ASSOCIATION OF WETLAND SIZE VERSUS THE ECOLOGICAL CONDITIONS AND ECOSYSTEM SERVICES OF STAGNANT WETLANDS IN THE AGROCLIMATIC ZONE (NAMAKKAL DISTRICT), TAMILNADU.

Dr. K. Varunprasath [a*] and Amritha P.S [b].
[a*]Dr. K. Varunprasath
Assistant Professor,
PSG College of Arts and Science, Department of Zoology, Civil Aerodrome Post, Coimbatore-14, Tamil Nadu, India 641 014
E-mail:- varunprasath@psgcas.ac.in

[b] Amritha P.S
PSG College of Arts and Science, Department of Zoology, Civil Aerodrome post, Coimbatore-14, Tamil Nadu, India 641 014
E-mail:- amritha3097@gmail.com

ABSTRACT
A wetland is an area with a water table, at, near, or above the land surface either seasonally or permanently throughout the year. Stagnant wetlands, defined as no current or flow and often, occur in a range of different sizes and represent a vast natural ecosystem that provides vital ecosystem services to humans. These areas are, however, not well-studied. The research looks into the association of stagnant wetland's size versus the ecological condition (EC) and Ecosystem services (ES), and their Land use, land cover (LULC) in the Agro-climatic zone of Namakkal district (ND) situated in the (N; 11.36, 78.30 East), TamilNadu, India. Twenty-one stagnant wetlands are hydrologically isolated; Every year, around 66.6% of wetlands are semi-parched from December to May. The wetlands were categorized into size categories for assessment, including small wetlands which is < 10 acres, medium wetlands were 11-100 acres, and large wetlands were > 100 acres. The ecological condition of wetlands data was got from the native peoples by using the questionnaire survey and field visit observations. Also, observed wetlands size, altitude, and GPS location from the study site. They selected wetlands were chosen based on their impact, availability, and access, as well as their land uses and Human Disturbance Score (HDS), which was calculated using Gernes and Helgen's technique (2002). The ecosystem services were calculated by household Survey (HHS), Focus Group Discussion (FGDs), and Key Informant Interviews. Our results showed that the ecosystem services of wetlands degraded by human anthropogenic activities and other degradation factors vary according to the type of wetlands. This is particularly important because ecosystem services such as livestock rearing and agronomy are vital income sources for local communities such as livestock rearing and agronomy are vital income sources. The analysis shows that wetland size is not associated with ecological status and ecosystem services. That said, the land use land cover changes, analyzed from 2010 to 2019, indicate that land development is increasing and that the area is also experiencing extensive changes in agricultural areas. Both of these conditions threaten wetland size. Our analysis indicated that prioritizing wetland conservation activities based on wetland size is not the best practice, however, assessing wetlands for their ecosystem services may allow prioritizing where to concentrate conservation resources.
KEYWORDS: Wetlands, Namakkal district, Ecosystem service, Anthropogenic, Human disturbance, RAMSAR.

INTRODUCTION

A wetland is an area with a water table, at, near or above the land surface either seasonally or permanently throughout the year and is extremely productive and biodiverse ecosystems (Keddy et al. 2009). Water bodies and allied wetlands supply vital ecological functions, such as a wildlife habitat, recharge the groundwater, carbon storage, water regulation (Gibbs 2000; Kayranli et al. 2010), and further ecosystem services (ES) that benefit people, such as flood management, fish production, water irrigation, and recreation (Mitsch and Gosselink 2000, Bassi et al. 2014, Keddy 2016). Wetlands continue a supply of substance for neighboring populations, especially in developing countries, and had extremely valued by many traditional cultures (Keddy 2010, Maltby and Acreman 2011, and Gopal 2013). The vanishing rate of wetlands has accumulated since the 18th century and is nowadays three times faster than the forest disappearance rate (Davidson 2014). Past 150 years, over half of the global wetlands have been changed or degraded because of human activities (Sica et al. 2016). The loss of over 50% of the world's wetlands is a significant concern as it disrupts these crucial functions and threatens the overall health of our planet (Davidson 2018). Overall, 1052 sites in Europe; 289 sites in Asia; 359 sites in Africa; 175 regions in South America; 211 sites in North America; and 79 sites in the Oceania region denoted as Ramsar sites or International important wetlands (Ramsar Secretariat 2013). The latest evaluation conducted in the Ramsar Convention on Wetlands exposed that the world's 64% wetlands lost since 1900 (RAMSAR 2015). Long-term loss of natural wetlands averages between 54% and 57%, reaching up to 90% in some regions of the world (Junk et al. 2013).

Wetlands in India, as elsewhere, are increasingly facing several anthropogenic pressures (Pratyashi Phukan and Ranjan Saikia 2014). In India, we have 757.06 thousand wetlands covering 15.3 mha, making up 4.7% of the country's total geographical area. Out of this, the area under inland wetlands accounts for 69%, coastal wetlands 27%, and other wetlands (> 2.25 ha) 4% SAC, 2011). The hydrologic cycle plays a crucial role in shaping the characteristics and diversity of wetlands in a given area. Wetlands are features that vary in size due to increases and decreases in water volume,but varying water volume may also threaten a wetland area or its integrity,including its functions and services (Brinson and Malvarez 2002). For decades there have been concerns about the cumulative reductions in ecosystem services that might result from shifts in wetland size (Leibowitz et al. 1992). Many small wetlands continued to neglect or overlooked due to their size and temporary hydrology (Russell et al. 2002). Increased understanding of the role served by small wetlands (Semlitsch and Bodie, 1998) has led to concern that size may not be an adequate condition t upon which to base difficult decisions about wetland conservation. Wetlands were created through combination of climatic, geological, biological, chemical, and anthropogenic causes (Machtinger 2007). The key reason for disturbing the wetlands through the 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).

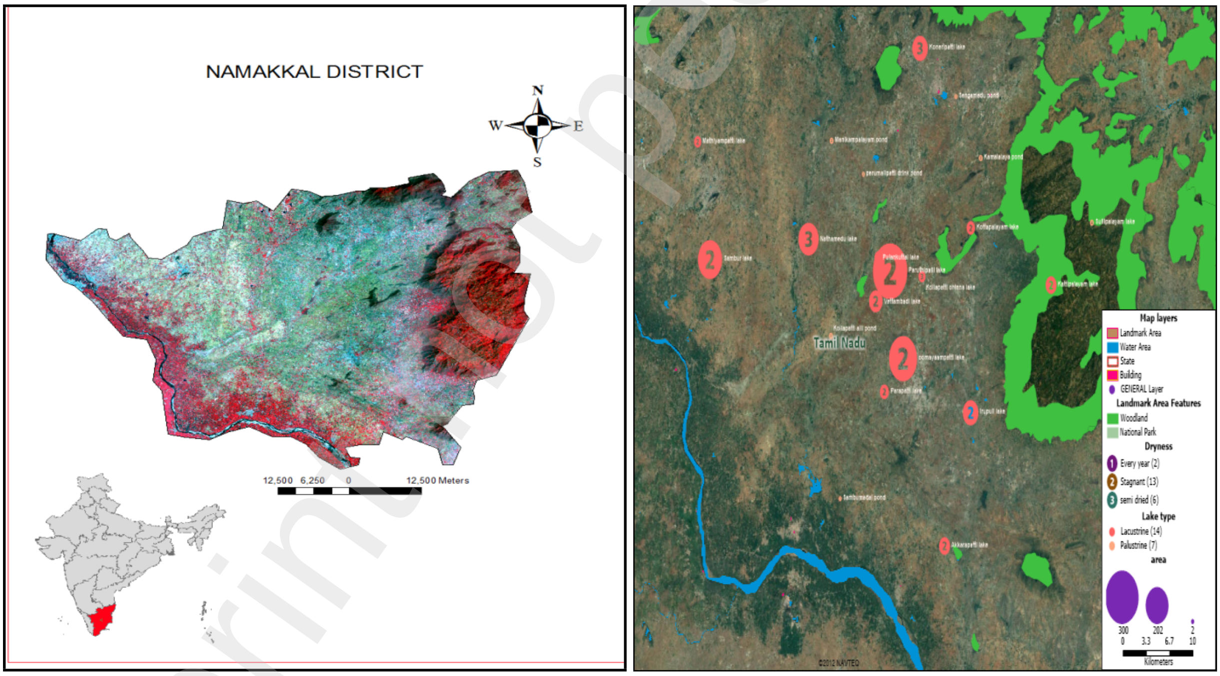
While dropping wetland regions poses the utmost clear menace, altering wetland connectivity also influences countryside roles, and people have changed the scale of connectivity (Pringle 2003). The studies on individual wetlands have been crucial for enhancing our understanding of fundamental wetland functions (Perry et al. 2004; Drexler and Bedford 2002). With growing attempts to restore formerly drained wetlands and develop new wetlands to enhance water quality (Mitsch and Day 2006; Zhi and Ji 2012), recognition of the importance of wetland size in delivering essential ecosystem services has also grown in recent years (Mitsch and Gosselink 2000). Smaller ecosystems, such as tiny lakes, have traditionally been considered insignificant in terms of their role in global events and cycles (Downing 2010). A 16-year monitoring project in Rainbow Bay, a small wetland (0.5 hectare), discovered 27 species of anurans and caudates (Semlitsch et al. 1996). Wetlands are not created equal, therefore restoring them must consider not just total wetland area targets, but also the kind, landscape location, and morphometry of the wetlands that are being repaired (Van Meter and Basu 2015). Several studies have found that small waterbodies bring more to storing carbon, local biodiversity, generation of fish, and leisurely use of water bodies than bigger ones (Downing et al., 1990, Kelly et al. 2001, Reed-Andersen et al. 2000, Scheffer et al. 2006). Not all wetlands supply whole Ecosystem Services at all times. Various wetlands offer a series of amenities under their kind, size, and position. In Namakkal district, some of 21 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 local people's perception of wetland management remains poorly studied. The Specific objectives include such as

1. To review the Ecological condition of stagnant wetlands in association with anthropogenic disturbance.
2. To determine 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.
4. To evaluate the people's perception of wetlands in the Namakkal district.

STUDY AREA: NAMAKKAL DISTRICT

Namakkal district (Lat 11°13'37 N, lon 078 11' 43 E), also known as Transport city or Egg city, can be found in the state of Tamil Nadu, in southern India as shown in Figure 1. Namakkal district is a part of the North-Western agro-climatic zone and extends into two watersheds between the Cauvery and the Vellar river systems. The district covers 3,364 km2 and has a population of 2,399,976 in 2023 (uidai.gov.in 2023). Namakkal is defined by moderate rainfall and forests covering 512.5 km2 or about 15% of the region's geography. The climate is hot and dry during the summer months from March to May, while winter is cold and misty, lasting from November to February. The normal rainfall of the district is on average 900 mm (IMD Chennai 2021). Temperature ranges from a maximum of 40'C and minimum of 18'C (IMD Chennai 2021). The most commonly grown crops include paddy, sorghum, groundnut, green gram, black gram, maize, cotton, and sugarcane.

FIGURE 1. LOCATION MAP AND SURVEYED WETLANDS IN NAMAKKAL DISTRICT.



METHODS

The wetland survey and the questionnaire interviews were conducted from June 2019 to April 2020 in the society existing within a 1 km radius of each wetland edges. The Wetland sizes are categorized into small wetlands, medium wetlands, and large wetlands which are less than 10 acres, 11 to 100, and above 100 acres respectively. Collected water samples from all wetlands kept inside the polythene bottles were tested in the laboratory by using the standard method (APHA, 1985). Water samples were gathered to be analyzed for either drinking or farming purposes. Temperature, turbidity, total dissolved solids (TDS), total suspended solids (TSS), pH, electrical conductivity (EC), total solids (TS), dissolved oxygen (DO) concentration, BOD, and COD were chosen as important parameters for physicochemical water quality analysis. The water samples' temperature, pH, and EC were determined in situ using a mercury thermometer and a glass electrode pH and EC meter, respectively (APHA, 2005). The depth of the water was measured using a meter scale. Turbidity and DO concentration were measured using a turbidity meter, the APHA (2005) standard method.

HUMAN DISTRUBANCE SCORE

Wetlands' ecological and biological conditions had calculated by a
variety of techniques are used to understand the wetland's ecological and biological conditions (Interviews, Ecosystem services (ES), Human Disturbance Score (HDS), and Physical characteristics). Wetlands are further graded and categorized into low, middle, and high impacts for Human Disturbance. The physical individualities of water are to measure the water standard and the ecological status of the wetlands. The extent of human disturbance to the wetlands had been considered using the Human disturbance score (HDS) protocol method (Gernes and Helgen 2002). Ecosystem services (ES) or benefits gained from each wetland were accredited and evaluated using data from the original cluster interviews. In addition, the researchers conducted a field study to measure the interference of wetlands from the ground, Ecosystem Services, and the Physical status of the wetlands. The gathered data brought together various quantifiable factors to compute the human disturbance factor.

Factor 1: Crucial zone-Disturbance inside 50 meters. 0-18 points
Factor 2: Buffer Zone-Disturbance inside 500 meters from the margin of wetlands- 0-18 points
Factor 3: Habitat Alteration-Disturbance within 50 meters from the edge of wetlands- 0-18 points
Factor 4: Hydrological alteration-Disturbance within 50 meters from the edge of wetlands- 0-21 points
Factor 5: Chemical Pollution-Disturbance within 50 meters from the edge of wetlands- 0-21 points
Factor 6: Presence or Absence of Fish yield- 0-4 points.

Full enumeration had used to gather data on wetland kind, hydrological conditions, land use patterns, Ecological state, and habitat assessment. At last, each factor was valued and classified (scored) in one of four categories ranging from best to poor, as stated aforesaid. All scored values from each factor concluded for each study wetland to gain their human disturbance gradient score out of 100%. If the categorical range of HDS of a wetland value falls within the ranges of 0-33, 33-67, 67-100 (Gernes and Helgen 2002). It can be ranked as least impacted, mid impacted, and most or highly impacted, accordingly. The respondents were requested to value the ES quoted for each wetland using terms of relative importance, particularly socioeconomic characteristics, wetland importance, and management aspects.

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 characteristics were household size, age of the respondent, level of formal education of the respondent, and gender. 2) The questionnaire made up a list of provisioning ES derived from wetlands. 3) Perceptions of wetland conservation. 4) Last, a primary income source from households near wetlands. The questionnaire was pre-tested and afterward administered face to face 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 wetland-dependent households had surveyed in these villages. Try to cover all the questions raised by the researcher and answered by the most senior available person in the household survey. 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, drivers of change, and their impacts on ecosystem services.

Focus Group Discussion (FGDs)

The list of ES had got from the household survey was validated during the focus group discussions. Five focus group discussions (FGD) were carried out at the society level in the villages, with a mean of 5–10 participants in each cluster 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

Representatives of the government agencies, NGOs, research institutes, researchers also exchanged views for an inventory of ecosystem services of the wetland earlier than the survey. The vital points asked during interviews concentrated on subsistence strategies and drivers of modification in the wetland ecosystem. A sum of 15 representatives from diverse organizations consulted as vital informants during the study to help us realize the patterns of change and the drivers. Criteria choice of the crucial informants was their acquaintance with the wetland resources and people's reliance on and commitment to the wetland's operation.

Data Analysis

The quantitative statistics were evaluated using frequency analysis from the Statistical Package for Social Sciences (SPSS) 25th Version computer software program, and Bird diversity measured by the Shannon index method. To find out regional individuals' reliance and the impacts of various drivers on the wetland ecosystem. Qualitative statistics derived from interviews were first coded and classified into themes under the research points, and the same coded themes were grouped. The ecosystem service grading executed participatory tools. Participants in focus group discussions had sought to detect critical ecosystems available from the wetlands. After listing key ecosystem services, the participants had asked to grade the listed ecosystem services on a scale of 1 to 10 (1 with the least preference and 10 with the highest). The overall ranking was based on the total marks for each ecosystem service, separated by the number of respondents. Likewise, drivers of ecosystem alteration defined via both qualitative analysis (focus group discussion) also got from household questionnaires.

LAND COVER AND LAND UTILIZATION

The current study was performed to assess variations in LULC classes, in the Namakkal District, using ArcGIS. Collection of data, image processing, and Time-series classification data of LULC of the study area were studied using Landsat imagery (TM, ETM+, OLIS/TIRS) got from the United States Geological Survey (USGS, https://www.usgs.gov/). 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 the images were cloud-free and gained in 2010 and 2019. The level 1 products were previously geographically estimated at UTM zone 37N WGS84. The images were composited and removed using the study area border shapefile in ArcGIS 10.4. Later image developments (typical false-color configuration and standard deviation stretch), sufficient training polygons were collected to identify LULC types consuming the training model manager in ArcGIS 10.4 (Lillesand et al. 2015). Based on these data, the five images were classified into six land-use categories (Water bodies, Paddy cultivated, vegetation, built-up area, and forest land using the Random Forest image classification algorithm. Random Forest was proposed by Breiman (2001) and has been increasingly used by professionals. This is because it is extra forceful than the outdated image sorting algorithms and offers high classification precision for using deranged and small training data sets (Jin et al. 2018). The level of separate LULC changes over time was assessed using percentage variation (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 transition matrix was used to illustrate the direction and area of different LULC types change within a time. This was achieved between diverse periods using cross-tabulation and overlap crossing in ArcGIS 10.4 software. The attribute tables got from these analyses were exported to Microsoft Excel to compute area change and rate of change of different years. 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).Data from interviews, field surveys, and Google Earth were used to sequence and allow the image in 2019. Nearly 50 to 60 ground truth points were composed in the field and Google Earth-Pro images for each LULC sort (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

For the accuracy assessment, the classified results are compared with reference datasets, which are assumed correct in defining a classification. Several methods are adopted to analyze user and overall accuracy of remote-sensed data (Aronica and Lanza 2005). Change accuracy of LULC is predisposed by issues like sensor element-related issues and data pre-processing procedures used with customary situations at the image acquisition time (Morisette and Khorram 2000). Based on the error of omission and commission, there are three different scales used in the accuracy calculation, in an error matrix: user's accuracy, producer's accuracy, and overall accuracy (Coppin and Bauer 1996; Carlotto 2009). The additional measurement in the image classification technique is the Kappa coefficient, which is used to enumerate the classification precision vital for all basics, with the diagonal ones (Coppin and Bauer 1996; Foody 2010). In the current study, accuracy assessment, 40 samples were identified, for the years 2010 to 2019. We adopted a stratified sampling method, where a minimum of ten ground truth data points was got, from the field, for each LULC class, using GIS ArcMap software. Using Equation 1, the percentage of the overall accuracy of each feature is calculated.

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

RESULTS

The questionnaire survey was filled out by 335 persons. Table 1 shows the mean responder age among males and females in all types of wetlands. In all wetlands, approximately 65% of respondents worked in agriculture. Table 1 shows the average mean age, a cumulative sample of persons, and jobs.

TABLE 1. CHARACTERISTICS OF STUDIED HOUSE HOLDERS DETAILS IN NAMAKKAL DISTRICT.

	Small Wetlands N= 104	Medium Wetlands N=108	Large Wetlands N=123
Total Families	23	24	26
Average family size	4.52	4.50	4.73
Mean Male age	41.65	46.79	46.15
Female Male age	43.09	47.50	47.92
Male respondent	19	20	22

Female respondent	19	19	20
Farming	78.26	66.66	65.39
Poultry	8.69	8.33	11.54
Business	8.69	16.67	15.38
Others	4.36	8.34	7.69
Total Occupation	100%	100%	100%

People living in and around the Namakkal district rely extensively on wetland resources on a daily basis for their livelihoods, nutrition/food security, and general well-being. Approximately 5 villages (with a total population of roughly 5000) may be found in the study sites, and they are the ones most intimately involved in maintaining the wetland resources.

In Namakkal district, out of 21 wetlands, each category 7, wetlands had selected for this study (Supplementary file, Fig 1). These selected wetlands are based on easy accessibility 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.

Physical characteristics of wetlands in the Namakkal district

The wetland physical characteristics are categorized into seven parameters for a better understanding of wetlands in Namakkal district. In the entire region, the temperature range from 23° C to 29°. In Namakkal district, Physically, there are differences among the wetlands structures of wetlands that were noted (Supplementary file). Overall n=18, (86%) wetlands were green and n=3, (13.3%) were colourless. The Large Wetlands occupied the Group 3 areas such as lake Paruthipalli, Oomayaampatti, Sambur lake, and Nathamedu lake wetlands and, the average mean values of size and depth of each district wetland had mentioned in (Table 1). According to the RAMSAR category, the wetlands in the Namakkal district had classified into Lacustrine, Palustrine, and Riverine kinds. In this district, Riverine wetlands were less common which comprises two wetlands (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. The chief origins of the water to the wetlands were Rainfall and River water. 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% were partially dried, and the remaining 9% of the wetlands were semi-dried out during summer.

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 parameters showed that the wetlands in Namakkal district were within the control limits of the World Health Organization (WHO) or the American Public Health Association (APHA) standard level (Table 2).

TABLE 2: AVERAGE MEAN WATER QUALITY PARAMETERS OF WETLANDS IN NAMAKKAL DISTRICT.

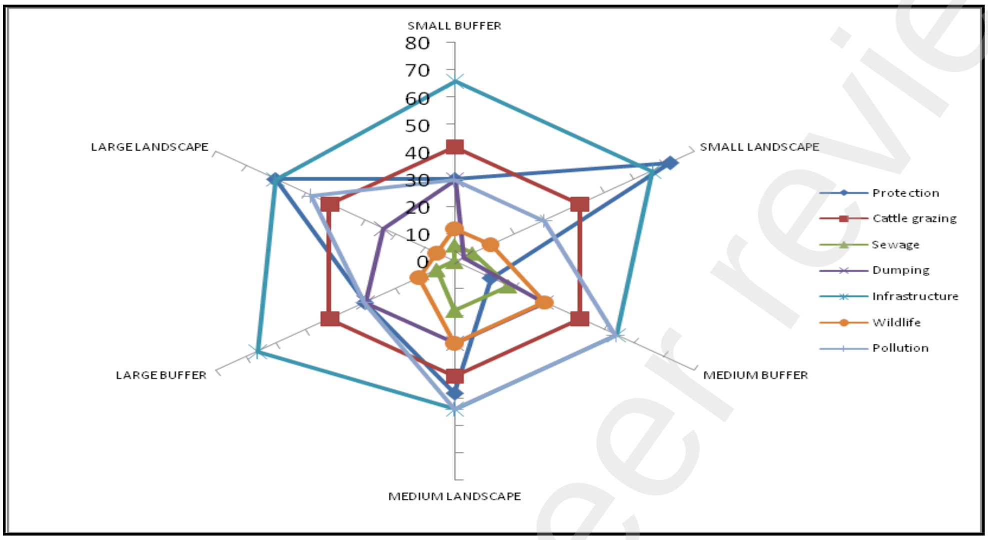
	Small Wetland	**SE**	**Medium Wetland**	**SE**	**Large Wetland**	**SE**
Temperature(C°)	26.6±2.5	0.92	26.1±1.5	0.55	27.4±1.9	0.75
Turbidity (NTU)	9.2±1.9	0.71	8.0±2.7	1.04	9.2±2.3	0.87
Ph(Ph meter)	7.1±0.2	0.09	6.7±0.7	0.26	7.2±0.6	0.24
Electrical conductivity (µS/cm)	207.3±46.3	17.50	275.9±145.6	55.03	365.4±293.1	110.79
Total solids(Mg/l)	1982.7±164.0	62.01	1843.9±101.6	38.39	1927.1±195.6	73.94
BOD((Mg/l)	22.07±10.8	4.08	17.2±10.0	3.81	17.4±13.4	5.08
DO(Mg/l)	4.9±1.5	0.56	3.9±0.6	0.24	4.7±1.2	0.45
Average area (Acres)	4.6±2.3	0.87	54.6±15.9	5.99	180.9±76.5	28.92
Average depth (feet)	3.7±0.5	1.32	25.6±9.1	3.46	14.0±.5.6	2.12
Altitude(meter)	658.4±60.5	22.9	708.6±19.4	7.33	613.8±241.3	91.18

Ecological condition of wetlands in the Namakkal district:

Buffer landscape (from the edge to 50 meters) was degraded highest in the Medium Wetlands, especially damaging 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, Average mean (AM): 4.29, Standard Deviation (SD): 2.92) noted. Meanwhile, the Small Wetlands (n=5, AM: 4.29, SD: 2.92) was protected by shoreline protection but MSW was less protected in Namakkal district. Cattle grazing was observed in many wetlands and equally shared (n=7, AM: 6.0, SD: 0.0). Sewage disposal was utmost in the Medium Wetlands (n=3, AM: 2.57, SD: 2.92). Dumping debris nearby the wetland habitat was recorded in the Namakkal district (n=5, AM; 4.29, SD: 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 Medium Wetlands wetlands were utmost in Namakkal district. (n=5, AM: 4.29, SD: 2.92). Tree cutting was not noted in any wetlands in Namakkal district. The buffer zone landscape disturbance showed that the highest degraded in Medium Wetlands followed by Small Wetlands and Large Wetlands. In the Namakkal district, 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 Small Wetlands, 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 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.

FIG 2: AVERAGE MEAN DISTRUBANCE OF BUFFER ZONE AND LANDSCAPE ALTERATION OF WETLANDS IN NAMAKKAL DISTRICT.

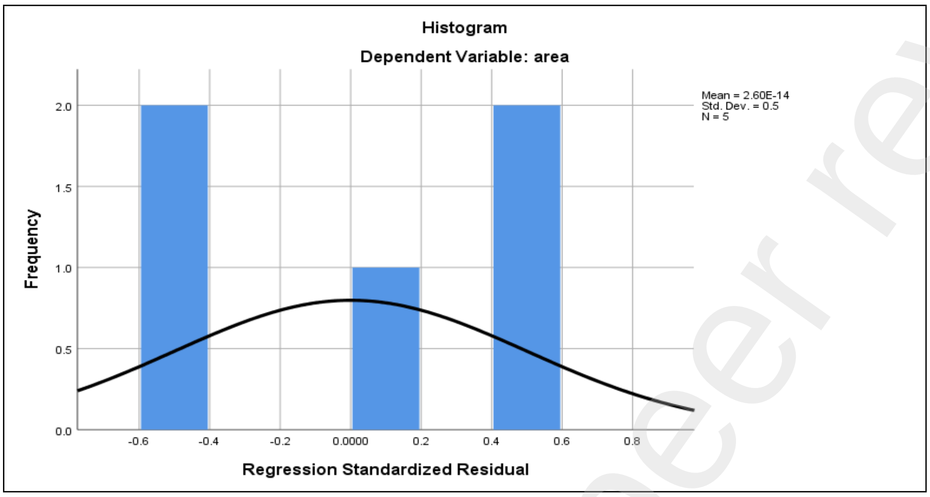


Abbreviation used: WP-Wetland Protection. SM-Sewage mixing, ID-Infrastructure Development, DD-Dumping Debris, CG-Cattle Grazing, WH-Wildlife Habitat, LA-Landscape, B-Buffer zone.

The graph represented that the changes in the Buffer zone and the Landscape alteration 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 Medium Wetlands despite infrastructure development (n=10, AM: 4.0, SD: 2.92). The infrastructure development despite constructing a commercial or residential building or road constructions was present in the Namakkal district wetlands and the maximum quantity recorded in the Small Wetlands (n=7, AM: 2.8, SD: 3.09) wetlands. Protection-wise, the entire district in the landscape zone was no protection, and utmost noted in the Small Wetlands (n=15, AM: 6.0, SD: 0.0). Cattle grazing was common in the landscape zone for entire wetlands. The sewage disposal is maximum in the Medium Wetlands. Dumping debris was a common mode of degradation to the wetlands in Namakkal district. Tree cutting wasn't noted in any district, even in the landscape habitat. Overall, landscape disturbance showed the highest degradation in the MSW. Habitat alteration of the wetlands was utmost in the Medium Wetlands (10.0). In the Medium Wetlands (n=13, AM: 5.2, SD: 2.1), most of the developmental activities such as offices either, private or government buildings's occupied in and around the wetland areas. Fish catching by boat in the Medium Wetlands is causing the highest alteration of habitat. Developments of roads either, single or two roads were nearby, the wetland habitat showed that almost all the districts and maximum in the Large Wetlands. 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 Small Wetlands and Large Wetlands. Overall, Habitat alteration of disturbance showed that utmost, in the Medium Wetlands followed by Small and Large Wetlands noted.

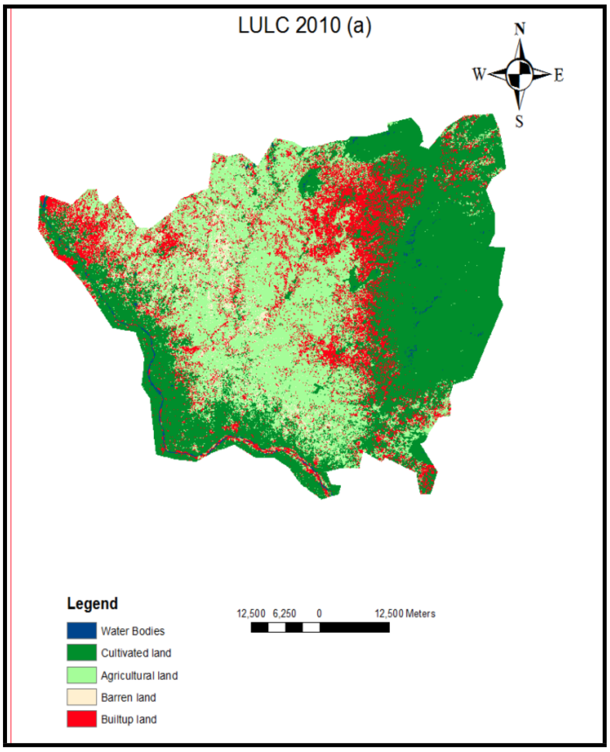
The hydrology alteration was utmost in the Medium Wetlands followed by large-sized and Small Wetlands in the Namakkal district. Hydrology disturbance like water withdrawal in almost as many wetlands because of water scarcity during summer (n=14, AM: 6.5, SD: 1.80). Water flooding had recorded in all and highest in the Medium Wetlands (N=15, AM: 7.0, SD.1.20). The discharge of sewage (n=4, AM1.87, SD; 3.20) was utmost in the Medium Wetlands. Garbage dumping nearby wetlands had been noted and, many wetlands (n=4, AM1.87) lead to a vital concern in most of the wetlands in the Namakkal district. We also check the correlation of the inundation of the water level with the wetlands area size. In Small Wetlands 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 Namakkal district. In Medium Wetlands 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 Namakkal district. In Large 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 Namakkal district. Overall, the Chemical pollutant disturbance was utmost (11.6) in the Medium Wetlands. Household wastes, municipal waste discharge, demolition of debris, and sewage outflow were general modes of pollution in the wetlands in the Namakkal distric6Figure 6. Some wetlands have water odors had recorded in Medium Wetlands and Large Wetlands. Watercolor changes are utmost recorded in (5.1) the Medium Wetlands. Washing of vehicles nearby the wetlands is a vital concern, especially in the Medium Wetlands. The data showed chemical pollutants were highest in the Medium Wetlands, followed by Medium Wetlands. Waterbirds are a key component of most wetland ecosystems, as they occupy several trophic levels in the food web of wetland. The present study recorded 22 bird species in and around the wetland habitat. In Namakkal district, by using the Shannon Weiner index (H), results high in the Medium Wetlands (1.317) followed by SSW (1.254), and LSW (1.019) were observed and have recorded no mammal species during the study period.

FIG 3: HUMAN DISTURBANCE VALUE OF WETLANDS IN THE NAMAKKAL DISTRICT.



All the HDS results were within the Potential 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 Namakkal district. 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), Medium Wetlands (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.



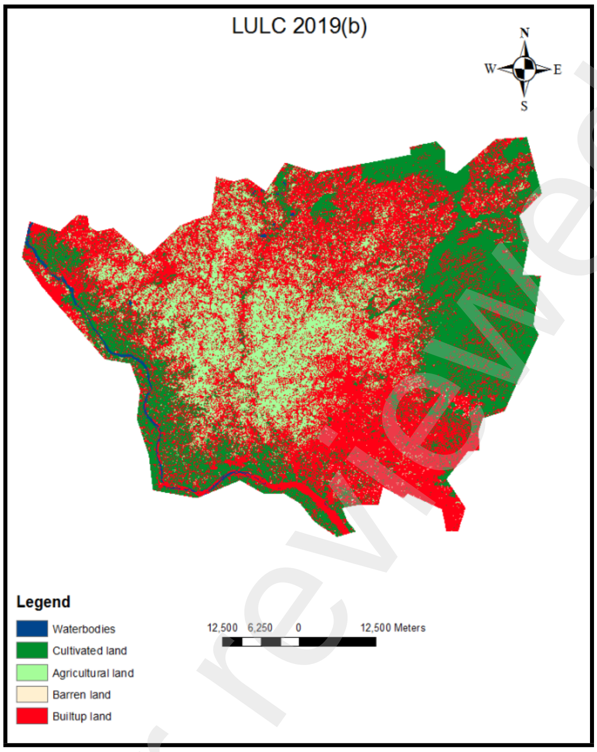


Figure 4. Classified Land use/land cover in the study area in 2010(a), 2019 (b).

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 3 .Wetland distribution area in the Namakkal District (unit: Square Kilometer)

Class	**Sum of area Sq.km**	2010 percent	**Sum of area Sq.km**	2019 Percentage
Agricultural land	1488.364	43.74	673.404	19.76
Barren land	105.148	3.09	9.7850	0.28
Builtup land	584.897	17.18	1671.870	49.06
Cultivated land	1206.540	35.45	1029.922	30.22
Waterbodies	17.797	0.52	22.298	0.65
Grand Total	**3402.745**	100	**3407.278**	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 4.Wetland type area transition matrix from 2010 to 2019 (Square kilometer)

Land class 2001		**Land class 2019 (SQ.KM)**					
Row Labels	**Sum of area**	**Agricultural land**	**Barren land**	**Builtup land**	**Cultivated land**	**Waterbodies**	**Grand Total**
Agricultural land	2.997	106597.001	3.647	6020120.002	35607.566	322.529	6162649.999
Barren land	1696.414	507387.999	3.574	4517170.001	11802.136	11.7990	5036369.999
Builtup land	1282120.001	522865.999	4.483	12500800.001	242061.001	366.470	13266099.999
Cultivated land	44937100.000	159378.001	7.892	9737460.001	301642.999	144.871	10198599.999
Waterbodies	626.503	0.8810	0.0259	143855.999	165781.000	240.996	309879.001
Grand Total	**76186400.001**	**1296229.991**	**19.623**	**32919400.000**	**756894.910**	**1086.661**	**34973599.910**

The change matrix analysis shows the shift of LULC from one type to the other. The gradual proportion of transition occurred among all classes in Namakkal District. The transition matrix from 2010 to 2019 showed that decreasing land for agriculture land, cultivation land, water bodies including rivers, barren land and increasing in the built-up areas all over the district. Percentage-wise changes and overall details are mentioned in Table 4 and Fig 4. 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 Medium Wetlands, followed by larger wetlands and small wetlands.

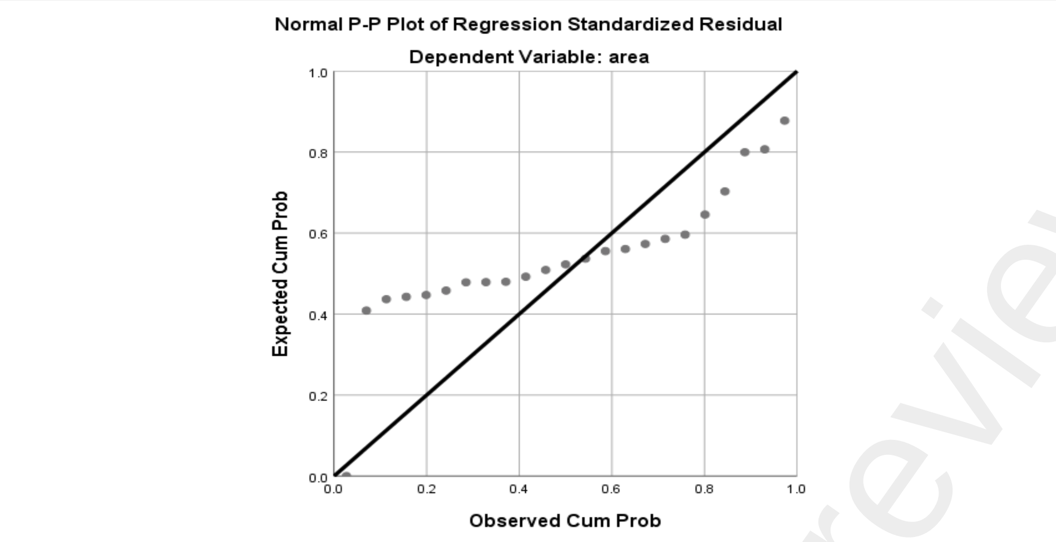
TABLE 4.ECOSYSTEM SERVICES AND PROVISIONING SERVICES OBSERVED BASED ON QUESTIONARY SURVEY IN THE NAMAKKAL DISTRICT.

	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 awareness	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 had assessed and categorized into provisioning, cultural, regulating, and supporting services. Based on ES were assessed collective methods of field observation and household interview data (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). 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 Namakkal district, 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 Namakkal district. 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.

FIG 5: WETLAND ECOSYSTEM SERVICE BASED ON QUESTIONARY SURVEY IN THE NAMAKKAL DISTRICT.



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 Namakkal district. 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 Small Wetlands (p= -2.047), Medium Wetlands (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).

DISCUSSION

The physical characteristics of the wetlands had categorized into seven parameters for a better understanding of wetlands. In Namakkal district, 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 Namakkal district wetlands, the maximum temperature had noticed during summer because of the open nature of the wetland site, along with the tropical climate in summer. Overall, 86% of the wetlands were green due to water-rich phytoplankton, algal growth; organic pollution and erosion usually appear 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 Namakkal district 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 matter such as clay, silt, organic and inorganic matter, plankton, and other microorganisms also contributes to the turbidity of the water, and our results showed that turbidity of water was more or less the same in Namakkal district districts. The EC, Total solids (TS) were different in each region. Namakkal district the Ph, BOD, and DO of wetlands within the control limits mentioned by the World Health Organization (WHO) or the American Public Health Association (APHA) standard level. 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 Namakkal district 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 because of a lack of management activities. Also, Koneripatti, Oomayampatti, and Vettampatti Lake had damaged because of both agricultural and infrastructure activities. In many small wetlands, the biological and broader environmental importance of many small wetlands continues to be neglected, probably because of their size and ephemeral hydrology (Russell et al.2002). Our study resembled that most of the Small Wetlands in the Namakkal district 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 Large Wetlands wetlands. Oomayampatti Lake was under the State planning commission of TamilNadu state land use research (SPC-TNSLURB) in Namakkal district. Landscape disturbance degraded was highest in the Medium Wetlands. Unplanned urbanization is a significant impact on the structure and function of wetlands. The factors such as hydrological modification, sedimentation regimes, dynamics of nutrients, and chemical pollutants. Habitat alteration of the wetlands is the utmost in the MSW because of the water quality, quantity, and developmental activities. Offices and either private or government buildings occupied around the wetland areas lead to an impact on the wetland value in the Namakkal district. The hydrology alteration was utmost in the Medium Wetlands, followed by Large Wetlands and Small Wetlands in the Namakkal district. Hydrology disturbance like water withdrawal during summer and Garbage dumping nearby wetlands had been noted in many wetlands lead a vital concern in most of the wetlands in the Namakkal district. Regional water conditions can have a dramatic effect on the quality of wetland habitats, both natural and established (Austin 2002). Our study resembled that wetlands' water depths, flow rates were controlled because of outlet structure and resistance to flow within the wetland. In small wetlands, depth control is via the settings of the outflow structure 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 Namakkal district, 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, municipal waste discharge, demolition of debris, and sewage outflow were the general mode of pollution into the wetlands in the Namakkal district. 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 Namakkal district 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 Medium Wetlands, 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 Namakkal district. Our study supported that many of the wetlands in urban and rural areas are subject to anthropogenic pressures, land-use changes in the catchment, pollution from industry and households, encroachments, tourism, and over-exploitation of their natural resources (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 serve as a food source for people in the local community and the sustainability of the local economy (Ondiek et al. 2016, Ambastha, Hussain, and Badola, 2007, Rebelo et al. 2010). This survey revealed in the Namakkal district the income source utmost from the Medium Wetlands, Large Wetlands, and Small Wetlands. 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' worries about quantity and quality of water for irrigation are allied with the repeated droughts that can upset the wetlands in Namakkal district perceived drought as the peak difficult environmental concern in the catchment. Even in the wet season, water availability can be a problem in the Namakkal district because of its soils having less ability to keep 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. The Small wetlands may not appear to be delivering significant importance (Johnston 1994, Trochlell and Bernthal 1998) and, our study supported Small Wetlands 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 labor are widely recognized to influence farmer or enterprise decision-making around the world (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 Namakkal district had dried out due to lack of management. All three types of wetlands had been used for cattle grazing in the Namakkal district and this indirect effect for wetlands. Our study supported that the people use the wetland for livestock grazing, and the increased grassing caused the drought condition of the study area (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 Namakkal district. Because of recent unplanned urbanization and infrastructure development supported recent development around the wetland habitat, cause the severe impact of wetland ES in the Namakkal district.

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-induced factors that markedly affect ecosystem services, and this resembled our study. Cultural services, recreational activities (Kamalaya pond), spiritual, educational, and research activities maximum in the medium size wetlands. Wetland ecosystems provide more types of support and regulating services than provisioning and cultural services (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 Namakkal district. Labor access and water scarcity are the greatest challenges to influence farmer/enterprise decision-making around the world. During the rainy season, water storage was an issue due to soils having poor water holding capacity in the Namakkal district.

CONCLUSION

The first time we have surveyed the 21 wetlands in and around the three different sizes in Namakkal district by using the questionnaire method along with field visits. The wetlands had assessed by various ecological parameters. Scientific consideration of wetland services has exploded, but few studies have been conducted on wetland size influences the ES and ES for conservation and management aspects. Regarding the ecological status of wetlands HDS, score under (MI) category. In the Namakkal district, 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 Namakkal district. Wetland degradation by buffer zone alteration is a major threat all over the district. Regarding ES, wetland provides 11 provisional services, and farming and livestock rearing was the vital source of livelihood income to farmers. Most of the farmers are interested in the wetland conservation program. Individual wetland studies will be necessary to strengthen the basis for decision-making for conservation and management aspects. 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.

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AUTHORSHIP CONTRIBUTION

Amritha P S[b]: Investigation, Data collection, Formal analysis, Visualization, Writing- original draft.

Dr. K. Varunprasath[a]: Supervision, Conceptualization, Final analysis, Writing review, and editing.* All authors *read and approved the final manuscript.*

DECLARATION OF COMPETING INTEREST

The authors declare no conflict of interest.

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