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# Analysis in the changes in Chennai-Pallikaranai Wetland

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## ABSTRACT

***The deterioration of Wetlands has become a devastating issue in the current scenario. Wetland, being the source for several species is a major Biodiversity which is under extreme danger. These wetlands also play a major role in flood control and in groundwater recharge. The major cause of this problem is Urbanization and Industrialization. The change caused in these wetlands reflects on its biodiversity which depletes the natural resources in and around the area. Based on its extent of deterioration, respective remedial measures might be taken to replenish the environment and in saving the endangered species. This could be achieved by the help of several LANDSAT images from USGS and with the help of remote sensing software ArcGIS. This project shows various wetland maps for Pallikaranai from 2008–2018, compares the rate of depletion/expansion of wetland's water surface area and identifies the variation in the dump yard area in the Pallikaranai wetland. The results indicate that there was a significant increase in the dump yard area land.***

***Keywords***— *Deterioration, Wetlands, Biodiversity, Remote sensing*

## 1. INTRODUCTION

A wetland is "an ecosystem that arises when inundation by water produces soils dominated by anaerobic and aerobic processes, which, in turn, forces the biota, particularly rooted plants, to adapt to flooding".

A wetland is a distinct ecosystem that is inundated by water, either permanently or seasonally, where oxygen-free processes prevail. The primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation of aquatic plants, adapted to the unique hydric soil. Wetlands play a number of roles, sometimes referred to as functions. Among these are water purification, water storage, processing of carbon and other nutrients, stabilization of shorelines, and support of plants and animals. Wetlands are also considered the most biologically diverse of all ecosystems, serving as home to a wide range of plant and animal life.

The main wetland types are swamp, marsh, bog, fen; sub-types include mangrove forest, carr, pocosin, floodplains, mire, vernal pool, playa, and many others. The water in the wetlands is either freshwater, brackish, or saltwater. Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation.

The aim of this study is to produce a land cover map of Pallikaranai wetland that experienced a rapid increase of dump yard area in the current decade at different years and to detect changes that have taken place within the inter-classes in land cover in the same given period (2008-2018).

## 2. OBJECTIVES

- To create wetland maps for Pallikaranai wetland from 2008 to 2018.
- To compare the rate of depletion/expansion of Pallikaranai wetland's water surface area.
- To identify the changes in the dump yard area in Pallikaranai wetland.

## 3. STUDY AREA

Pallikaranai wetland (Fig 1) is a freshwater marsh located in Chennai, in the Indian sub-continent. It is located with the coordinates of 12°56′15.72″N 80°12′55.08″E. It has a geographical area of 31 square miles. It is one of the last surviving wetlands of South India. The Government of India had recognised this wetland as one of the most significant wetlands of the country. This wetland is one among the three wetlands in Tamil Nadu, which has been identified under the National Wetland Conservation and Management Programme (NWCMP).

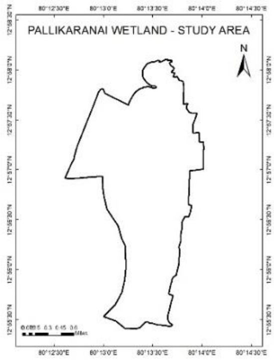



**Fig. 1: Study area**

The wetland is located in the Coromandel Coast of Adyar Estuary and surrounded by the Old Mahabalipuram Road and residential areas of Madipakkam, Pallikaranai, Siruseri and Perungudi, Velachery. The catchment area is about 91 square miles which include the urban areas of Navalur, Pallikaranai, Velachery. The wetland serves as a habitat for several grass species, bird species, aquatic species and several endangered species. The heterogeneous ecosystem of the marshland supports about 337 species of floras and faunas. Pallikaranai marsh is home to 115 species of birds, 10 species of mammals, 21 species of reptiles, 10 species of amphibians, 46 species of fishes, 9 species of molluscans, 5 species of crustaceans, and 7 species of butterflies. About 114 species of plants are found in the wetland including 29 species of grass.

## 4. THE SCOPE OF THE STUDY

Application of remotely sensed data made possible to study the changes in land cover in less time and with better accuracy in association with GIS. With the help of these data, the rate of change in the wetland area can be determined to identify the impact of Urbanisation in a natural bio-diversity. Based on the scale of the impact on natural resources, suitable remedial measures can be adopted to prevent the wetlands and their features.

## 5. NEED FOR THE STUDY

India is facing a drastic loss of their water bodies including wetlands in recent decades due to rapid Urbanisation. Wetlands are indispensable for ecosystem services that they provide biodiversity and also helps in flood control and groundwater recharge. This study proposes to determine the rate of changes in wetland's water surface area and dump yard area, thereby it can be regained before it is totally depleted.

## 6. MATERIALS AND METHODS

### 6.1 Data Collection

Satellite images are those images collected by imaging satellites operated by governments all around the world that focuses on Earth or other astronomical bodies like stars, planets, meteors etc…The Earth Resources Technology Satellite was launched on July 23, 1972, and was later renamed to Landsat. Millions of images were acquired by the instruments on the Landsat satellites.

**6.1.1 Landsat 7:** It is the seventh satellite of the Landsat enterprise which was launched on April 15, 1999. Its main goal is to refresh the global archive of spatial photos, providing cloud-free and updated images. Landsat 7 data totally has 8 spectral bands for collecting precise details and has a resolution ranging from 15 to 60 meters. The satellite, Landsat 7 was designed to last for five years and has an ability to gather and transmit up to 532 images, a day**.** The satellite weighs up to 1.973 kilograms and the main instrument onboard Landsat 7 is ETM+.

### 6.2 Image Acquisition

Acquisition of images involves the creation of photographic images such as the physical features (or) of the interior structure of an object. The term often assumed to imply or include the processing, compression, storage, printing and display of such images.

The United States Geological Survey is a scientific agency of the US government. USGS is used to study the landscapes, natural resources and natural hazards. The organization has four major science disciplines, concerning biology, geography, geology, and hydrology. For this study, Landsat images of Pallikaranai wetland were collected for a span of 11 years (2008-2018) from USGS (Fig 2). Images from Landsat-7 ETM+ C1 were used.

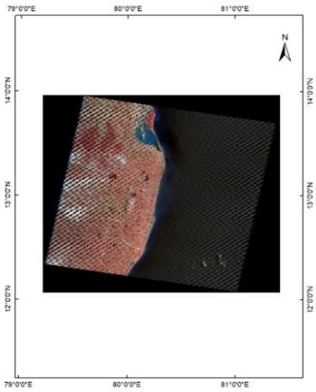


**Fig. 2: Satellite image**

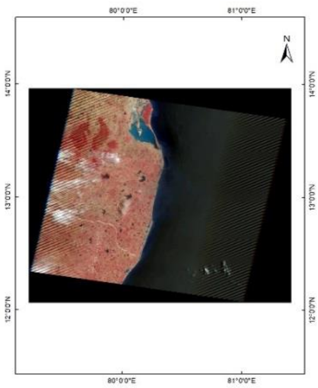


**Fig. 3: Rectified image**

### 6.3 Image rectification

The transformation by projecting multiple images onto a common image surface is called image rectification. It is used for correcting a distorted image into a standard coordinate system. When the map points are not known properly or when the clearly identifiable points are lacking in images that correspond to the maps, then they seem to be as primary difficulties.

### 6.4 Image Preprocessing

The data acquired from the satellite consists of several distortions, errors, noise and other geometric and radiometric errors. These errors have to be removed, or at least minimized in order to acquire accurate image characteristics and details. Image Processing involves the elimination of errors present in the remotely collected data. This process is mandatory in any remote sensing projects, as the data with errors result in false or inaccurate results.

**6.4.1 Geometric correction:** The geometric correction of image data is an important prerequisite which must be performed prior to using images in Geographic Information Systems (GIS) and other image processing programs. To process the data with other data or maps in a GIS, all of the data must have the same reference system.

**(a) Focal analysis:** Landsat time series commonly contain missing observations, i.e., gaps, due to the orbit and sensing geometry, data acquisition strategy, and cloud contamination. A spectral-angle-mapper based spatiotemporal similarity gap-filling algorithm is presented that is designed to fill small and large area gaps in Landsat data, using one year or less of data and without using other satellite data. Each gap pixel is filled by an alternative similar pixel that is located in a non-missing region of the image (Figure 3).

### 6.4.2 Radiometric correction

Radiometric correction is done to calibrate the pixel values and/ correct for errors in the values. The process improves the interpretability and quality of remotely sensed data. Radiometric calibration and corrections are particularly important when comparing multiple data sets over a period of time.

**(a) Haze correction:** Haze correction is the process of removing the effect of haze to enhance the production of reflectance values. This correction is done when the effect of haze is high, such that it causes difficulties during analysis. This function sharpens the imager using either a Tasseled Cap or Point Spread Convolution approach.

**(b) Noise correction:** Noise correction is done to reduce the excessive noise present in the satellite image. This is done to maximise the image clarity and for easy interpretation of the values during analysis.

Both the Geometric errors and Radiometric errors and analyzed and reduced with the help of ERDAS software.

### 6.4.3 Atmospheric correction

Atmospheric correction is the process of removing the effects of the atmosphere to produce surface reflectance values. Atmospheric correction can significantly improve the interpretability and use of an image. Ideally, this process requires knowledge of the atmospheric conditions and aerosol properties at the time the image was acquired.

### 6.5 Image Enhancement

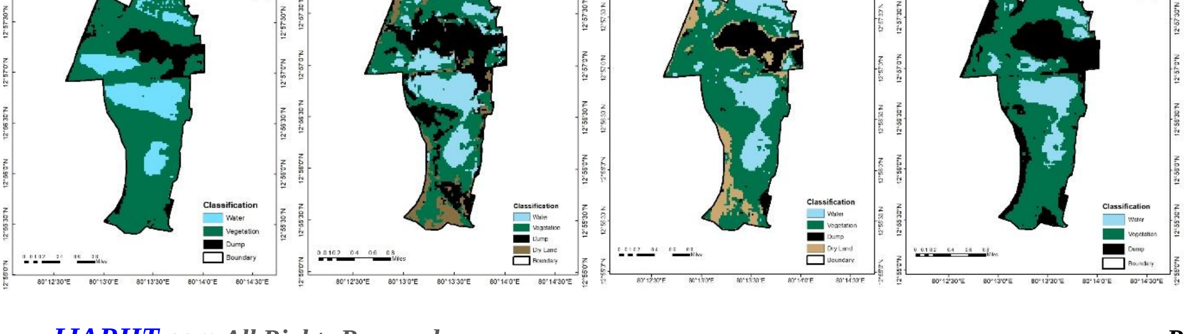
Image enhancement is the modification of an image to alter the impact on the viewer. Generally, enhancement distorts the original digital values; therefore enhancement is not done until the restoration processes are completed. There is a strong influence of contrast ratio on resolving power and detection capability of images. Techniques for improving image contrast are among the most widely used enhancement processes.

### 6.6 Supervised Classification

This is the based on the idea that a user can select sample pixels in an image that are representative of specific classes and then direct the image processing software to use these training sites as references for the classification of all other pixels in the image.

The user specifies the various pixel values or spectral signatures that should be associated with each class. This is done by selecting representative sample sites of a known cover type called "Training Sites". Training sites are selected based on the knowledge of the user. The user also sets the bounds for how similar other pixels must be to group them together. These bounds are often set based on the spectral characteristics of the training area. Supervised classification is more accurate than unsupervised classification, but depends heavily on the training sites, the skill of the individual processing the image and the spectral distinctness of the classes.

## 7. RESULTS AND DISCUSSIONS



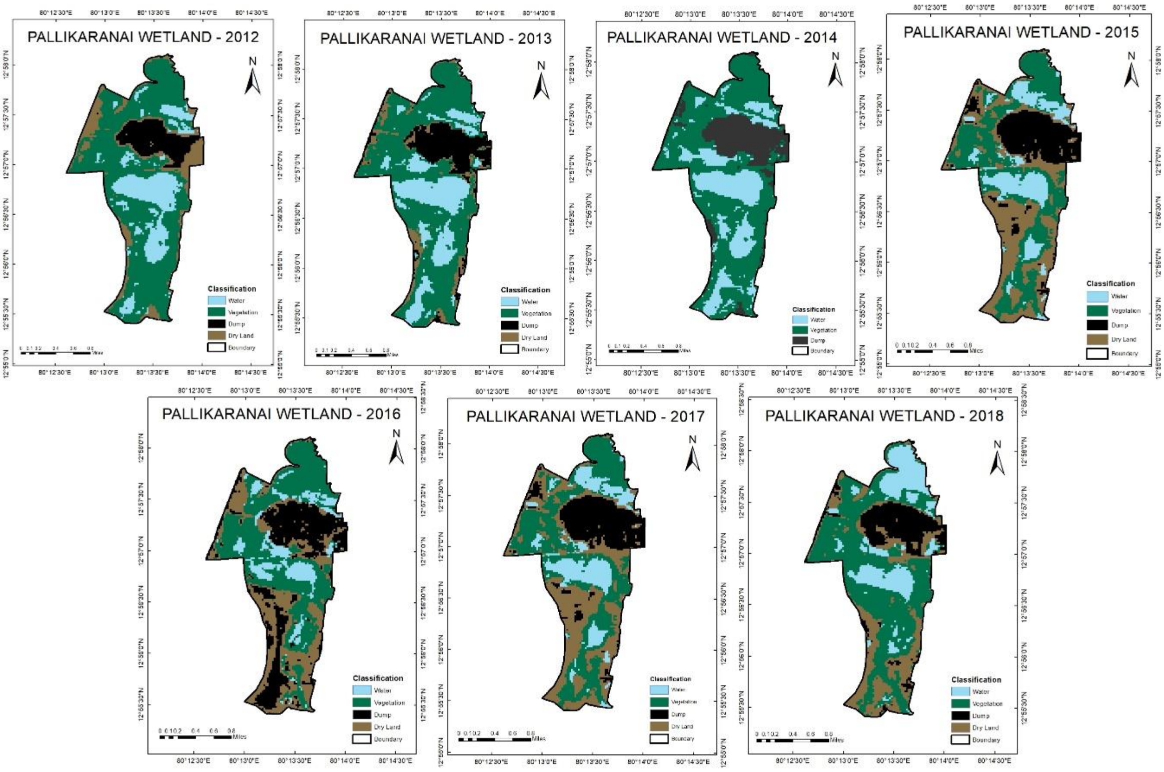



**Fig. 4: Land cover map for Pallikaranai wetland from 2008-2018 (Summer)**

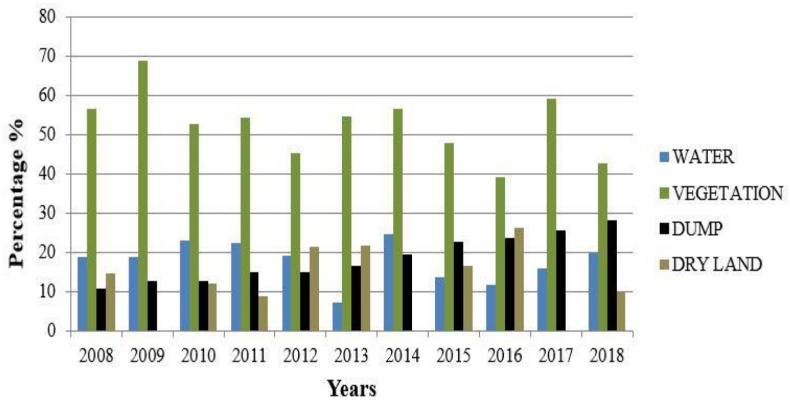



**Fig. 5: Inter class change of land cover in Pallikaranai wetland from 2008-2018 (Summer)**

From the above maps and a bar graph (Figure 4 and figure 5), it can be inferred that various features of the Pallikaranai wetland change from year to year. The changes of each feature can be easily inferred from the graph easily, individually. The water shows a gradual increase in the area from 2008 to 2010 reaching 18.81% to 22.99 %, then it gradually declines to the least per cent of 7.16% in the year 2013. Further, it sharply rises to 24.48% in 2014 and shows a decline until 2016. It again gradually increases and reaches to 19.7% in 2018. The vegetation shows a gradual increase till 2011 and falls to 45.22% in the year 2012. It again fluctuates and reaches 56.42% in 2014 and drops to 47.76% in the year, 2015. It suddenly drastically drops to 38.96% in the next year, 2016. By the next year, it reaches the maximum area of 58.96% in 2017. In the next year, it reduces to 42.69%.

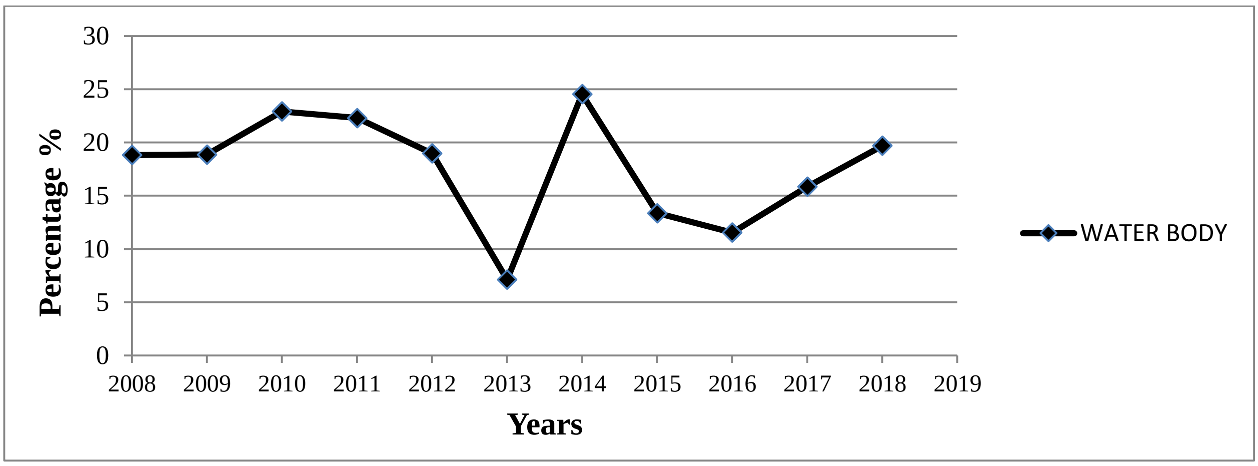



**Fig. 6: Variation in water area in the Pallikaranai wetland from 2008-2018 (Summer)**

From the graph (figure 6), it can be inferred that the dump area, starting from the year 2008 at 10.6%, shows a gradual increase in the area, every year. It reaches a peak area of 28.21% in the year 2018. It does not show any fluctuation but shows a gradual and steady increase every year. The dry land fluctuates the most when compared with other features of the wetland. In 2008, it occupies 14.48% of the total wetland area. By the next area, 2009, it drops to 0%. For the next four years, till 2013, it raises and reaches 21.64% and in 2014, it again drops to 0%. For the next two years, till 2016, it raises and reaches to 26.12% and in the succeeding year, 2017, it again occupies 0% of the total wetland area. In the year 2018, it occupies 9.55% of the total wetland area.

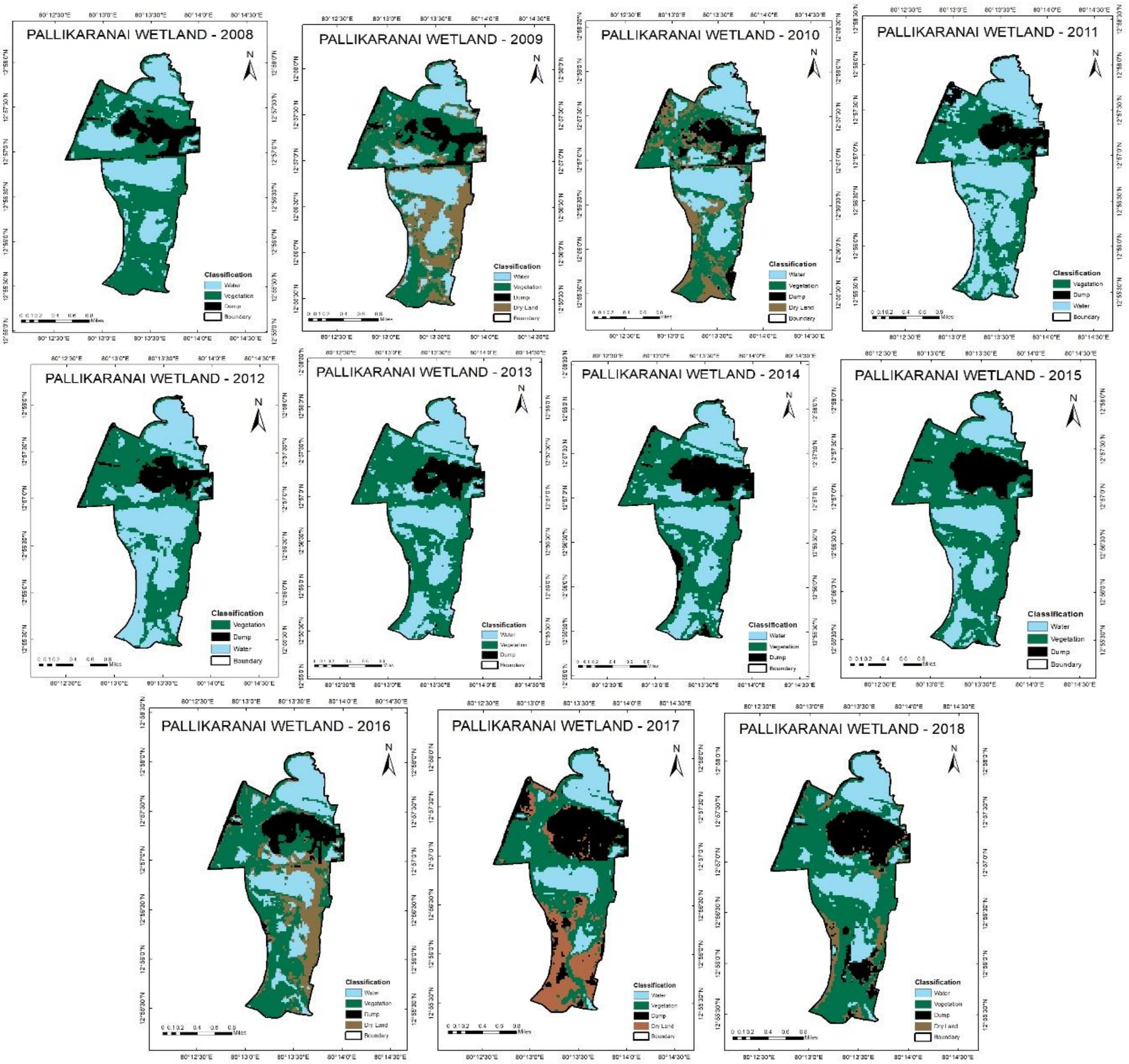



**Fig. 7: Land cover map for Pallikaranai wetland from 2008-2018 (Winter)**

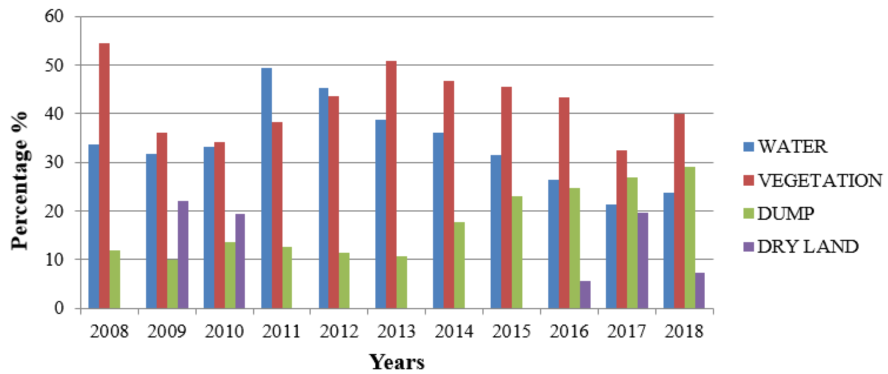



**Fig. 8: Inter Class Change of Land cover in Pallikaranai wetland from 2008-2018 (Winter)**

From the above maps and a bar graph (figure 7 and figure 8), it can be inferred that various features of the Pallikaranai wetland change from year to year. The changes of each feature can be easily inferred from the graph easily, individually. The water shows a decrease in the area in 2009 reaching 31.79% from 33.73 %, then it gradually inclines to 49.4% in the year 2011. Further, it slightly falls to 45.22 in 2012 and shows a decline till 2017. It again gradually increases and reaches to 23.73% in 2018. The vegetation shows a gradual decrease till 2010 and rises to 43.58% in the year 2012. It again fluctuates and reaches 50.94% in 2013 and drops to 46.64% in the year, 2014. It suddenly drops to 31.46% in the next year, 2015. By the year 2017, it reaches the peak decline area of 21.19% in 2017. In the next year 2018, it increases to 23.73%.

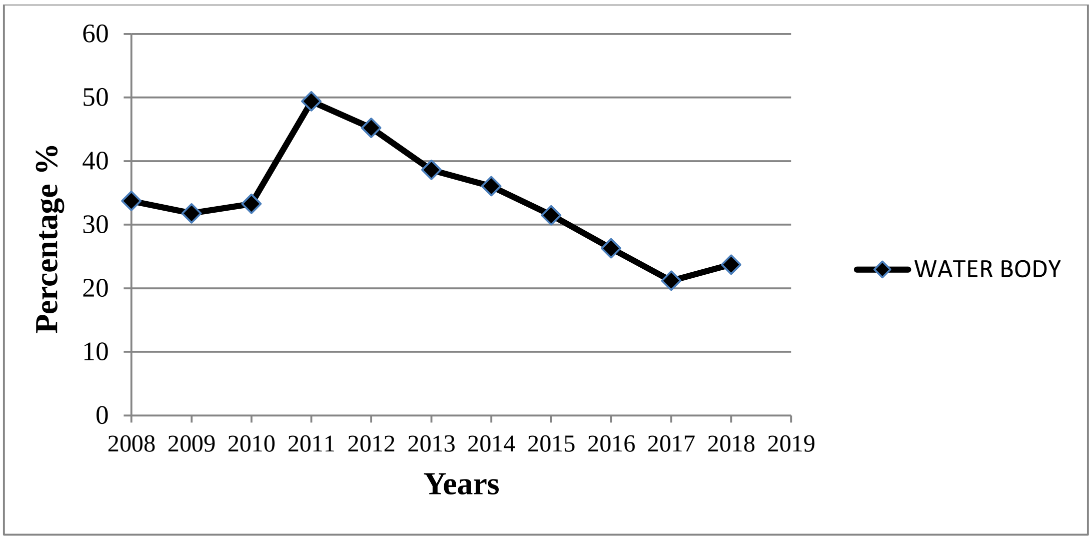



**Fig. 9: Variation in water area in the Pallikaranai wetland from 2008-2018 (Winter)**

The dump area, starting from the year 2008 at 11.79%, shows a gradual increase in the area, every year. It reaches the peak area of 29.1% in the year 2018. It does not show any fluctuation but shows a gradual and steady increase every year. The dry land fluctuates the most when compared with other features of the wetland. In 2008, it occupies 0% of the total wetland area. By the next area, 2009, it rises to 22.09%. In the year 2010, it declines slightly and occupies an area of 19.25%. For the next five years, until 2015, it occupies 0% of the total wetland area. For the next two years, till 2017, it raises and reaches to 19.55% and in the succeeding year, 2018, it occupies 7.16% of the total wetland area. (Figure 9)

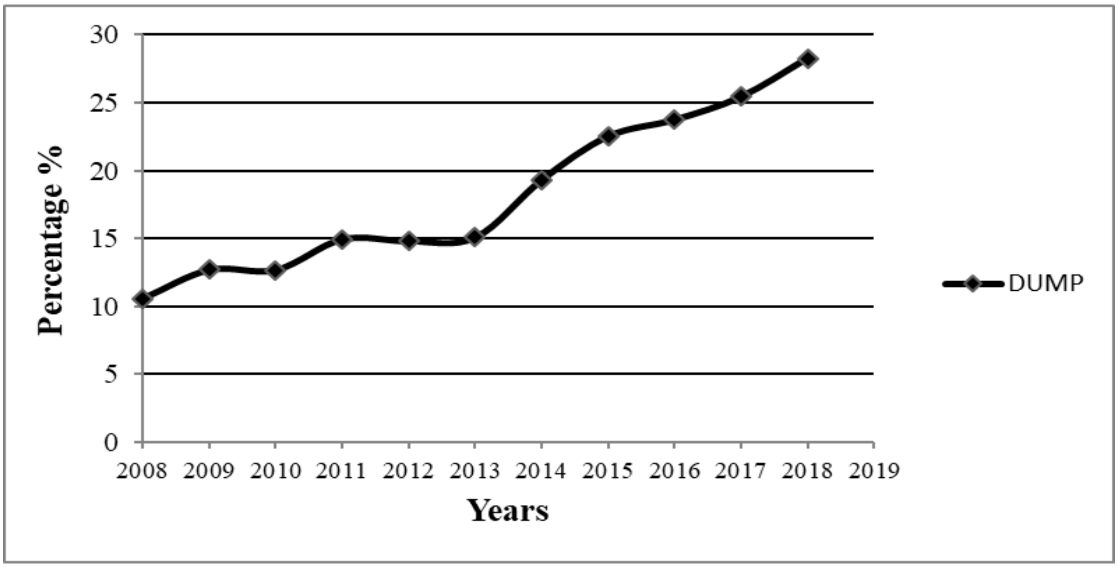



**Fig. 10: Variation in Dump yard area (2008 – 2018)**

The area of the dump yard gradually increases up to 14.94% till the year 2011. It slightly increases to 15.07% of the wetland area in the year 2013. In the year 2014, it increases up to 19.32% and raises up to 28.28% till the year 2018. The rise of the total dump area is stable throughout the years and it is increasing phase. The total dump area occupies the peak value of 28.28% of the total area of the wetland while it occupies the least total area of 10.59% in the year 2008. (Figure 10)

## 8. CONCLUSION

The increase in the dump area is a huge threat to the welfare of the wetland. The dump filled inside the wetland area consists of several hazardous materials and chemicals that cause harmful effects to the species that depend on the wetland. The hazardous matters present in the dump not only affects the species that depend on the wetland, but also the soil underneath the dump. The soil lying below the dump loses all its nutrients and become infertile.

The SIPCOT Area Community Environmental Monitors group analysed an ambient air sample collected downwind of the garbage dump in Pallikaranai and found that it contained at least 27 chemicals, 15 of which greatly exceed health-based standards set by the United States Environmental Protection Agency. Three of the 27 chemicals are also known to cause cancer in humans and were found in quantities as high as 34,000 times above safe levels.

Such soil cannot be used for any purposes, further, these soil causes hazardous effects to the environment. If the dump area increases in this rate, it will occupy most of the wetland area in a very shorter period. This may lead to the total deterioration of the wetland. This may be prevented by reducing the quantity of dump in the wetland or dumping in a different suitable place.

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