Association of Wetland Size Versus Ecological Scenarios and Ecosystem Services With in the Agroclimatic Zone (Namakkal District), Tamilnadu

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Abstract

Stagnant wetlands have a vast natural ecosystem of different sizes, provide vital ecosystem services to humans, but are not well detailed. The study investigates the association of the Stagnant wetland's size versus the ecological condition (EC), ecosystem service (ES), and their Shifts in land use / land cover (LULC) in the Agro-climatic a location of Namakkal district. Twenty-one chosen wetlands are hydrologically isolated, few semi-parched in summer, surveyed by the range of methods. The Wetland sizes had categorized into small wetlands (SW), medium wetlands (MW), and large wetlands (LW) which, are less than 10 acres, 11 to 100, and above 100 acres, respectively. Our results showed that ES of entire wetlands degraded by human anthropogenic activities and degradation factors differ in the wetland kinds. Also, ecosystem services such as livestock rearing and agronomy are vital income sources. Overall, the hypothesis results show that wetland size is not associated with ecological status and ecosystem services. However, the LULC changes had analyzed from 2010 to 2019. The data corroborate that the increase in constructing the property and extensive changes in agricultural areas are a deep concern for wetland size reduction. Finally, wetlands conservation activities priorities given to are wetlands size-based seems not the best practice.

I. Introduction

Wetlands are highly efficient and diverse flora and fauna systems (Keddy et al. 2009). Water bodies and associated wetlands perform critical ecological roles including wildlife habitat, water reuse, carbon sequestration, and water balance (Gibbs 2000; Kayranli et al. 2010), and additional ecological processes (ESS) that impact society, like as flood risk assessment, fishing, water agriculture, and amusement (Mitsch and Gosselink 2000, Bassi et al. 2014, Keddy 2016). Wetlands continue a supply of substance for neighboring residents, particularly in developing nations, and had extremely numerous classical cultures esteem (Keddy 2010, Maltby and Acreman 2011, and Gopal 2013). Wetland demise has accelerated that since the 18th century, but is now 3 times greater than forest destruction (Davidson 2014). Over last 150 years, human changes impacted or diminished more than half of the world's wetlands (Sica et al. 2016), and more than half of a planet's waterbodies were managed to lose (Davidson 2018). Ultimately, 1052 spots in Europe, 289 in Asia, 359 in Africa, 175 in South America, 211 in North America, and 79 in Oceania have been designated as Ramsar sites or Internationally Significant Wetlands (Ramsar Secretariat 2013). The latest evaluation conducted in the Ramsar Convention on Wetlands, the world has lost 64% of its wetlands since 1900. (RAMSAR 2015). Long-term failure of healthy wetlands average values among 54% and 57%, with some regions losing up to 90% (Junk et al. 2013). Wetlands in India, elsewhere in, are likely to intensify from a variety of anthropogenic stresses (Pratyashi Phukan and Ranjan Saikia 2014).In India, wetlands are 757.06 thousand wetlands comprise of wetlands cover 15.3 million hectares, compensating for 4.7% of the total land mass. Inland wetlands relate 69 percent, shoreline wetlands contribute 27 percent, and other wetlands (> 2.25 ha) contribute 4 percent (SAC, 2011).The hydrologic cycle of an area can determine the type of wetland that is present. A certain change in water content, whether it goes up or down, or the timescale of lower and higher waters, endangers wetland portion and integrity (Brinson and Malvarez 2002). Beginning at least 20 years ago, concerns about cumulative reductions in ecosystem services might result from shifts in wetland size distributions at landscape scales (Leibowitz et al. 1992). Many small wetlands continued to owing their tiny dimensions and temporary water quality (Russell et al. 2002). Increased understanding of the role served by small wetlands (Semlitsch and Bodie 1998) has raised concerns that size was not a factor for appropriate condition upon which to start difficult outcomes. The wetlands were created by relations climate, geology, biology, chemistry, and human induced provokes (Machtinger 2007). The key reason for disturbing the wetlands like anthropogenic activities (Vorosmarty et al. 2010, Clark et al. 2014). Regulations that failed to sufficiently protect smaller wetlands increased the use of mitigation banks that replace losses of many small wetlands with created or restored wetlands that are fewer, larger, and at locations distant from where the damages occurred (Adamus Paul 2013). While dropping wetland regions poses the utmost clear menace, altering wetland connectivity also influences countryside roles, and people have changed the scale of connectivity (Pringle 2003). Specific wetland surveys have been critical in improving our knowledge of core wetland features (Perry et al. 2004; Drexler and Bedford 2002). Not all wetlands supply whole Ecosystem Services at all times. Various wetlands offer a series of amenities under their kind, size, and position. In ND, some of 190 wetlands were available in diverse sizes but, few studies have investigated the wetland size influence the key ecological states and the ecosystem delivery. Also, the public's belief of water governance remains poorly studied. The Specific objectives include such as

1. To examine the ecological state of stagnant wetlands in relation to human impact.

2. Identifying the wetland size association against the Ecological condition (EC) and Ecosystem Services (ES) from from different wetland categories.

3. To evaluate the LULC changes over the periods in the Agroclimatic zones in the Namakkal district.

I I. Materials And Methods

STUDY AREA: NAMAKKAL DISTRICT

Namakkal district is called Transport city or Egg city in (N; 11.36, 78.30 East) the state of Tamil Nadu, India. (Fig. 1.A.and B). On July 25, 1996, the area was separated from Salem District, with Namakkal as its main office functioning independently from 01 to 01-1997. The district has two Revenue Divisions, Namakkal and Tiruchengode, and has 7 Taluks viz., Namakkal, Tiruchengode, Kumarapalayam, Rasipuram, Paramathi Velur, Kolli Hills, and Sendamangalam. Namakkal district had bounded by Salem district on the North; Karur in the South; Perambalur, Tiruchirappalli District, Salem District on the East and Erode region on the West. Namakkal District is located in Tamil Nadu's North-Western Agro-climatic Region. It is located on the border of two waterways, the Cauvery and the Vellar. On the east are the Taluks of Attur, Rasipuram, and Namakkal, and on the west are the Taluks of Salem, Omalur, and Mettur. Tiruchengode taluk is the only one in the Western Agro-climatic zone. Aside from the above two zones, Kolli or a few secluded mountains and grooves dispersed across Namakkal, Sendamangalam, Rasipuram, and Tiruchengode, together with canyons and green fields, constitute the locality's distinctive topography. 3429,671 hectares of the geographical area had divided into four taluks, namely Namakkal, Paramathi, Tiruchengode, and Rasipuram. Namakkal is the district headquarters, has the most extensive coverage of 1767 75 sq. km. The Namakkal District has 3,363 areas (sq. km) in the total area with a 14.96 lakhs population. Namakkal Area has centrist rain and a great natural forests. The total forest land in this area is 512.5 square kilometres, accounting for approximately 15% of the geography. Full Reserve Forests, Reserve land areas in Namakkal District totaling 51245.065 hectares on under regulation of the District Forest Officer, including 3413 sq.km of very dense forest area, 48 Sq.km of moderately dense forest, 217 sq.km of open forest, 247 Sq.km of total forest cover, and 512.5 Sq.km of Shared Forest Area.The climate conditions of the district are hot and dry during summer (from March to May), winter is cold and misty (November to February). The Normal Rainfall of the District is 900 mm. Temperature ranges from a Maximum of 40’C and minimum of 18’C. Paddy, Sorghum, Groundnut, Green gram, Black gram, maize, cotton, and sugarcane crops had been cultivated in the Namakkal district (Fig.1 and 2).

SATELLITE IMAGES

Landsat imagery files are produced using the Mapitute software at Version 20. During the 18/11/2020, data were acquired quality and clearness (just under 20% cloud contain). Further, India Vavteq2012 have used better sampling.The ratio for the mapping is Ratio 1:1,313,972.

B. METHODS

The wetland poll and series of questions analyzes were held out in the culture prevailing inside one 1 km radius of each wetland from June 2019 to April 2020. The Wetland sizes are categorized into small wetlands (SW), medium wetlands (MW), and large wetlands (LW) which are less than 10 acres, 11 to 100, and above 100 acres respectively. Water samples were gathered among all wetlands and stored in polyethylene vials were examined using the consistent way (APHA, 1985).

HUMAN DISTRUBANCE SCORE

A number of methodologies (interviews, ecosystem services (ES), human disturbance (HD), and physical parameters) were used to calculate the wetland's ecological and biological state. Wetlands are further classified as having a low, medium, or high impact on human disturbance. Water quality is concerned with the physical characteristics of water and the ecological state of wetlands. The Human disturbance score (HDS) protocol approach was used to assess the level of human disturbance to the wetlands (Gernes and Helgen, 2002). Using relevant information with the first cluster interview sessions, benefits produced in each wetland or the ecological services (ES) were secured and tested. A field survey was carried out to investigate the ground impact of wetlands. Ecosystem Services, and the physical state of the wetlands. The collected data included several quantitative criteria to calculate the human perturbation element.

Factor 1: Critical zone-Disturbance within 50 metres of the wetlands -0-18 points

Factor 2: Buffer Zone-Disturbance within 500 metres of the wetlands' margin- 0-18 points

Factor 3: Habitat Alteration-Disturbance within 50 metres of the wetlands' edge- 0-18 points

Factor 4: Hydrological Change-Disturbance within 50 metres of the margin of wetlands-0-21 points

Factor 5: Pollution of Chemical disruption within 50 metres of the margin of wetlands-0-21 points

Factor 6: The presence or absence of fish yields a score of 0-4 points.

The standard enumeration method was used to collect information on wetland types, hydrological conditions, land use patterns, ecological state, and habitat evaluation. Finally, each component was rated and classified (ranked) into one of four categories ranging from best to worst, as previously indicated. Each study wetland's human disturbance gradient score (HDS) was calculated by adding all scored values from each element to a total of 100 percent. According to (Gernes and Helgen, 2002), if the category range of a specific wetland's HDS score falls within 0-33, 33-67, and 67-100. It can be categorised as least impacted, somewhat influenced, and most or strongly impacted. Respondents were asked to assign a value to the ES stated for each wetland based on relative relevance, namely socioeconomic variables, wetland importance, and management elements.

WETLAND ECOSYSTEM SERVICE

Household Survey

The ES derived from the wetlands is classified into Wetland provisioning services (WPS), wetland regulating services (WRS), cultural services (CS), and supporting services (SS). ES got from the native peoples by using questionnaire survey methods and field survey observations. In each wetland, a minimum of five household surveys (HHS) were randomly selected from the nearby area. 225 individuals took part in this study. A questionnaire comprising twenty questions structured into four sections: 1) the socioeconomic features were residential size, participant age, defendant tier of formal qualifications, and identity.2) The questionnaire made up a list of provisioning ESS derived from wetlands. 3) Perceptions of wetland conservation. 4) Last, a primary income source from households near wetlands. The questions was pre-tested and then prescribed one on one to 225 respondents. Initial, rapid assessment of the wetland survey was carried out in 2 villages that were not a component of the certain sample. Pre-testing approved the interviewers to increase knowledge with the questionnaire and offer a chance to apply and check the method. The attention was on measuring how respondents assumed our inquiries and pinpointing any complications met in providing solutions. In our final questionnaire stages, the changes were offered, revised, and integrated. Using the structured questionnaire, 225 In such communities, wetland-dependent families were polled. Try to cover all the questions raised by the researcher and clarified by its most senior member obtainable in the survey conducted. Most of the respondents were age ranges between 32 and 65 years old, and 58% were female, 42% were male. The questionnaire fixed on the ecosystem services used, the person’s need for them, alter drivers, and the effects on ecosystem services

Focus Group Discussion (FGDs)

During group discussion, the list of ES obtained from the household survey was validated. Five focus group discussions (FGD) were held at the local levels, with an average of 5-10 respondents for each set over the survey term. The focus group crew being chosen determined their survival planning and reliance on the wetland. To evade a few of the known concerns with focus discussion groups, we maintained the range of groups of 5–10 people, and they outlined ES graded during group discussions.

Key Informant Interviews

Before the survey, representatives from government agencies, non-governmental organisations, research institutes, and researchers were contacted for a list of the wetland's ecological services. During the interviews, the major questions concentrated on income-generating tactics and the causes of alteration in the wetland ecosystem. During the study, 15 delegates from various organisations were engaged, as key informants to assist us comprehend the arrays of variation and the causes for them. The crucial informants were chosen based on their understanding of wetland resources as well as their reliance on and engagement in wetland management.

2.3. Data Analysis

The statistical data were assessed to use regularity table and the Statistical Set (SPSS 25th Edition) for Social Sciences computer software tool, and the Shannon index approach was used to quantify avian diversity. Assess the dependency of a local population and the consequences of various influences on the wetland environment. Based on the study topics, the qualitative information from interviews was first classified and grouped into topics.; related coded themes were then grouped. The rating of ecological services was carried by utilising participative tools. Participants in focus group talks requested that essential ecosystems available from wetlands be identified. Following the listing of key ecosystem services, Scale of 1 to 10, participants rated the designated ecosystem services. (1 is the least preferred, and 10 is the most preferred).The overall ranking was calculated by dividing the total points for each ecological service by the digit of responders. Equally, the reasons of Qualitative approach were used to expose ecosystem transition (focus group talks) as well as household surveys.

LAND COVER AND LAND UTILIZATION

The study used ArcGIS to appraise variability in LULC classes in the Namakkal District. Satellite image imagery (TM, ETM+, OLIS/TIRS) obtained from the U.s. Geological Survey (usgs (USGS, https://www.usgs.gov/) was used for data gathering, image recognition, and period classification data of LULC in the study region. Landsat 5 thematic mapper (TM) images containing six bands for 2001with the pixel resolution of 30-120meter, Landsat 7improved thematic mapper (TM) for 2010 with resolution of 30 meters and 60 meters, and Landsat 8 in OLI operation land image with 9 spectral bands under resolving 114X 112 millimeter were gained from United States Geological Survey (UGGS) and map created by using ArcGIS software. All of the photos were taken between 2010 and 2019 and were cloud-free. The level 1 brands were originally assumed geographically at UTM zone 37N WGS84. The images were combined and separated in ArcGIS 10.4 using the study site boundary shapefile. Later image advancements (typical false-color layout and variance stretch) yielded enough training polygons to classify LULC types using ArcGIS 10.4's training model manager (Lillesand et al. 2015). Using the Random Forest image classification algorithm, the five images were grouped into six land-use categories (water bodies, paddy cultivated, vegetation, built-up area, and forest land). Breiman (2001) proposed Random Forest, which has grown in popularity among professionals. This is due to the fact that it is more powerful than outdated image grouping algorithms and provides high precision when using deranged and small training set (Jin et al. 2018). The level of transition in distinctive LULC over period was tested using percentage difference (PC, Eq. 1) (Fenta et al. 2017; Berihun et al. 2019) and transition matrix models (Gashaw et al. 2017; Berihun et al. 2019).

$PC=Ub-Ua/ Ua$

Where PC= LULC rate of changes, Ua= area of start date LULC type, and Ub= area of end-date LULC type.

A land-use redefinition was used to show how the motion and region of various LULC types change and evolve. This was accomplished using the pass and overlap transition in ArcGIS 10.4 software. The attribute charts obtained from these evaluations were exported to Microsoft Excel in computing area change and percentage of change over time. The output map accuracy was confirmed by execution classification accuracy assessment (Kappa coefficient and overall accuracy) using field GPS data, aerial pictures, group debate, key informer meetings, and reference imageries (Congalton, 1991). The LULC categories of Namakkal district and their descriptions such as agricultural land (Including crops, vegetables, fruits, irrigated land), Barren land (all Barren lands) Built-up area (Including all residential, commercial, roads.), Cultivated land (Including all kinds of cultivation.), Water Body (Including all water bodies (river, lakes, stream, canals, and reservoirs). In 2019, obtained through interviews, field observations, and Google Earth were used to pattern and permit the image. In the specialty, nearly 50 to 60 ground truth positions were collected, and Google Earth-Pro pictures were created for every LULC type (Lillesand et al. 2015). Finally, the classified images of the five LULC classes, namely water bodies, cultivated land, agricultural areas, Barren land, and built-up areas with the help of Arcmap application software. All images covered the area of the Namakkal district. The range of study areas was separated by raster images by the spatial analytical tool in the ArcGIS mask extraction method. Three LULC maps and the distribution area information are presented in Fig 2.

LULC accuracy assessment

The marked results are compared with the standard datasets, which are believed accurate when defining a categorization, for evaluation. Numerous techniques are used to evaluate the accuracy of remote-sensed data and the user (Aronica and Lanza 2005). Modify accuracy of LULC is influenced by topics such as sensor component issues and data pre-processing practices to use with standard situations during camera calibration (Morisette and Khorram 2000). In an error matrix, three distinct metrics are used in accuracy processing and analysis on the error of omission or commission: user's accuracy, producer's accuracy, and overall accuracy (Coppin and Bauer 1996; Carlotto 2009). The Kappa coefficient, which is used to quantify the classification accuracy necessary for all fundamentals, is an additional unit of measure in the image supervised classification (Coppin and Bauer 1996; Foody 2010). In the present study, 40 samples were identified for evaluation from 2010 to 2019. We used a stratified sampling, collecting at least ten ground truth data points from the field for each LULC class using the GIS ArcMap software. The proportion of accuracy rate of each attribute is computed using Formula 1.

Overall accuracy = Total Number of Correct pixels/Total Number of Pixels X 100 (1)

TABLE 1. THE LULC CATEGORIES OF NAMAKKAL DISTRICT AND THEIR DESCRIPTIONS

Class name	Description
Agricultural land	Including crops, vegetables, fruits, irrigated land
Barren land	Including all barren lands
Built-up area	Including all residential, commercial, roads
Cultivated land	Including all kinds of cultivation
Water Body	Including all water bodies (river, lakes, stream, canals, and reservoirs)

I I I. Results

In ND, out of 21 wetlands, each category 7, wetlands had selected for this study (Supplementary file, Fig 1.A, 1 B). These selected wetlands are based on easy convenience and availability. Most of the wetlands in different habitats and altitude range below 780 feet. Also, three wetlands like the Paruthipalli Lake, Oomayaampatti, and Sambur lake were the biggest.

a. Physical characteristics of wetlands in the Namakkal district

The wetland physical characteristics are categorized into seven parameters for a improved comprehension of wetlands in ND. In the entire region, the temperature range from 23° C to 29°. In ND, There are physiological differences between the wetlands systems of wetlands that were noted (Supplementary file). Overall 18wetlands, (86%) wetlands were green and 13.3% were colourless. The LSW had occupied the Group 3 areas such as lake Paruthipalli, Oomayaampatti, Sambur lake, and Nathamedu lake wetlands and, the overall The size distribution and texture of each district wetland had been listed in (Table 1). According with RAMSAR type, the ND wetlands had classified into Lacustrine, Palustrine, and Riverine kinds. In this district, Riverine wetlands, that include two wetlands, become less prevalent (10%), five wetlands (24%) were Palustrine type, and the remaining fourteen wetlands were (66%) belong to the Lacustrine type were the dominant form of wetlands. The notable largest wetlands are Paruthipalli lake, Oomayaampatti lake, Sambur lake and Nathamedu lake, Irupuli lake, Koneripatti lake, and Vettambadi lake. Based on the depth of wetlands, 33% of the wetlands have a depth of fewer than ten feet, 33% of the wetlands were 11-20 feet depth, and the remaining 33% of wetlands were above 20 feet such as Parapatti Lake, Mathiyampatti lake, Akkarapatti lake, and Sambur lake. Rainfall and river steam were the primary sources of water for the wetlands. Also, 47% of the total wetlands get water from the rivers, 53% of the wetlands depend on rainfall. During the study period, the wetland dryness during summer had recorded. Overall 62% of the wetlands were stagnant water, 29% partially dried, and the remaining 9% of the wetlands were semi-dried out during summer.

b. Water quality of Wetlands in the ND district.

Few deviations in temperature and pH ranges (6.67 to 7.17) between the different wetlands had been observed. The wetland’s average values were mentioned in Table 2. The water quality parameters revealed that the wetlands in ND were within the WHO (or APHA) standard level (Table 1).

TABLE 1

AVERAGE MEAN WATER QUALITY OF NAMAKKAL AREA WETLANDS

	Small Wetland	SE	Medium Wetland	SE	Big Wetland	SE
Temperature(C°)	26.57±2.44	0.922	26.14±1.46	0.553	27.43±1.98	0.751
Turbidity (NTU)	9.24±1.88	0.713	8.01±2.73	1.035	9.16±2.31	0.874
Ph(Ph meter)	7.08±0.24	0.094	6.67±0.70	0.265	7.17±0.63	0.242
Electrical conductivity(μS/cm)	207.29±46.29	17.498	275.86±145.59	55.029	365.43±293.12	110.791
Total solids(Mg/l)	1982.71±164.07	62.013	1843.86±101.58	38.394	1927.14±195.62	73.938
BOD((Mg/l)	22.071±10.80	4.083	17.16±10.09	3.814	17.34±13.43	5.076
DO(Mg/l)	4.87±1.46	0.555	3.93±0.63	0.24	4.66±1.18	0.447
Average area (Acres)	4.57±2.29	0.869	54.57±15.85	5.991	180.86±76.51	28.921
Average depth (feet)	3.71±0.49	1.322	25.57±9.14	3.456	14.0±.5.59	2.116
Altitude(meter)	658.43±60.51	22.87	708.57±19.40	7.33	613.80±241.26	91.18

c. Ecological status of wetlands in the Namakkal district:

Buffer landscape (from the edge to 50 meters) was deterioted most in the MSW, especially adverse the Infrastructure development (building construction either as commercial or housing). Wetland pollution caused by sewage disposal and waste dumping such as degradable, nondegradable, and both mixed waste (n=5, AM: 4.29, SD: 2.92) noted. Meanwhile, the SSW (n=5, AM: 4.29, SD: 2.92) was protected by shoreline protection but MSW was less protected in ND. Cattle grazing was observed in many wetlands and equally shared (n=7, AM: 6.0, SD: 0.0). Sewage disposal was utmost in the MSW (n=3, AM: 2.57, SD: 2.92). Dumping debris nearby the wetland habitat was recorded in the ND (n=5), Ave Mean 4.29, Std Dev 2.92). Infrastructure development maximum in the small and large size wetlands (n=7, AM: 9.43, SD: 1.21) and wildlife habitat degraded in MSW wetlands were utmost in ND. (n=5, AM: 4.29, SD: 2.92). Tree cutting was not noted in any wetlands in ND. The buffer zone landscape disturbance showed that the highest degraded in MSW followed by SSW and LSW. In the ND, the wetlands buffer strip was altered by anthropogenic activities within 10 meters by farming or infrastructure activities (Google pro satellite image analysis). All three types of wetlands have shoreline protection itself and lack fencing around the wetlands. In SSW, especially the Kamalalaya pond was surrounded by infrastructure activities. Sullipalayam lake lack water most of the time and facing a severe water shortage nowadays. Medium size wetlands, especially Akkarapatti and Kottapalayam lake were facing water shortages because of a lack of management activities. Large size wetlands, except for the Sambur and Irupuli lake the remaining lake face severe water shortages because of the anthropogenic activities, and Koneripatti, Oomayampatti, and Vettampatti lake face both agricultural and Infrastructure activities.

The graph represented that the changes in the Buffer zone and landform modification of the ND. The results recorded that landscape alteration was higher when compared with buffer zone alterations degradation (Fig. 2). Overall degradation, such as infrastructure development as construction of buildings and roads, wetland protection, cattle grazing, and pollution are a serious concern for both buffer zone and landscape degradation. Landscape disturbance (from the edge to 500 meters) degraded in the highest at MSW despite infrastructure development (n=10, Ave Mean: 4.0, Std Deviation: 2.92). The infrastructure development despite establishing a residential or business structure or road constructions was present in the ND wetlands and the highest amount indicated in the SSW (n=7), (Ave Mean: 2.8, Std Dev: 3.09) wetlands. Protection-wise, the entire district in the landscape zone was no protection, and utmost noted in the SSW (n=15), Ave.Mean: 6.0, Std Dev: 0.0). Cattle pasture was widespread in the landscape zone for entire wetlands. The sewage disposal is maximum in the MSW. Dumping debris was a common mode of degradation to the wetlands in ND. Tree cutting wasn't noted in any district, even in the landscape habitat. Overall, landscape disturbance showed the highest degradation in the MSW. Wetland habitat modification was critical in the MSW (10.0). In the MSW (n=13), Ave Mean: 5.2, Std Dev: 2.1), most of the cctions such as office buildings either in privately or public around wetland areas. Fish catching by boat in the MSW is causing the greatest habitat modification. Developments of roads either, single or two roads were nearby, the wetland habitat showed that almost all the districts and maximum in the LSW. Most of the wetlands were schools and colleges nearby the wetlands had recorded. Livestock grazing, dumping of debris around the wetlands was common in many wetlands. The algae presence in the wetlands showed utmost in the MSW (n=6, AM: 2.40, SD: 1.5) and followed SSW and LSW. Overall, Habitat alteration of disturbance showed that utmost, in the MSW followed by Small and LSW noted.

The hydrology alteration was utmost in the MSW followed by large-sized and SSW in the ND. Hydrology disturbance like water withdrawal in almost as many wetlands because of water scarcity during summer (n=14), Ave Mean: 6.5, SD: 1.80). Water flooding had recorded in all and highest in the MSW (N=15), Ave Mean: 7.0, Std Dev 1.20). The discharge of sewage (n=4), Ave Mean=1.87, Std Dev 3.20) was utmost in the MSW. Garbage dumping nearby wetlands had been noted and, many wetlands (n=4, AM1.87) lead to a vital alarm in most of the wetlands in the ND. We also check the correlation of the inundation of the water level with the wetlands area size. In SSW wetlands, out of the seven wetlands, the inundation of the last 1o years (Mean (M) = 3.29, Standard Deviation (SD) =3.30), and the area sizes (M=4.57, SD=2.30). The Pearsons, r data analysis revealed a positive correlation r=.30. The inundation of wetlands water level has correlated with the SSW in the ND. In MSW wetlands, out of the seven wetlands, the inundation of the last 1o years (M = 7.57, SD=181), and the area sizes (M=54.57, SD=15.85). Pearsons r data analysis revealed a negative correlation r=-.06. The inundation of wetlands water level has not correlated with the MSW in the ND. In LSW wetlands, out of the seven wetlands, the inundation of the last 1o years (M= 2.14, SD =2.11), and the area sizes (M=180.85, SD=76.51). Pearsons r data analysis revealed a negative correlation r=-.09. The inundation of wetlands water level has not correlated with the LSW in the ND. Overall, the Pollutant disruption caused by chemicals was utmost (11.6) in the MSW. Household wastes, Municipal solid waste discard, wreckage demolition, and sewer discharge were general modes of pollution in the wetlands in the ND (Fig.6 B). Some wetlands have water odors had recorded in MSW and LSW. Watercolor changes are utmost recorded in (5.1) the MSW. Washing of vehicles nearby the wetlands is a vital concern, especially in the MSW. The data showed chemical pollutants were highest in the MSW, followed by SSW. Waterbirds are a key ,they are an essential element with most wetland ecosystems because they take up numerous lineages in the wetland food chain. The current research identifies 22 bird species around the wetland area. In ND, by using the Shannon Weiner index (H), results high in the MSW (1.317) followed by SSW (1.254), and LSW (1.019) were observed and have recorded no mammal species during the study period.

All of the HDS outcomes fell within the Effective range of (0 -100). All three types of wetlands were under the MI score, but the score level was different between wetlands. In Mid impact (MI), caused by habitat alteration disturbance, and utmost scores had registered in the medium wetlands (63). In larger wetlands, HDS scores (51) had been recorded, caused because of hydrology alteration. The small wetlands HDS scores were (44) caused by the landscape and habitat alteration. Overall, the HDS scores were high in the Medium wetlands, followed by larger wetlands and small wetlands in the ND. ANOVA table (test using alpha=0.05) had observed that $F (1,3) =.730$, $P<.674$, $R2=.687$. The alternative hypothesis revealed that some differences between the samples of the three wetland ecosystem services. The alternate hypothesis accepted the wetland size does not influence the Ecosystem service. All three wetlands were not significant. The P values such as small wetlands (p=.576), MSW (p=.269), and the Large wetland (p=-.616) had noted. Overall, the ANOVA tables mentioned that the size of the wetlands wasn't affected by the wetland impact system (Fig.3).

The Land use Lanc cover (LULC) maps of the Namakkal district produced for two reference years (2010 and 2019) are presented in Fig. 5. Overall the classified area of the Namakkal district was divided into 5 key classes as water bodies, rivers and inland ponds, cultivated lands, agricultural areas, Barren land, and built-up areas. Three land cover maps, distribution area, and class percentage information are presented in Fig.4 and Table 2, respectively.

The Agricultural land areas are dominant in all the years but, gradual reduction of area size (In 2010 comprises 43% and 2019 19%) followed by a gradual increase of built-up areas, especially after 2010. A few changes in the forest land areas were observed. The significant changes in land cultivation and continuous size reduction of water bodies in recent years were observed in the LULC map.

Table 2

Wetland distribution area in the Namakkal District (unit: Square miles)

Class	**Sum of area Us acre**	2010 percent	**Sum of area Us acre**	2019 Percentage
Agricultural land	367782.72	43.74	166401.84	19.76
Barren land	25982.49	3.09	2417.93	0.28
Builtup land	144531.14	17.18	413127.99	49.06
Cultivated land	298142.60	35.45	254499.16	30.22
Waterbodies	4397.67	0.52	5509.90	0.65
Grand Total	**840836.61**	100	**841956.81**	100

The landscape type 2001 was considered a basic map. The two-period wetlands landscape raster maps were overlapped, and intersect maps properties were separated using ArcGIS software 10.7.1. The classification of the area type and transition matrix of the initial state (Table 3) were received from the 2010 to 2019 period were used as the initial transition matrix was calculated and for mapping and calculation using maximum livelihood type.

Table 3

Wetland type area transition matrix from 2010 to 2019 (Square miles)

Land class 2001		**Land class 2019 (SQ.MILE)**					
Row Labels	**Sum of area**	**Agricultural land**	**Barren land**	**Builtup land**	**Cultivated land**	**Waterbodies**	**Grand Total**
Agricultural land	1.156951	41157.33179	1.408421	2324381.32668	13748.15828	124.52873	2379412.4673
Barren land	654.98944	195903.60201	1.380364	1744089.08750	4556.82968	4.555858	1944553.3282
Builtup land	495029.29951	201879.69122	1.730716	4826585.86350	93460.27459	141.49455	5122069.8454
Cultivated land	17350311.30863	61536.18982	3.046937	3759654.32472	116465.0134	55.934609	3937701.4741
Waterbodies	241.894095	0.34009878	0.010086	55543.11211	64008.40194	93.048533	119644.9507
Grand Total	**29415733.49157**	**500477.20096**	**7.576527**	**12710251.3979**	**292238.7932**	**419.56229**	**13503382.4520**

The transition probability evaluation illustrates the change from one type of LULC to the next. The gradual proportion of transition occurred among all classes in Namakkal District. The transition matrix from 2010 to 2019 showed that decreasing ground for agribusiness, cultivation land, sources of water together with rivers, and barren land and increasing in the built-up areas all over the district. Percentage-wise changes and overall details are mentioned in Table 5 and Fig5.b. The accuracy level of the LULC map, including overall accuracy, producer's and user's accuracy, is mentioned in Table 5. Also, calculated the Kappa accuracy by using the formula. **In producers accuracy and Users accuracy were 100 % except for Builtup land (72.7%). The overall accuracy showed that in 2011(95%), and 2019(87%) were noted. The Kappa accuracy in 2010** (0.937) and in 2019 was 0.69 recorded.

Ecosystem service in the Agro-climatic zones seems a major income source for households in the Namakkal district wetlands by questionnaire survey. 168 respondents completed the questionnaire survey. The average respondent's age was 51 years, 59% were female, 41% were male, and most of the respondents lived in the wetland habitat. Seven aspects of income sources received from the wetlands like crop cultivation, horticulture, fish fishing, livestock rearing, spiritual services, fodder grass, and tourism income. According to this survey, the income source from the respondents showed that the utmost income from the MSW, followed by larger wetlands and small wetlands.

TABLE 4

ECOSYSTEM SERVICES AND PROVISIONING SERVICES OBSERVED BASED ON QUESTIONARY SURVEY IN THE NAMAKKAL DISTRICT.

	Small	%	Medium	%	Large	%	Total N	Total %
PROVISIONAL SERVICE Crops	40	71.42	55	98.21	56	100	151	89.88
Vegetables	24	42.85	56	100	47	83.92	127	75.60
Fruits	7	12.5	34	60.71	31	55.35	72	42.86
Fishing	8	14.28	56	100	32	57.14	96	57.14
Livestock Drinking	56	100	56	100	55	98.21	167	99.40
Human Drink	6	10.71	0	0	0	0	6	3.57
Domestic Use	8	0	23	41.071	0	0	31	18.45
Irrigation	37	66.07	49	87.5	53	94.64	139	82.74
Fodder Grasses	12	21.42	31	55.35	33	100	76	45.24
Seedlings	7	12.5	6	10.71	4	7.14	17	10.12
Medicinal Plant	3	5.357	16	28.57	5	8.92	24	14.29
REGULATING SERVICES Microclimatic	8	14.28	6	10.71	0	0	14	8.33
Check Erosion	16	28.57	3	5.35	7	12.5	26	15.48
Flood Migration	9	16.07	24	42.85	32	57.14	65	38.69
Water Purification	13	23.21	14	25.00	8	14.28	35	20.83
Water Regulation	12	21.42	33	58.92	41	73.21	86	51.19
Sediment	0	0	13	23.21	0	0	13	7.74
CULTURAL SERVICES Recreational Value	17	30.35	48	85.71	19	33.92	84	50.00
Educational And Awarness	5	8.92	0	0	0	0	5	2.98
Spiritual Service	24	42.85	32	57.14	8	14.28	64	38.10
SUPPORTING SERVICES Biodiversity	37	66.07	55	98.21	55	98.21	147	87.50
Pollination	3	5.35	2	3.57	8	14.28	13	7.74

Ecosystem services were evaluated and classified as procurement, cultural, governing, and aiding. Data from household survey and cohesive strategies of site investigation were judged based on ES (Table 4, Fig 3). In SSW, the income source of wetlands by livestock rearing contains (100%) followed by farming practice comprises (71.42%). Farmers cultivated species like Sorghum, maize, paddy, green gram, cotton. In cultural medication (42.85%), tourism (28.57), foddering comprise (14.28%) and fish farming (14.28%) by rearing fish species such as Catlacatla, rogue, red tilapia, catfish species had recorded (Table 3, Fig 5 and 6. C). In medium wetlands, income by farming practice comprises (100%) such as Sorghum, maize, paddy, green gram, cotton, and fish farming (100%) by rearing species such as (Catlacatla, rogue, red tilapia, catfish) and livestock grazing (85.71%). Tourism, Cultural medication (57.14%), and foddering (28.57%) had observed. In LSW, income source by Farming practice (100%) and cultivated Sorghum, maize, paddy, green gram, cotton, and groundnut. In livestock (75%), fish farming such as Catlacatla, rogue, red tilapia, catfish species contains (57.14%), fodder and tourism (28.57), and cultural medication recorded. Overall in the ND, wetlands provided Farming crops (Sorghum, maize, paddy, green gram, cotton, groundnut), vegetables (Tapioca, onion, tomato, Bhendi, Brinjal), Fruit cultivation (Mango, Banana, Jack fruit, Pineapple, Guava, Papaya Coconut) had a dominant source of income to the farmers. After farming, followed by livestock cattle grazing, fish farming such as Catlacatla, rogue, red tilapia, catfish species contain (100%) had been observed. Regulating services such as wetlands provide water regulation (51.19%) followed by Flood Migration (38.69%) in the big wetlands. Water purification showed that more or less the same in many wetlands. Control of Runoff, erosion regulation, sediment all had recorded in a few percentages in the ND. Cultural services as Recreational activities (50%) followed by Spiritual (38.10) Educational and research (2.98%) and activities maximum in the medium wetlands. Supporting services such as Biodiversity (87.50%) in many wetlands and Pollination dominated in (7.74%) in Large size wetlands had recorded.

The ANOVA table (test using alpha=0.05) had observed that F (3, 19) =1.148, P<.355, R2=.153. The alternative hypothesis clearly showed that some differences between the wetlands ecosystem services of three wetlands noted in ND. However, the alternate hypothesis accepted the wetland size does not influence the Ecosystem service. All three wetlands were not significant. The p values, such as SSW (p= -2.047), MSW (p=.638), and the LSW (p= -1.417) were noted. Overall the ANOVA tables, the size in not influence the Ecosystem service, but similarities in the wetland protection values were observed (Fig.5).

I V. Discussion

The physical characteristics of the wetlands had categorized into seven parameters for a better understanding of wetlands. In ND, physically, there are differences among the wetlands structures had noted. For all three wetland kinds, the temperature range from 23° C to 29° according to season. In ND wetlands, the maximum temperature had noticed because the unique nature of the wetland location in during summertime, along with the tropical climate in summer. Overall, 86% of the Wetlands were green due to the presence of water-rich plankton and algal growth; concentration of pollutants and deterioration are typically green. Larger wetlands (< 100 acres) had been observed in Paruthipalli lake, Oomayaampatti lake, Sambur lake, and Nathamedu lake. Wetland depth is based on wetland types, locations, hydrology, and our study recorded three different wetland depths. In the ND district, 66% belong to the lacustrine nature of wetlands. Water stagnation and source of water got from the rivers, rainfall during the southwest and northeast rainfall. Suspended material such as clay, silt sediment, organic and inorganic matter, plankton, or other microbes also create water turbidity, and our result reveal that turbidity was similar in ND districts. In each region, the EC and total solids (TS) were different. The Ph, BOD, and DO of wetlands in Namakkal district are within control limits specified by the American Public Health Association (APHA) normal tier. The buffer zone landscape highest degraded in the MSW because of infrastructure development as the construction of buildings and roads, lack of wetland protection, cattle grazing, and pollution is a serious concern for both buffer zone and landscape degradation of the ND wetlands. The wetlands buffer strip had altered because of anthropogenic activities within 10 meters. Farming or infrastructure activities and lack of fencing around the wetlands are also vital factors to damaged wetland habitat. Sullipalayam lake, Akkarapatti, Kottapalayam lake, Sambur, and Irupuli were facing water shortages as a result of a lack of strategy formulation Also, Koneripatti, Oomayampatti, and Vettampatti Lake had damaged because of both agricultural and infrastructure activities. Because of their tiny region and fluctuating quality of water, the biological and greater environmental cost of many tiny wetlands persists underappreciated (Russell et al.2002). Our study resembled that most of the SSW in the ND had not been recognized because of its smaller size and lack of water holding capacity during summer. Also, the wetland conservation projects carried by government or private on the LSW wetlands. Oomayampatti Lake was under the State planning commission of TamilNadu state land use research (SPC-TNSLURB) in ND. Landscape disturbance degraded was highest in the MSW. Unplanned urbanization is a significant impact on the structure and function of wetlands. The factors such as hydrological modification, Sediment deposition, nutrient retention, and chemical contaminants are all factors to consider. Wetland habitat modification is critical in the MSW because of the water quality, quantity, and developmental activities. Offices and Privately or publicly buildings made adjacent wetlands have a consequence on the ND's wetland benefit. The hydrology alteration was utmost in the MSW, followed by LSW and SSW in the ND. Hydrology disturbance like water withdrawal during summer and Garbage dumping nearby wetlands had been noted in many wetlands lead a Many wetlands are critically important in the ND. Local groundwater constraints can have a significant impact on the quality of both natural and created wetland habitats (Austin 2002). Our study resembled that wetlands' water depths, flow rates were controlled because of the wetland's outlet framework and flow properties. Insight influence in tiny wetlands is accomplished through outflow configuration contexts and also the SSW showed that a strong positive correlation of the inundation of the water level with the wetlands area size. The water depth of all three kinds of wetlands had varied in the ND, and this had supported by the depth and duration of water in different wetlands that can be extremely variable (Rahman Ahidur, 2016). In LSW in our study showed that the major alterations had been recorded. The wetland depths are determined by floral density, terrain, water flow rate, not by outflow construction scenery. The Small wetlands can perform these water quality improvement functions more efficiently (in terms of area) than large wetlands (Blackwell et al. 2009) but, our study does not support that.

The Chemical pollutant disturbance caused by anthropogenic disturbance was utmost in the Medium wetlands because the Household wastes, Solid waste emission, debris, demolition, and effluent outlet were the most common pollutants further into ND wetlands. The higher inflow of sewage from the catchment areas into the water bodies has resulted in excessive macrophytic growth (Dar et al. 2014) and, resembles our studies that sewage outflows had recorded in the ND wetlands. Wetland complexes are associated with greater wildlife species richness. Our study recorded 22 bird species in and around the wetland habitat (Shannon Weiner index) high in the MSW, followed by the small size and large size wetland. Our study supported the bird's diversity based on the ecological status of wetlands and not on wetland size. Overall, the HDS scores were high in the Medium wetlands followed by large wetlands and small wetlands in the ND. Our study supported that Numerous wetlands in urban and rural areas face human induced burdens such as land-use changes in the watershed, environmental damage from consumers and industry, incursion, travel industry, with over of natural assets (Bassi et al. 2014). The ANOVA table shows the wetland size does not influence the HDS Score.

Respondents view that the key source of income from the wetlands by crop cultivations, fish fishing, livestock rearing, spiritual services, fodder grass, and tourism income. Our study supported that the wetlands provide food for the surrounding community and contribute to the long-term viability of the domestic economy. (Ondiek et al. 2016, Ambastha, Hussain, and Badola, 2007, Rebelo et al. 2010). This survey revealed in the ND the income source utmost from the MSW, LSW, and SSW. Medium wetlands, income from the farming practice, fish farming, and livestock grazing. In Large size wetlands, prime income from the Farming practice, livestock, and fish farming. Small wetlands, the income source, from livestock rearing and farming practice. Normally, water sources to be their greatest challenge nowadays. The agronomists' concerns about the quantity of irrigation water, combined with the routine water shortages that can disrupt the wetlands in ND, ranked drought as the most complicated environmental concern in the catchment. Even during the rainy seasons, fresh water can become an issue in ND due to its soil biota' limited retaining water.

The ANOVA table showed that there is some difference between the three wetland ecosystem services were observed. Also, the wetland size does not influence the Ecosystem service, but the wetland protection values had some similarities observed. In our study, ES in small wetlands like livestock, farming practice, other services including cultural medication, tourism, foddering, and fish rearing are important sides. Tiny wetlands might not even seem to be of significance (Johnston 1994, Trochlell and Bernthal 1998) and, our study supported SSW was not in much importance while compared with other medium and large wetlands during the study period. ES in the medium wetlands by farming, fish rearing, livestock grazing and tourism, cultural medication, and foddering. Resource constraints like Access to labour is universally acknowledged to inspire agriculture or business choice all over the globe (Fish et al., 2009). Our study supported that the labor shortage and unavailability of a water source during summer leads to the shifting of farming to other practices, like fishing. In Large wetlands, ES mainly by farming, livestock, fish farming, fodder, and tourism but, during summer, most of the largest wetlands in the ND had dried out due to lack of management. All three types of wetlands had been used for cattle grazing in the ND and this indirect effect for wetlands. Our study supported that the people use the wetland for livestock grazing, and the expanded grassing contributed to the assessment area's water deficit (Zahir and Nijamir 2018). Regulating services such as wetlands provide water regulation, flood migration observed in the Big wetlands. Water purification, control of Runoff, erosion regulation, sediment retention had recorded in the ND. Because of recent unplanned urbanization and infrastructure development supported recent development around the wetland habitat, cause the severe impact of wetland ES in the ND.

Small wetlands that can deliver the service of water purification were given by Blackwell et al. (2003) and this resembled our study. Change the land cover (Costanza et al., 2014, Kubiszewski et al., 2017) and degradation of land (Nkonya et al. 2016a, Nkonya et al. 2016b; Sutton et al. 2016) Are among the human-caused major determinant impact on ecosystem services, and this was similar to our analysis. Cultural services, recreational activities (Kamalaya pond), spiritual, educational, and research activities maximum in the medium size wetlands. Wetland ecosystems provide it with provisioning and cultural amenities (de Groot et al. 2012; Ramsar Convention on Wetlands 2018) but, our study had not correlated with these because provisional service is higher in all three types of wetlands in the ND. Labor access and water scarcity are the finest confronts in influencing farmer/business decisions around the planet. During the rainy season, water storage was an issue due to soils having poor water holding capacity in the ND.

V. Conclusion

For the first time, we used a questionnaire and ground consults to review the 21 wetlands all across three distinct sizes in ND. Diverse natural variables were used to evaluate the wetlands. Although scientific investigation on wetland amenities has increased, few studies have been done on how wetland sizing influences the ES and ES for mitigation and restoration purposes. Regarding the ecological status of wetlands HDS, score under (MI) category. In the ND, the wetland size does not influence the Ecological Status of wetlands, but the inundation of wetlands water level has correlated with the SSW in the ND. Wetland degradation by buffer zone alteration is a major threat all over the district. Regarding ES, wetland provides 11 provisional services, and Farmers relied solely on agriculture and farm animals, rearing for a living. The majority of farmers are enthusiastic about the wetland conservation program. Specific wetland surveys will be suggested to improve the foundation of the ecosystem based outcome. Sullipalayam Lake, Akkarapatti, Kottapalayam Lake, Sambur, and Irupuli were facing water shortages because of a lack of management activities, and Koneripatti, Oomayampatti, and Vettampatti Lake were damaged by both the agricultural and Infrastructure activities. Fundamental cognizant of the wetlands number, scale, location in the terrain, and the impact of neighboring activities used for wetland performance, the vulnerability of wetlands can furthermore exactly be measured. Our study suggested that the size of wetlands leads to some quantified amount of impact on wetlands, and further research will be needed to identify the impact on wetlands.

Abbreviations

used
B-Buffer zone
LA-Landscape
ID-Infrastructure Development
CG-Cattle Grazing
WH-Wildlife Habitat WP-Wetland Protection. SM-Sewage mixing
DD- Debris Dumping.

Declarations

DECLARATION OF COMPETING INTEREST

The authors declare no conflict of interest.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Dr.Varunprasath Krishnaraj: Supervision, original draft writing, conceptualization, writing review, final analysis, and editing.

Subha Mathesh: Data collection, Investigation, Visualization, Formal analysis,

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICAL APPROVAL

Not applicable

CONSENT TO PARTICIPATE

Not applicable

CONSENT TO PUBLISH

Not applicable

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Figures

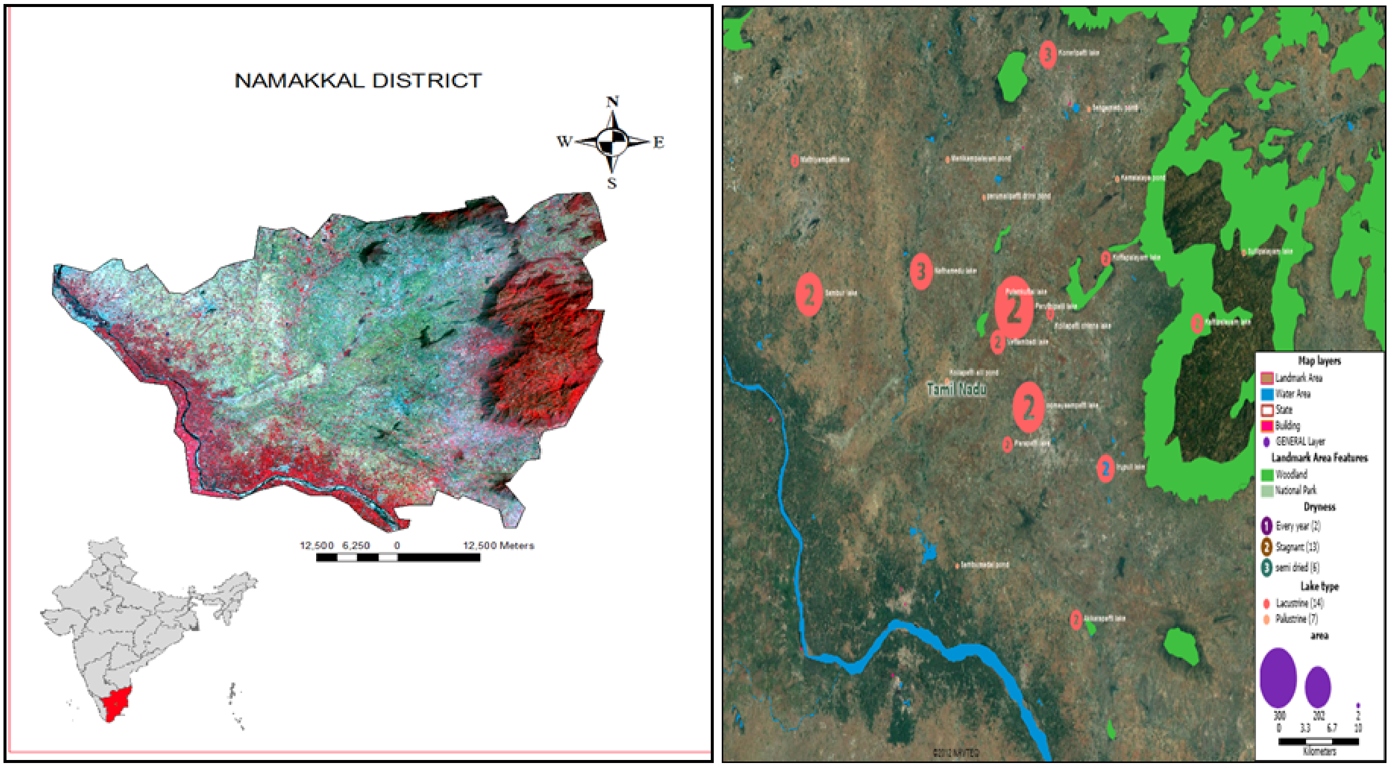

Figure 1

A) Location map of Namakkal district (ND) and Figure 1.B) Surveyed wetlands in ND.

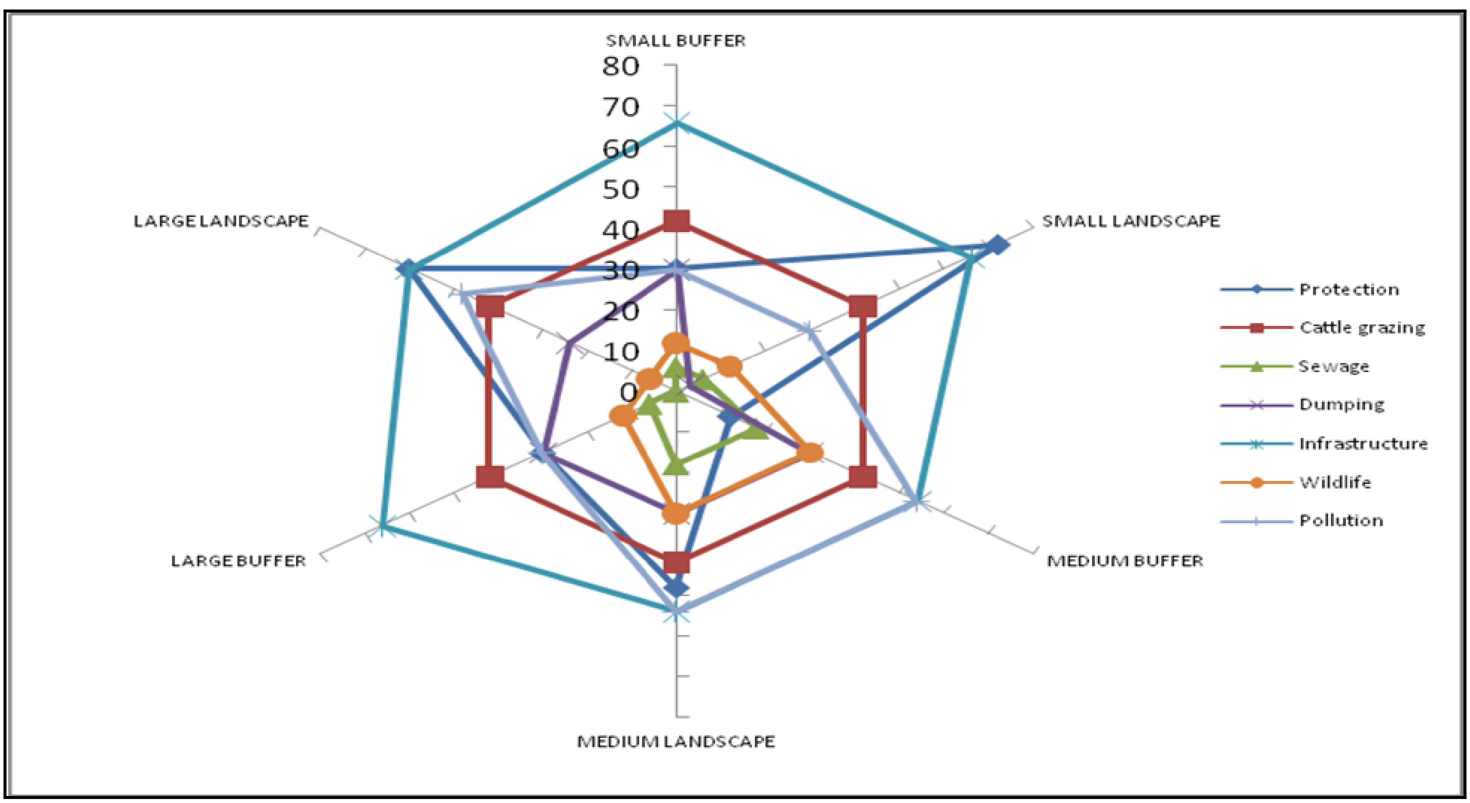

Figure 2

AVERAGE MEAN DISTRUBANCE OF BUFFER ZONE REGIONAND LANDFORM MODIFICATION OF WETLANDS IN NAMAKKAL DISTRICT

Abbreviation used: B-Buffer zone, LA-Landscape, ID-Infrastructure Development, CG-Cattle Grazing, WH-Wildlife Habitat WP-Wetland Protection. SM-Sewage mixing, DD- Debris Dumping.

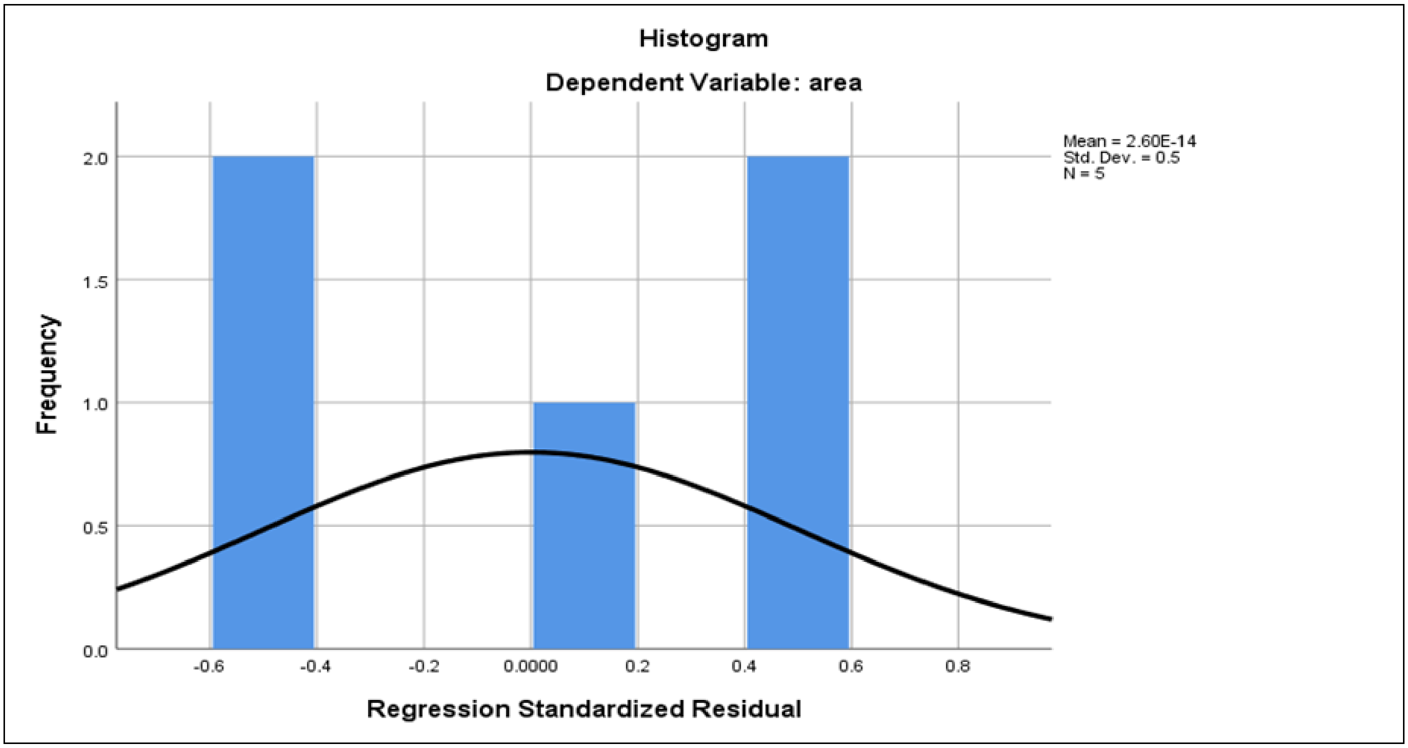

Figure 3

HUMAN DISTURBANCE VALUE OF WETLANDS IN THE NAMAKKAL DISTRICT.

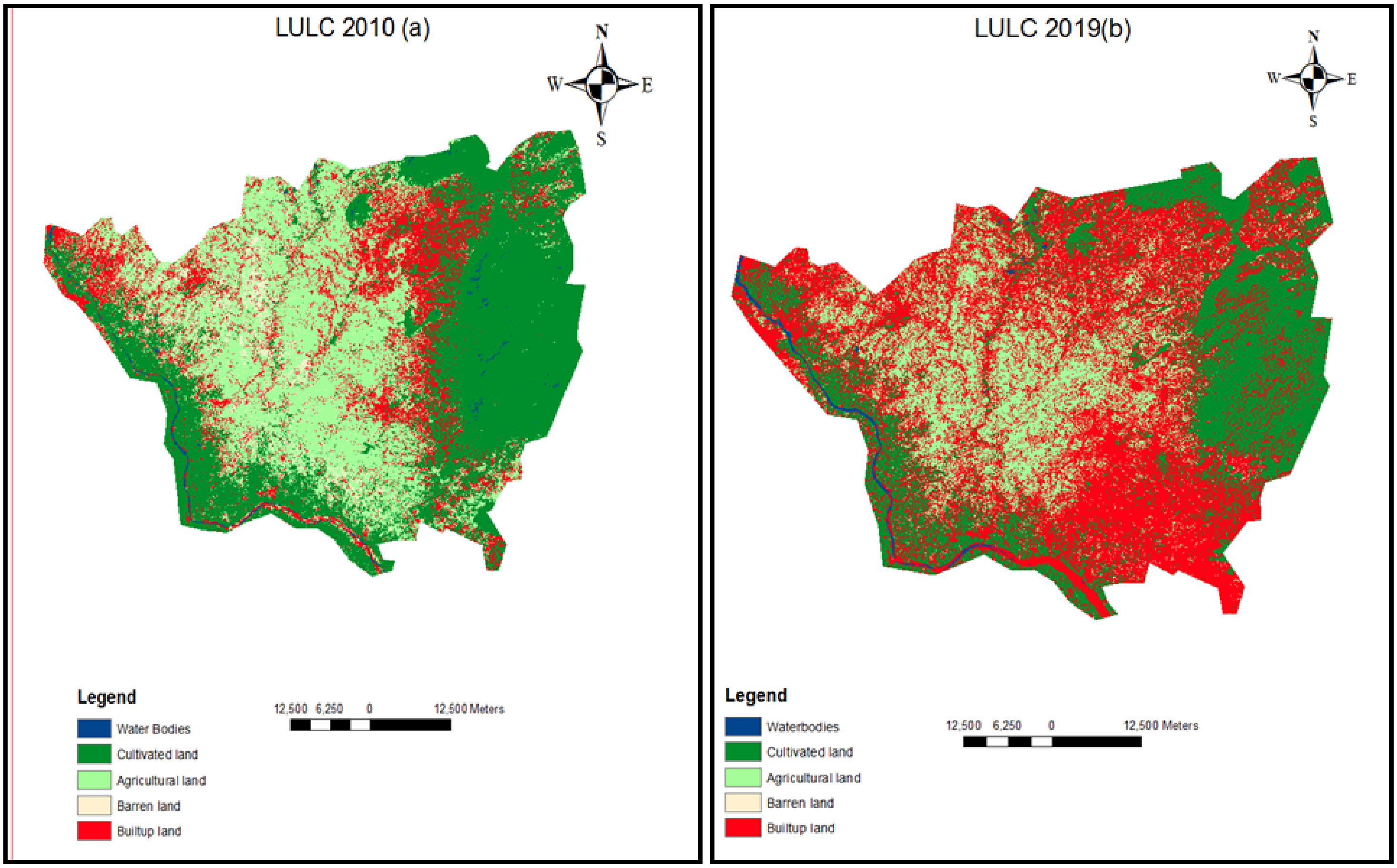

Figure 4

Classified Land use/land cover in the study area in 2010(a), 2019 (b).

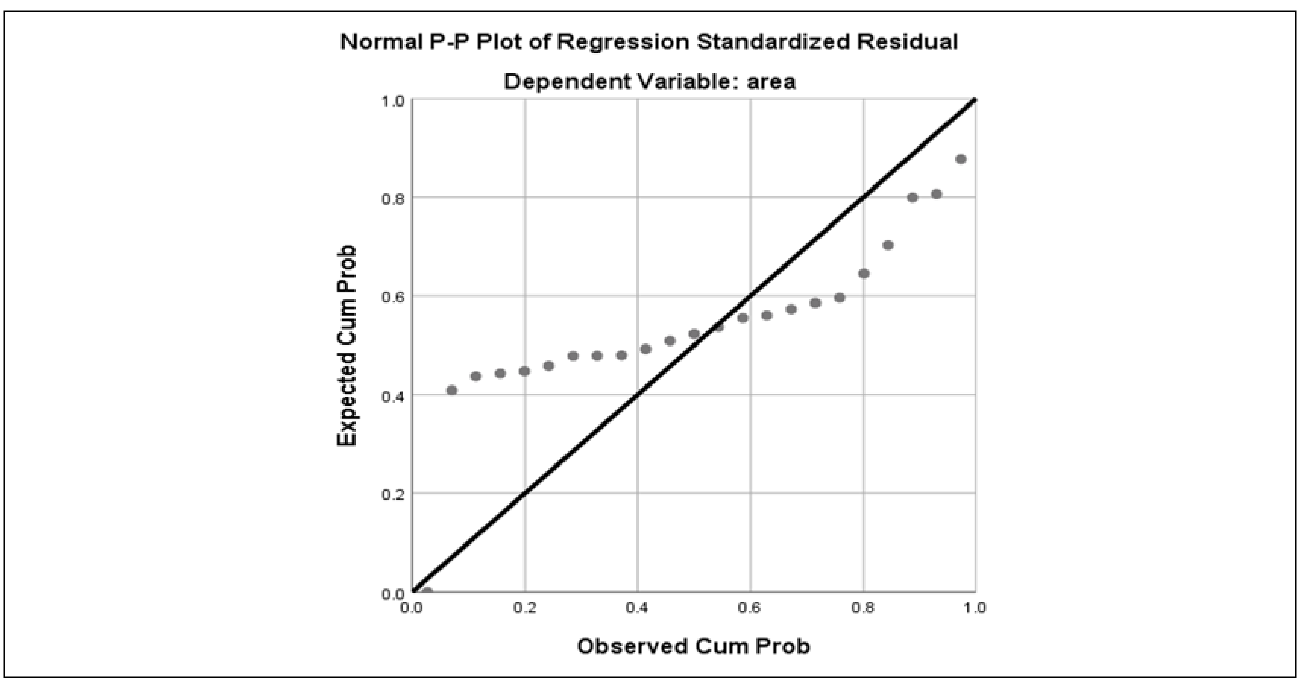

Figure 5

WETLAND ECOSYSTEM SERVICE BASED ON QUESTIONARY SURVEY IN THE NAMAKKAL DISTRICT.

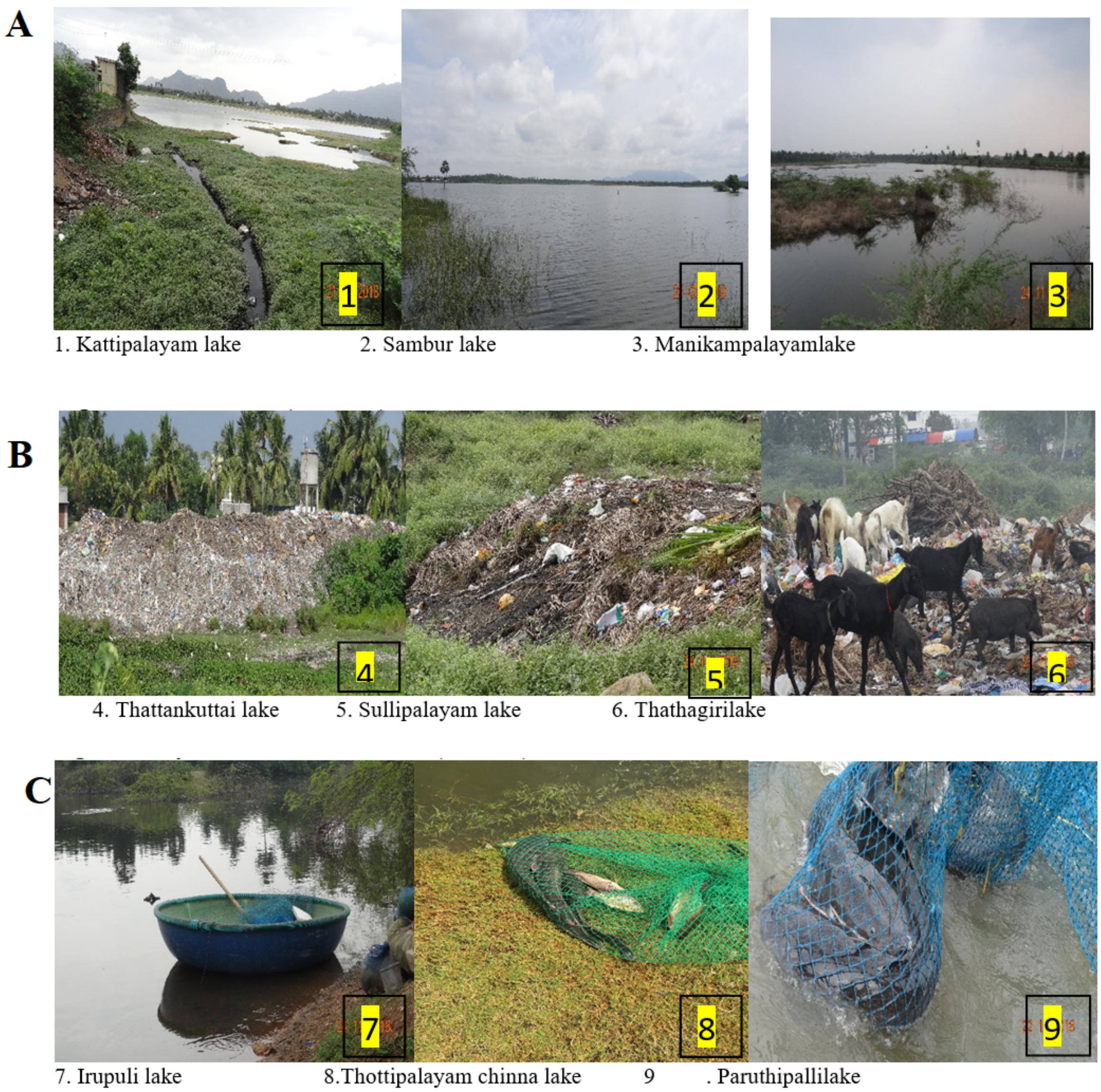

Figure 6

A. Photos of different types of Wetlands in and around Namakkal district.

B.Wetland status (Pollution) in Wetlands in and around Namakkal district.

C.Ecosystem services of wetlands (fisheries) in the Namakkal district.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- QuestionnaireforAssessmentofwetlands..pdf