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THE CASE OF THE SHRINKING PALLIIKARANAI MARSH, CHENNAI, INDIA: ENVIRONMENTAL ECONOMICS TO THE RESCUE?

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The intangible benefits provided by water bodies and wetlands in urban areas often tend to go unnoticed. In order to assess the true values of welfares and benefits to society, social benefit cost analysis (SBCA) presents itself as a useful tool. In this paper, hedonic pricing method (HPM) has been used in apprehending the environmental and aesthetic benefits of Pallikaranai marsh, Chennai, India, and the results are used in analysis of costs versus benefits. We attempt to quantify the impact of the presence of water bodies in urban settings and distance from the Pallikaranai marsh has been found to be the significant variable, and the price rate of residential land decreases by .367/m^2 for every metre distance away from the marsh. Many other smaller water bodies surround the marsh. Another variable, denoted by the component of interaction of distance from the marsh and distance of other smaller water bodies is found to be a significant variable, while the distance from other smaller water bodies is found to be not a significant variable. The results of the analysis describe and demonstrate the role of water bodies in the urban context and provide data for land planners and water managers to make informed decisions in the planning and management agenda.

***Keywords**: Urban water bodies and wetlands; Urban environmental quality; Hedonic Pricing Method; HPM; Social Benefit Cost Analysis; SBCA; Restoration of water bodies; Restoration of marshes; Pallikaranai; South Chennai*

INTRODUCTION

While cities occupy only 2% of the earth's surface, they use up around 75% of the natural resources and generate 70% of all the waste produced on a global scale (McInnes, 2013). Wetlands deliver multiple benefits, such as providing drinking water, mitigating flood risk and regulating local climate. They are also significant contributors to recreation by virtue of their aesthetic quality and improve the quality of life of humans. Unfortunately, too often, wetlands are neglected in city planning, and though cities and towns are human constructs, protection of wetlands is mostly neglected in the planning agenda. Chennai, India is a city where the landscape is dotted with wetlands though there is no perennial river. There are numerous small and large wetlands which characterize the geology and hydrology of the region, though neglected and unrecognized in larger fora. This is due to the fact that awareness among the public and sensitive action on the part of the governing agencies are lacking even though these wetlands play a significant role.
The Ramsar convention, an institutional framework for protection and wise-use of wetlands since 1971, stipulates that "the maintenance of the ecological character of wetlands, achieved through the implementation of ecosystem approaches within the context of sustainable development" is the basis of 'wise-use'. In India, there are 42 Ramsar sites as of the year 2021. Wetlands are coalescing of land and water, combining attributes of terrestrial and purely aquatic ecosystems. They are characterized by the presence of water, the depth of which, at low tide, does not exceed six metres. A study of the ability of urban ecosystems to generate local ecosystem services in Stockholm, Sweden, revealed that of seven ecosystem types (street trees, lawns/parks, forests, cultivated land, wetlands, streams and lakes/sea) only wetlands managed all six of the services assessed (air filtering, micro-climate regulation, noise reduction, rain-water drainage, sewage treatment and recreational or cultural values) (Panel & Convention, 2013). The aggregate value of the ecological services generated by wetlands, on a global scale, has been estimated to be $4.9 trillion/year (Costanza et al., 1998).
The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty which lays down the guidelines for national action and international cooperation for the conservation and wise use of wetlands. Because wetlands are very

important for ecological processes as well as for their rich flora and fauna, the broad objectives of the Convention are to ensure their conservation and wise use.
To meet these objectives, the Convention places general obligations on member countries relating to the conservation of wetlands throughout their territory, and special obligations pertaining to those wetlands which have been designated for the List of Wetlands of International Importance (the “Ramsar List”).
In many places, wetlands have traditionally been seen as sites to be converted (either to something “useful” or to something more “benign”): the connotation is that there needs to be something more valuable reclaimed from the wetland. While this perception has changed significantly in recent years, there are still residues of its influence in the decision-making processes operating in some places. In Algeria (Samraoui & Samraoui, 2008), Brazil (Ribeiro et al., 2020), China (Mao et al., 2021), Nepal (Siwakoti & Karki, 2009) and Serbia (A et al., 2018) the institutional mechanism and impact of inclusion in Ramsar list have been discussed. Few studies have attempted to quantify recreational and aesthetic benefits of lakes / water bodies in India, namely the study on Bhoj wetland, (Verma, 2001), the studies on Sikkim (Maharana et al., 2000; Uprety & Rai, 2000), the studies on Pallikaranai (Balakumar & Das, 2015; Venkatachalam & Jayanthi, 2015) and various case studies mentioned in the report of The Economics of Ecosystems and Biodiversity India Initiative (TII) (India, 2014). But the topic of quantification of aesthetic benefits of such water bodies is yet to find much scholarship in literature.
Cost benefit analysis (CBA) of conservation projects related to wetlands and lakes becomes a viable tool to justify the expenses incurred by such projects. It is based on welfare economics and is easily understood by the non-economist. Social Benefit Cost Analysis (SBCA) takes into account societal benefits accrued from non-market and aesthetic benefits from the environment and its impact on economics. There are very few studies addressing intangible benefits and here, we aim to justify them in our case, the Pallikaranai marshland.
The main objective of this paper is to obtain market and non-market aesthetic benefit cost ratios for the Pallikaranai marsh, Chennai, India, and justify the expenses towards conservation as taken up in the past ten years. Possibility of revenue generation for further upkeep and improvement of quality of work and the quality of landscape is another objective. The study could prove useful for land planners involved in policy and decision-making towards a better management of resources.

MATERIALS AND METHODS

Pallikaranai was originally a panchayat (the word refers to an administrative unit, originally meaning village council) under the village, St.Thomas Mount in the pre-1970s and then annexed with Chitlapakkam when it became a village panchayat. Later, it came under the Corporation of Chennai. The marshland in the 1970s was much larger than its current extent, and it is a well-known fact that the marsh extended to 5500 hectares according to the 1906 topo sheet and it has shrunk to 593 hectares in recent times (Vencatesan, 2007; Vencatesan et al., 2014).
Pallikaranai village is predominantly along the western edge of the marsh surrounded by Madipakkam, S.Kulathur, Kovilambakkam, Pallavaram, Jalladampettai, Pallavaram and Tambaram further west and Velachery in the north and Perumbakkam in the south, situated on the geo-coordinates of 12.949371°N latitude and 80.218184°E longitude as seen in Figure 1.

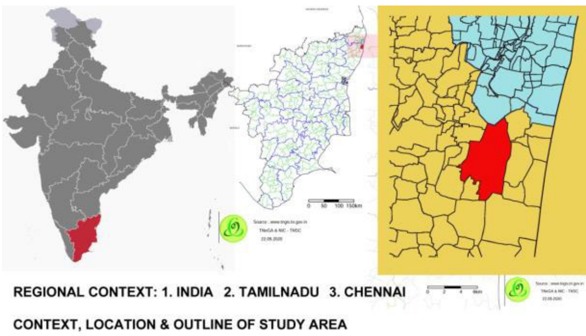

Figure 10. Study Area

The maximum water spread area of the marsh, is less than 695 ha as the water body dries out in summer and maximum depth has been estimated as 6 metres (Vencatesan et al., 2014). After the year 2000, a road across the water body, dividing it into north and south, connecting the eastern and western edges of the marsh (and thus skyrocketing real estate growth on both sides of the marsh) was established. While there are many criticisms regarding the way this road was designed, viz., insufficiency in the culverts' sizes and capacity to permit water flow from the northern half to the southern half, the road is still popular and has facilitated accessibility and a view of the marsh on both sides. On the east, the said 200ft Radial Road, as it is called, connects with the Old Mahabalipuram road or the information technology zone, with a number of multinational companies, major residential and also some commercial development. The development of this road enjoyed the support of the government, as part of the city's economic growth and runs close to the marsh. Hence, in the eastern side, the urban development is powered by the presence of this IT corridor.

On the western side lies the Pallikaranai village and neighbouring villages, comprising a landscape of a large number of tanks. 34 of these tanks lie in this region (Department, n.d.) and the surplus of these tanks drains into the marsh by means of the inlet canals in the northwest. Much of this land remained a landscape of agricultural lands till the onset of development in the late 1990s. The government commissioned studies and Environmental Impact Assessments (Mott MacDonald, Cambridge, 1993; NEERI, 1998) to arrive at the feasibility of a light industrial development in this area and the studies ascertained that the area could support development, which resulted in a burgeoning of population and supporting infrastructural growth.

The study addresses the lands on the western side of the marsh, as we are concerned with the transformed natural landscape and intend to explore environmental economics. Hence, we examine these water-rich regions where peri urban growth and development has occurred. The department of forests has taken over the marsh since it was declared as a reserve forest in 2007.

This department has received funds from the government and data on funds and expenditure towards the upkeep and reclamation was obtained from the department of forests. A study on adaptive management of the marsh was conducted by an NGO (Non-governmental organization), 'Care Earth' and submitted to the government. In 2018, the state government announced that it would commence the restoration of 695 hectares of the wetland under the National Adaptation Fund for Climate Change over 5 years from 2018 to 2023. Hence, other than stabilization by bunds, establishment of an interpretation centre, acquisition of lands and clearance of encroachments, the restoration process is still an on-going process. The forestry department has not promoted or collected any revenues from the citizens and hence declared nil income from the reserved forest area.

For assessing the aesthetic/ recreational benefit of Pallikaranai marsh and other water bodies in the area, Hedonic Pricing Method (HPM) was the tool used (Chaudhry, 2013). HPM estimates economic values for environmental benefits and other goods. In this case, the ecosystem services constitute the environmental benefit, in other words, aesthetic benefit from the water body and other goods constitute residential plot prices in the surrounds of Pallikaranai and the tanks which drain into it. Typically, many attributes jointly combine and influence residential land prices. Statistical techniques have been utilized to separate parts of transaction prices due to each of these attributes (Jim & Chen, 2006).

Data used in this research was collected in December 2020 from the field. The primary data includes specifics on environmental attributes and spatial locations and prices of land. Data on air quality, noise pollution in the region were collected from the Tamilnadu Pollution Control Board, and water quality was measured (with the help of a portable TDS meter and pH solution) and availability round the year was determined by enquiry in the field for every individual sample house.

Garbage disposal and quality of parks nearby was considered. As most of it is an urban area, attributes like distance from workplace and distance from nearby schools were also considered. The distance from the marsh and from nearby water bodies was measured from Google Earth engine using the distance tool and by pinning the locations with geo-coordinates.

The guideline value of the plots in Rupees/m^2 and Rupees/ft^2 were also obtained from the webportal of the land revenue department (www.tnreginet.in) which provides streetwise data for the whole of Tamilnadu.

RESULTS AND DISCUSSION

In this paper we have attempted to quantify ecological benefits by specifying certain variables in the analysis. Statistical Package for Social Sciences (IBM SPSS Statistics Viewer for Windows) was used to perform multiple regression analysis. Market rate of residential plots (PLOTRATE) in Rupees /m^2 was considered as dependent variable.

The relationship between the dependent variable and other independent variables can take several forms. Linear, semi-log and double-log specifications were considered and the results of linear regression are presented as R^2 with standard error estimate (SEE) appearing better in this form. The dependent variables considered were: size of plots (PLOTSIZE),

air quality (AIRQLTY), water quality (WATQLTY), noise level (NOISELVL), garbage disposal (GARBDISP), distance from water bodies (DISTWTBODY), and distance from Pallikaranai marsh (DISTMARSH). These were the eight independent variables considered. In regression, one always has to take into account the possible influence of the independent variables on each other and in our case, the distance from the marsh and distance from water bodies are found to have a high correlation. Hence, another variable, which is denoted by the interaction of distance from the marsh and distance from these water bodies (INT_DM_DWB) was also included in the regression.
Five of these variables (airquality, water quality, noise level, garbage disposal and quality of parks) were of dichotomic nature that is, taking values 0 or 1, 0 for bad aspect and 1 for good aspect.
Variables other than plot size are considered hedonic variables as their inclusion in the equation exhibits a relationship with value of residential plots.
The following table (Table 1) gives the descriptive statistics including sample mean, standard deviation, maximum and minimum values of the dependent and independent variables for the plots examined, where data on environmental variables was collected.

Table 1. Descriptive statistics of the variables

	Mean	Standard Deviation	Maximum	Minimum
PLOTSIZE (m^2)	211	48.6	446	111.5
PLOTRATE (Rs./m^2)	15600	5940	36060	2390
DISTMARSH (m)	3770	2610	8650	236
DISTWTBODY (m)	492	291	1730	14
AIRQLTY	0.92	0.27	1	0
WATQLTY	0.47	0.5	1	0
NOISELVL	0.92	0.28	1	0
GARBDISP	0.83	0.38	1	0
QLTYPARK	0.38	0.49	1	0
INT_DM_DWB	3.1x105	8.2x105	40.7x105	-12.2x105

The average plot size considered was 210.85m^2, ranging between 111.5m^2 and 446m^2. The average rate of plots /m^2 was found to be Rs.15600 /m^2 ranging from Rs.2390 /m^2 to Rs.36100 /m^2. The distance of the sample plots from the Pallikaranai marsh was at an average of 3770m ranging from 236m to 8650m. The distance of the sample plots from the nearest water bodies (in some cases if more than one water body is nearby, the significant nearest water body or average of distance of all the nearby water bodies) was at an average of 490m ranging from 14m to 1730m. The interaction between these two variables was also included in the equation as seen in Table 1. The results of the hedonic price regression analysis are given in the following table. The explanatory variables account for 9.8% of the plot rate variance (adjusted R^2=0.098) and the F-ratio test indicates that the model fits properly.
As seen from Table 2, on examination of the student's t-statistics, (t=-3.291) it is revealed that the distance from the marsh is a significant variable influencing plot prices, and the rate of plots decreases by Rs.0.367 / m^2 as one move away from the marsh. Hence, the land value appears to be higher in regions which are in closer proximity to the marsh. The distance from smaller water bodies is not a statistically significant variable but the interaction of the distance from the marsh and the distance from the water bodies is again a significant variable (t=2.027) exhibiting an increase of Rs.0.187 /m^2 as one move away from the marsh and water bodies. Figure 2 shows the graph of rate of plots vs. distance from the marsh. The rate decreases with distance from the marsh. Figure 3 shows the graph of rate of plots vs. interaction of distance from marsh and distance from other water bodies. In this case the rate increases with increase in distances combined.

Table 2. Linear Regression model results

	Coefficients Beta	t-statistic	Significance
(Constant)		4.59	<.001
PLOTSIZE	-.038	-.438	.662
AIRQLTY	-.099	-.880	.381
WATQLTY	-.104	-1.143	.255
NOISELVL	.206	1.748	.083

GARBDISP	-.123	-1.201	.232
QLTYPARK	.003	.031	.975
DISTMARSH	-.367	-3.291	.001
DISTWTBODY	-.022	-.230	.819
INT_DM_DWB	.187	2.027	.045

Dependent variable: PLOTRATE (m^2)

Notes: Adjusted R^2= 0.098 F= 2.566 ($p<0.05$) Dependent Variable: PLOTRATE(m^2) n=130

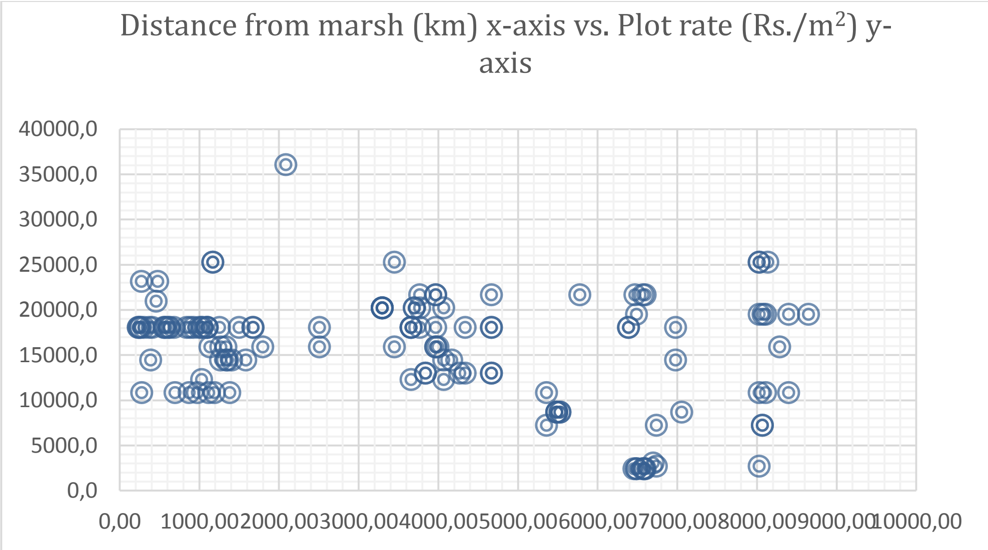

Figure 2. Graph showing price of plots (y-axis) and distance from the marsh (x-axis)

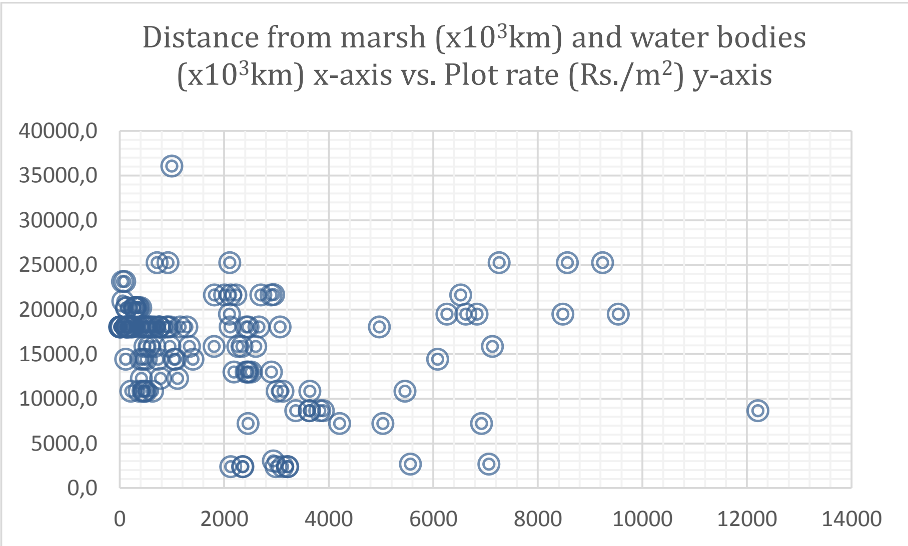

Figure 3. Graph showing rate of plots (y-axis) and distance from the marsh and water bodies (x-axis)

Of the variables used in the regression equation, the independent variables denoting air quality and noise level which were obtained from the Pollution Control Board and are not found to be significant variables. Air quality in terms of suspended impurities, was mostly within permissible limits, except for areas where garbage burning was practised i.e., areas near waste dumps. Traffic noise level was accepted by most residents as it is a highly populated area. Water quality was measured in each sample site, (TDS, pH and availability round the year were considered). The water was mostly alkaline and TDS ranged from 400 to 950 with an average of 550 parts per million. Studies have shown that the TDS should be a minimum of 400 to be considered good quality. Hence, the variables 0 and 1 were applied accordingly.

But this variable is not found to be significant in the equation. Quality of parks was considered and so were distances from nearby school and workplaces. Most people surveyed worked within 3-4km from their residences and many schools were also found to be available in the area. Since this is a small part of a larger city network and mostly uniform in the study area boundary, these variables were not considered.
Distance from the marsh is a significant variable, whereas distance from the tanks/ water bodies in the study area was not found to be a significant variable. However, an interaction component between the two was included in the equation and was found to be a significant variable. To remove multi-collinearity, we have mean-centred the interacting variables and subsequently calculated the interaction component. The graphs show that the plot rates and plot prices decrease as the distance from the marsh increases, which shows that the presence of the marsh and its aesthetic benefit do impact plot prices. However, as the interaction of distance from the marsh and distance from other water bodies increases, plot price increases, which implies that at greater distances from the marsh, the proximity to the smaller water bodies does not necessarily imply higher plot rate. Water bodies proximity has been found to be an influencing factor in residential plot prices in developed countries according to Jim and Chen (2006; 2007). Hence, we can conclude that the aesthetic benefit of the smaller water bodies in our study area, have not been realized in these terms.

BENEFIT-COST ANALYSIS

Benefit Cost Analysis, which takes root from welfare economics, is an analysis that is comprehended by the layman. Three types of Benefit Cost Analysis may be distinguished. Informal, Quantitative and Monetized or Formal Benefit Cost Analysis may be performed. In the informal category, benefits and costs are compared in detail, but not necessarily quantified or monetized. In the quantitative category, benefits and costs are compared quantitatively in terms of m^2, gallons or decibels (for noise level), but not necessarily monetized. In the third, benefits and costs are quantified in terms of their dollar/ rupee value.
Formal Benefit Cost Analysis is dependent on the Paraeto optimality criteria. According to this criteria, social welfare is increased if the given transaction enables that the (living) conditions of some people (the beneficiaries) are improved and nobody suffers degeneration of conditions (Williams, 1979). One way to achieve it is to make the beneficiaries pay for the transaction including the sum necessary to compensate the losers. If at the end of this, the beneficiaries still enjoy the advantage, the Paraeto optimality criteria are achieved. In order to achieve these criteria, the sum of benefits flowing from a given transaction must be greater than the sum of costs incurred, in which case, society has the potential to benefit from it. According to a report by the ministry of Water Resources in India, (2009), Benefit Cost ratio (BC ratio) has to be minimum 1:1 in Special Category States, undivided KBK districts (refers to a backward region) of Orissa, in drought prone, tribal and naxal-affected areas and 1.5:1 in other areas.
To do a benefit cost analysis, we must identify the primary benefits and primary costs. In our case, the primary benefits of ecological restoration of Pallikaranai marsh would be to facilitate the public with a lung-space, which serves the many benefits of air and water purification, ground water recharge, flood moderation, recreational benefits such as biodiversity and birdwatching, enjoying the presence of water and further, tourism benefits if promoted wisely. The primary costs would be the cost of restoration, involving physical measures like demarcating the marshland extent, reclaiming by clearing encroachments, creation of bunds and stabilizing the edges, apart from unexpected costs of disaster management at times of extreme floods, which could be averted by restoration. The secondary benefits may be identified as social benefits derived by commuters, employment benefits for people engaged in restoration works, reduction of inundation risk, by reclaiming the marshland. The secondary costs are the loss of wetland if these efforts are not taken, and the frequent financial and physical damages by flooding, loss of community support because people may vacate and abandon the area if the living conditions are not good enough and hence loss of ecosystem services.
Mercy Corps (Okapi & Corps, 2016) and Rajan et.al., (2016) have quantified the damage to Chennai, India, by the major flood of 2015. Rajan et al., have determined that a loss of over Rs.15,000 crores impacting 10-15% of the country’s production, was suffered by the industry lobby. Other studies describe Contingent valuation method (CVM) and Travel cost method (TVM) which have been used to study environmental economics with respect to the landscape of Sikkim, Himalayas by Uprety and Rai (2000) and Maharana et al. (2000).
Total Economic Value (TEV) is a methodology adopted in welfare economics for environmental management. The TEV is arrived at by analysing the various direct and indirect uses of the water body. There are active and passive uses, and the community is approached in order to gauge their willingness to pay for the benefits derived, which are, in other words, the ecosystem services or their willingness to accept compensation for the unfavourable conditions. In our case, Venkatachalam et.al., (2015) have conducted one such survey in 2015, in the villages surrounding Pallikaranai marsh, viz., Perungudi, Pallikaranai, Jalladampettai, Perumbakkam, Okkiyamthoraipakkam and Karapakkam with a total voter

population of 155000 and surveyed 733 households, the results of which were that on an average, an amount of Rs.2096/- per annum could be spent per household for the coming five years. They discussed various scenarios and surveyed if the people were willing to pay for the status quo, or for moderate improvements or Option Value of an enhanced future of their living conditions and the marsh. It is also significant that, many people were not willing to participate in this survey because they were afraid they would be evicted.

A way of arriving at the total economic value (TEV), would be, for a water body, the value of the land occupied by the water body. In our hedonic pricing study, the average guideline value of the properties in proximity to the marsh was found to be, Rs.17200/ m^2. The total extent of the marshland, which is designated reserve forest area, is 695 ha and hence the value amounts to Rs. 11.9 $x10^{10}$.

This method of arriving at economic value may have a negative connotation as it should not lead to an inference that more land is available for real estate, as it is not true. The current marsh extent is almost only ten per cent of the original marsh outline. Data on government funds allocated for the restoration of the marshland was acquired from the forestry department. Table below (Table 3) gives the amounts allocated and spent from 2011 till 2020.

Table 3. Expenses towards the upkeep of the marsh

S.No.	Year	Funds received in $x10^5$ rupees	Funds spent in $x10^5$ rupees	Present value of funds spent (2021) in $x10^5$ rupees
1	2011-12	517	271	498
2	2012-13	404	185	319
3	2013-14	341	250	401
4	2014-15	113	113	170
5	2015-16	-	-	
6	2016-17	-	132	172
7	2018-19		417	511
8	2019-20	2030	1460*	836
	2020-21			781
Total present value of amount spent towards the marsh				3688

*Assuming half amount for each period

For estimating the aesthetic and environmental benefit derived from the Pallikaranai marsh, as reflected in property prices of residential areas around the marsh, the city zone has been earmarked as four zones. The zone nearest to the marsh has a property value of Rs.17200/ m^2 (Zone 1) followed by Zone 2 with a property value of Rs.17300/ m^2. Zone 3 exhibits a property value of Rs.10500/ m^2 and Zone 4 exhibits a property value of Rs.13900/ m^2. These results show that the plot prices are significantly higher in the zones in close proximity to the marsh. Refer Table 4 and Figure 4.

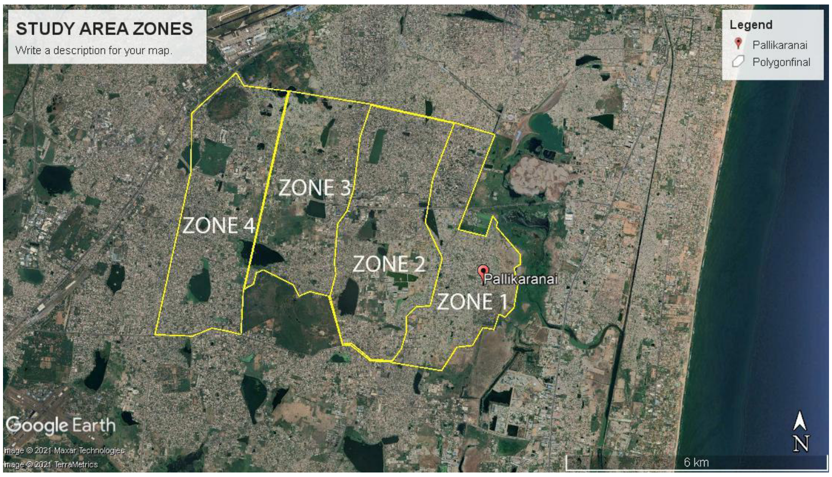

Figure 4. Study area zones

Table 4. Descriptive statistics zone wise

	Zone 1	Zone 2	Zone 3	Zone 4
No. of plots	50	38	21	21
Mean plot size (m^2)	191	214	223	227
Maximum plot size (m^2)	223	446	223	446
Minimum plot size (m^2)	112	112	223	112
Mean plot rate (Rs./ m^2)	17200	17300	10500	13900
Mean Amount (Rs.)	$37x10^5$	$33x10^5$	$23x10^5$	$32x10^5$
Mean distance from the marsh (m)	1000	3915	6130	7800

A one-way ANOVA test, which is generally used to compare means of three or more than three groups was performed between the zones of varying distances from the marsh (Table 5). A higher F-statistic shows that the samples were drawn from populations with different mean values. The respective F-values ($p<0.01$) show that the division of the study area west of the Pallikaranai marsh into four zones of varying average distances from the marsh is statistically correct.

Table 5. One-way ANOVA for division of study area into four zones

	Source	Sum of Squares SS	Mean Square MS	F-Stat	P-Value
Area of residential plots (m^2)	Between Groups	$24.8x10^3$	8260	3.72	0.0132
	Within Groups	$28x10^4$	2220		
	Total:	$30.4x10^4$			
Price of residential plots ($x10^5$ rupees)	Between Groups	$2.7x10^3$	913	4.25	0.0068
	Within Groups	$27.1x10^3$	215		
	Total:	$29.8x10^3$			
Rate of residential plots ($x10^5$ rupees /m^2)	Between Groups	0.09	0.03	9.7	0
	Within Groups	0.37	0.00		
	Total:	0.46			
Average distance from the marsh (km)	Between Groups	847	282	1034	0
	Within Groups	34.4	0.27		
	Total:	881			

Since this part of the city has grown in recent years, the evolution of plot prices (in $x10^5$ rupees) over the past two decades is also studied. This is an interesting aspect relevant to the study and the data is collected from the website of the land registration department of Tamilnadu. The data obtained was from 2002 till current date and a one way Anova test was performed to compare means and the results were found to be as follows (Table 6).

Table 6. One-way Anova for time periods

Groups	N	Mean	Std. Dev.	Std. Error
9/6/2017-current	130	0.16	0.06	0.01
1/4/2012-8/6/2017	130	0.23	0.09	0.01
1/8/2007-31/3/2012	130	0.08	0.06	0.01
1/4/2003-31/7/2007	130	0.02	0.01	0.00
1/4/2002-31/3/2003	130	0.02	0.01	0.00

F-statistic value=364.00563; P-Value=0

Source	Sum of Squares (SS)	Mean Square (MS)	F-Stat	P-Value

Between Groups	4.38	1.1	364	0
Within Groups	1.94	0.0		
Total	6.33			

An observation of the means shows that during the period 1/4/2012 to 8/6/2017, the average plot rate was highest, of a value of Rs.23200/ m^2 and has dipped to Rs. 15700/ m^2 in the period 9/6/2017 to present. The Anova shows that the sample means are from different populations.

The slopes in the regression lines, (Rate vs. distance and price vs. distance) shows distance from the marsh negatively correlates with prices. Other data on the governmental attention towards the marsh which consolidated in the period following 2012 and later stringent action on encroachments following 2017 may be attributed as the cause for the plot prices as per our investigations.

Srivathsan et.al., (Srivathsan et al., 2021) have discussed that, in Chennai, affordable housing is available mainly in the peripheries, especially in the south and west, and even in these areas, the value of land is as high as Rs.1000/- to Rs.2000/- per $ft.^2$ (or Rs. 10,800/- to Rs. 21,500/- per m^2). If this is to be considered a baseline, one reads that the study area has witnessed an escalation in recent times. The difference in mean rates of plots between Zones 1 & 2 is found to be Rs. -70/-, while the difference in mean rates of plots between Zones 2 & 3 is found to be Rs. 6830/- Therefore the magnitude of aesthetic benefit due to lake proximity is arrived at by taking the average of the two, which amounts to Rs.3390/ m^2.

According to Mendonca et al. (2020), property and land tax as well as public transport subsidies play an important role in spatial location, as they affect households' willingness to pay for housing further away or closer to the city centre. They have also studied that, in the city of Aveiro, Portugal, the presence of environmental amenities attracts the wealthy to find housing in close proximity to the amenities. Another study by Scholte (2016) discusses wetland communities' perception of ecosystem services and their relationship to attitudes to restoration. The study by Zhou et al. (2020) discusses methods of quantifying ecosystem services in the rural-urban fringe of Netherlands applying various studies and comparing with CVM results for the same. Hill (2014) and Wang (2018) have used hedonic pricing method in studies on market values affected by environmental externalities. The significance of hedonic pricing studies in this context is further demonstrated by Sylla (Sylla et al., 2019), and discussed by Mendelsohn and Eagle (2004). This reiterates the importance of the hedonic pricing study and it adds value to the economic valuation in our study. Field observations showed us that the regions in proximity to the water bodies have been developed with greenery in the roads and parks and have an attractive quality. The richness in biodiversity makes the marsh a valuable resource. Research has shown that the wetland possesses aquatic grass species (29 sp.), scrubs (18 sp.), climbers (8 sp.) and sedges (9 sp.). The wetland has a great many faunal species including 10 sp. of mammals, 21 sp. of reptiles, 115 sp. of birds, 46 sp. of fish, 10 sp. of amphibians, 7 sp. of butterflies, 5 sp. of crustaceans and 9 sp. of molluscs (Jose et al., 2016; Vencatesan, 2007).

Key-informant interviews revealed that lands bordering the marsh, which were originally belonging to agricultural land use, were converted into residential land use with the help of the development authority (CMDA) and the erstwhile agriculturists have sold those lands. A system of registration, believed to be legitimate and effective, is seen to have encouraged people to encroach on the water bodies and canals, as they were all able to obtain a 'patta' or ownership document for their land. Field observations and observation from Google Earth showed existence of unmetalled roadways very close to the marsh edge coupled with outlier constructions, here and there.

Also, it happens to be a flood-sensitive area that may only partly deter occupants from taking over, as seen from experience. On the eastern edge, many high-rise residential complexes share a border with the marsh, but for our study, we have limited to the western side, which comprises one and two storey residences, tenements and canals and water bodies.

CONCLUSION

Our studies have shown the impact of the water body on land value and hence on the population growth. Similar studies demonstrating in detail, the value of ecosystem benefits for recreation and aesthetics have been examined to draw parallels. The conservation of the wetland will boost the living conditions and ecosystem value and a cost benefit analysis has shown the parameters involved. Hence, this needs to be implemented by all stakeholders for the benefit of the community. Our studies have shown that awareness is present to a limited extent, especially among economically higher sections of the population. Economic justification is an added tool to support restoration and prevent further damage to the ecological potential of the region. This paper has quantified environmental values and their economical values for the purpose of generating plans and policies with a pro-environmental attitude for the benefit of living beings and other species. Maintaining water bodies is the only way to sustain biodiversity, which is very much called for, in a densely populated country like India.

Though this implies competition for land resources, effective planning and management can show the way for winning both ways, by practising sustainable development, and making it economically viable. Promoting biodiversity and protecting water bodies has longer-range positive impacts, which is often a neglected factor. Education and reworking our mistakes from traditional scientific conventions typically based on western philosophy may go a long way in achieving these goals.

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