is purpose of your visit?
    a. Sight-seeing and recreation
    b. Boating
    c. Bird watching
    d. Cultural events
    e. Others

11. Where do you live?

Country

State

District

City

12. Distance of home town from Kole wetland? (km)

13. If you were not on this tour today, what would you most likely be doing?

a. Working
b. School or college
c. Housework
d. Others

14. Please give the details about your trip?

a) Travel from hometown to Kole wetland	Cost
Private car (fuel)	
Motorcycle	
Flight	
Train	
Bus	
Taxi/Hired Vehicle Expenditure	
Others	
a) Total Boarding and lodging charges (&no. of days)	
b) Food, water and beverages	
c) Sight-seeing and recreation	
d) Others	

b) The visit to Kole wetlands was your primary objective Yes/no

If no specify

a. Visiting relatives and friends
b. Business
c. Tour to another place/destination
d. Conference
e. Others

c) Please tell about nature of your visit.

a. Leave ☐
b. Weekend ☐
c. Holiday ☐
d. Vacation ☐
e. Off-day ☐
f. Break during working hours ☐
g. Function ☐

d) Remarks

e) Signature

APPENDIX - III

College of Forestry,

Kerala Agricultural University (KAU)

Economic Valuation of Ecosystem Services; A Case Study of Kole Wetlands, Ramsar Site

WTP questionnaire

Name of the respondent: **Date:**

Place:

Contact No.:

Background:

Kole wetlands support various types of livelihood activities directly or indirectly to people around it. Kole is very important economically as well as ecologically. Kole wetlands perform a number of functions which can be summarised into hydrological, chemical, biological and socio-economic functions. The hydrological functions are important in preventing flooding and include recharging aquifers in around wetlands. The chemical functions include water quality improvement, sediment trapping and wastewater treatment. It is a sink or a natural cleaning centre for pollution. Biological functions can be divided into two series: productivity and biodiversity. The socio-economic functions include productive agricultural areas, production of drinking water, firewood and the stock of fish, etc. The non-consumptive elements in the socio-economic functions include the recreation, education, aesthetic, cultural and spiritual. These are the ecological functions provided by Kole wetlands which support different livelihood activities.

When it comes to people around Kole lands, it provides best suited condition to paddy in the month of October to April. It also provides ideal condition for lotus farming all over the year. It acts as flood plain and provides ground for pisciculture as well as natural fishing. Tourism is another activity which takes place in various places at Kole and gives different ways to generate income like food corners, general shops, boating, photography, toddy shops, hotels, transport facility etc. It is easy to understand value of wetland economically rather than ecologically.

Today, wetland degradation and destruction are occurring more rapidly than in any other ecosystem. Developmental projects, road construction, encroachment, mining etc. are the reasons behind destruction of Kole lands. Protection of Kole land is very important and that calls for cooperative planning among communities, non-profit organizations, government and industry.

1. Are you receiving any direct benefit from Kole wetland?

Yes ☐ No ☐

If yes,

2. Distance from Kole wetland? ☐

3. What do you like most about Kole?

1. Primary source of income ☐
2. Source of water ☐
3. Scenic beauty ☐
4. Biodiversity ☐
5. Paddy fields ☐
6. Spiritual significance ☐
7. others ☐

4. Do you support conservation of Kole wetlands?

Yes ☐
No ☐

5. Any suggestion for better conservation and management of Kole wetlands?

Willing to Pay for the conservation of Kole Wetland

6. Suppose the government aspires to improve the conservation and management facilities of Kole wetlands and starts to build up project for the same with your participation. A budget has been planned and government wants to obtain a certain amount of it through crowdfunding. Would you volunteer to make a donation of Rs 100 for this project?

Yes ☐ No ☐

If yes,

Will you contribute Rs 500?

If yes,

Will you contribute Rs 1000?

If yes

What will be the maximum amount that you will be contributing?

≤ 10,000 ≥ 10,000

If no,

Will you contribute Rs 50?

If no,

What will be the minimum amount that you will contribute? ☐

7. What will be maximum amount that you will be contributing for conserva ☐

8. If yes, what are the reasons for willing to pay?

Sl.no	Reasons	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	The conservation of Kole wetland is good and essential for me and society					
2.	This amount is reasonable for me.					
4.	I can afford to pay this amount					
5.	Others					

9. If no, what are the reasons for not willing to pay?

Sl.no	Reasons	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	Conservation of Kole wetland is not important					

2.	Its government responsibility					
3.	Now, I am not able to contribute this much money, but may be later.					
4.	Others					

10. Are you willing to contribute in conservation efforts in any other way?

Yes ☐

No ☐

11. If yes,

Sl no	Particulars	No. days/month
1.	Contribution as labour	
2.	Participation in any conservation project	
3.	Others	

12. What is your opinion about the developmental projects in the Kole wetlands such as

	Yes	No	Neutral
a) Roads			
b) Rails			
c) Building			
d) Construction of other developmental projects			

13. Would you like to be member of any environment protection project?

Yes ☐

No ☐

14. How much will you pay for the protection of Kole wetlands for your future generation?

☐

15. How much will you pay for the protection of Kole wetlands for benefits your all family members are receiving from Kole lands? ☐

If No,

2.Distance from Kole wetlands? ☐

3. Do you support conservation of Kole wetlands?

Yes ☐

No ☐

4. Suppose the government aspires to improve the conservation and management facilities of Kole wetlands and starts to build up project for the same with your participation. A budget has been planned and government wants to obtain a certain amount of it through crowdfunding. Would you volunteer to make a donation of Rs 100 for this project?

Yes ☐ No

If yes,

Will you contribute Rs 500?

If yes,

Will you contribute Rs 1000?

If yes,

What will be the maximum amount that you will be contributing?

≤ 10,000 ≥ 10,000

If no,

Will you contribute Rs 50?

If no,

5. What will be the minimum amount that you will contribute?

☐

6. What will be the maximum amount that you will be contributing?

☐

7. If yes, what are the reasons for willing to pay?

Sl.no	Reasons	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	The conservation of Kole wetland is					

	good and essential for me and society					
2.	This amount is reasonable for me.					
4.	I can afford to pay this amount					
5.	Others					

8. If no, what are the reasons for not willing to pay?

Sl.no	Reasons	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	Conservation of Kole wetland is not important					
2.	Its government responsibility					
3.	Now, I am not able to contribute this much money, but may be later.					
4.	Others					

9. Are you willing to contribute in conservation efforts in any other way?

Yes ☐

No ☐

10.If yes,

Sl no	Particulars	No. days/month
1.	Contribution as labour	
2.	Participation in any conservation project	
3.	Others	

11. What is your opinion about the developmental projects in the Kole wetlands such as

	Yes	No	Neutral
a) Roads			
b) Rails			
c) Building			
d) Construction of other developmental projects			

12. Would you like to be member of any environment protection project?

Yes ☐

No ☐

Ranking of goods and services provided by wetland

No	Goods/services	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Flood plain					
2	Water supply					
3	Food					
4	Providing special condition for paddy fields and pisciculture					
5	Erosion control and sediment retention					
6	Biodiversity conservation					
7	Climate regulation					
8	Waste treatment or recycling					
9	Recreational services					
10	Fish availability					
11	Nutrient cycling					
12	Carbon sequestration					
13	Provides habitat for migratory birds					
14	Spiritual significance					
15	Fodder source					
16	Medicinal plants					
17	Raw material - Source of thatching materials for roofs, baskets, mats, paper etc.					

What are the main threats to wetland?

Sl No.	Threats	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Household sewage and water contamination					
2	Causing water and sound pollution in the area					
3	Over exploitation of wetland resources					
4	Improper implementation and management plan					
5	Invasive species					
6	Encroachment and illegal agriculture farming					
7	Population growth					
8	Unmanaged tourism					

Remarks

Observation-

Interest of person in survey:

(1- Extremely interested ☐ 2- Somewhat interested ☐ 3- Slightly interested ☐

4- Not interested at all)