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Biodiversity Assessment of the Mugalur Wetland : Post Restoration

Submitted to

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1. Introduction

Premise

The Mugalur wetland has been restored and is currently brimming with water after being dry for about 35 years. The work has been planned and executed by MYRADA. Before the initiation of restoration activity, an assessment of biodiversity was undertaken by Care Earth Trust during . Following all the activities after restoration, fencing and greening, the wetland and its vicinity was surveyed again for the status of biodiversity. It is to be noted that the water spread area has increased considerably. This report presents the results of the biodiversity studies after the restoration of Mugalur wetland.

Site description

Mugalur wetland is located in Mugalur village of Anekal taluk in Bengaluru (urban) district of Karnataka. The wetland is spread across 56 acres in a non-undulating terrain on the outskirts of the Mugular village, 9 km from Bengaluru. The waterbody is primarily fed by rainwater during the northeast monsoon and possess six inlets and one outlet canals. The waterbody is located southside of Mugalur village and northside of Kugur village with east and westside monocultures of Eucalyptus, Coconut, plantain and Teak plantations. Agricultural lands are present along the bund. Since human and cattle movements are frequent in this area, the waterbody and the adjoining plantations are disturbed constantly.

Drainage

The waterbody is mainly fed by the surface runoff from the tracts of degraded vegetation patches and plantations. There are inlets that help water inflow at six points and there is only one outlet. Five inlets have been restored in the year long process, by clearing of debris, silt and some encroachments. The wetland is filled with water this year after experiencing an above average rainfall in October .

Vegetation

The vegetation of Mugalur wetland is mainly represented by species of *Acacia nilotica, Acacia auriculiformis, Terminalia cuneata, Syzygium cumini*, and *Bambusa bambos*. These tree species have been planted under various panchayat and rural development schemes. Most of the trees are mature for harvest now, especially the *Acacia nilotica*. The waterlogged areas were lined with a good growth of *Saccharum spontaneum* before the summer of this year; but these have been submerged with the brimming water. Bund vegetation is mostly of herbs and shrubs. Plantation of new species, especially Bamboo, has been contributing to the biodiversity of the wetland periphery.

Assessing the biodiversity

Biodiversity is the short form of 'biological diversity'. It means 'all the variations and variability in life, seen and unseen'. In other words, it is the totality of variations in life – variations in form, habits, food, and habitat preference. Organisms that are similar and naturally interbreed are called as Species. This definition is known as the 'biological species concept'. Species is the most commonly used unit of life in assessing biodiversity. It is important to understand the increasing need for effective assessment and monitoring in rapidly changing landscapes urban waterbodies.

Different species occupy different niche in an ecosystem. To understand an ecosystem, it is very much important to know what species and how many of them inhabit the ecosystem. To start with, an area's species richness should be assessed first in biodiversity assessment. Species Richness is the number of different species present in a given area; a checklist of plants, invertebrates and vertebrate fauna would be the usual result of the above-mentioned survey. The next step is to look at the population of each major species, which eventually lead to the study of Relative Abundance. An understanding of the local food chain and food web will also be a result of biodiversity assessments.

Biodiversity assessment is a measure of some defined components of an ecosystem—most often components that are thought of as indicators (or surrogates) of the

conservation status of a species or area (Schipper, 2018). For instance, assessing areas of high biodiversity is important for determining key areas for conservation efforts to focus—but also as a tool to measure species communities and even discover new species. A rapid assessment of biodiversity is a tool to quickly inventory species in an area. It may be necessary to obtain either a quick initial inventory, to survey for a particular species or to compare between sites over larger areas. Biodiversity monitoring is similar to assessment except that it is repeated over time to capture information about trends and possible future trajectories of population, species, or communities in the natural system being studied. In fact, an assessment produces the baseline information upon which monitoring is developed. Effective assessment and monitoring are in turn fundamental to setting up an early warning system for biodiversity.

Choice of organisms – target organisms are species groups that are readily identified in the field. Identification is possible only when the plant or animal is clearly seen (or heard in case of some animals). Organisms may also be chosen based on the status, such as endangered species, endemic species, invasive alien species, keystone species, medicinal plants, wild relatives of crop plants, bio-indicators, etc. Not all the organisms (especially invertebrates) are easily seen or identified in the field and hence not included. However, insects like butterflies, dragonflies and ants can be identified during the assessment. Most commonly used species are those of birds and mammals. Sometimes depending on the expertise available, reptiles, amphibians and fish are also surveyed. Among flora, all higher plants including trees, shrubs, herbs, and grasses are included as target organisms.

An assessment of the status of biodiversity in and around the wetland has been carried out in the month of January 2022. The survey was done before the initiation of wetland restoration process, coinciding with the dry and cold season. This year, after the earth works, plantation and fencing works having been completed, another biodiversity survey has been undertaken by a team of experts.

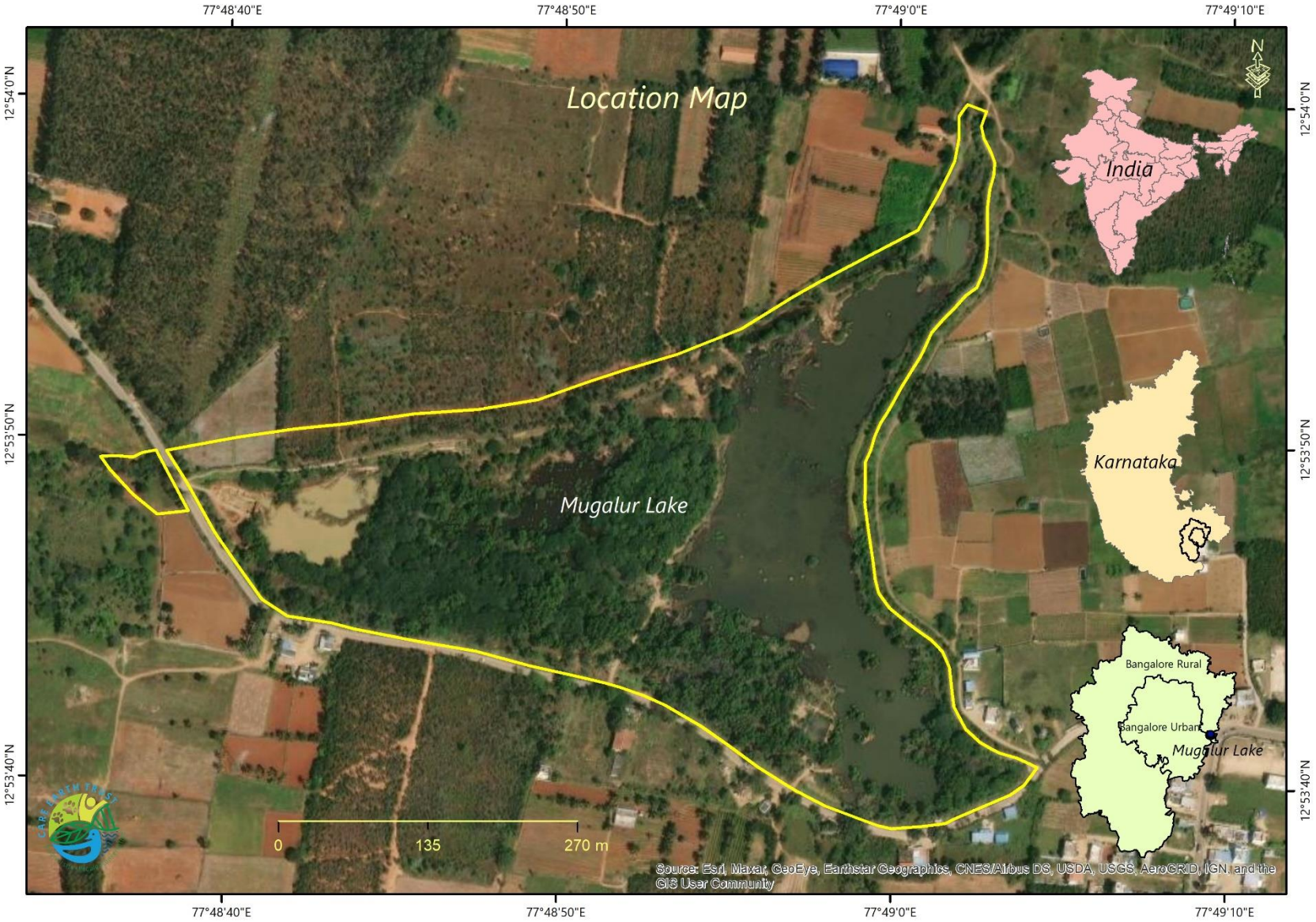
2. Methodology

The team has carried out the study largely in two aspects, *i.e.*, biodiversity and hydrology. Biodiversity assessments have been carried out in two different methods for animals and plants. The hydrology part was studied using the geographical information system (GIS) with ground verification from the site. The survey was carried out for about a week. All the parameters of both biodiversity and hydrology were recorded twice a day, *i.e.,* early morning and late evening. The wetland, its neighbourhood, associated check dams, inlet and outlet canals were all studied for a through understanding of the hydrological regime post restoration.

Biodiversity

Standard scientific protocols have been followed to assess the biodiversity in and around the wetland. The readily identifiable group of macroflora and macrofauna has been chosen for delineating the biodiversity profile of the wetland post monsoon. Larger groups with established standard taxonomy were studied for inventorying. Angiosperms are inventoried for plants; for animals, groups like Odonates, Butterflies, Birds, Mammals, Amphibians and Reptiles were studied.

The pre restoration works survey was carried out largely on the wetland bed, which has become a water spread area after the monsoon season, whereas, the post restoration studies has been largely concentrated over the uninundated areas of the wetland and its bunds. Many of the plants that were found on the wetland bed were submerged and eventually perished. The north and north-western portion has been added to the wetland from the encroached lands that were used for agricultural purpose. This portion is slightly elevated and has not been dredged, which harbours many species of grasses and other herbaceous plants.



Map 1. Location of the Mugalur wetland

Animal assessment and faunal survey

Birds and mammals are the faunal group that has been surveyed. All-out-search for all the faunal groups has been employed owing to the smaller area of the study site; *i.e.*, a thorough search of faunal elements in the landscape has been carried out in all seasons. The survey has been carried out on early mornings and late evenings, the time when the animals are active. Various bird species were identified and recorded while travelling to and from survey sites and separated from the standard survey times and survey spots. Indirect signs include skeleton remains, sloughs, shells, feathers, excreta, nails, calls, foot prints, etc. Photography has been the main tool for identification of both flora and fauna. Each Class of organisms are identified with the help of various manuals, books, and field guides. All the animals are photographed as much as possible; and the online field guides and e-books are used for secondary identification and to scrutinize diagnostic features.

Avifauna and mammals are the major indicators of wetland and land use changes. Moreover, the field team has carried out a detailed survey on birds to estimate the population and density. Birds are active during the early morning and evenings. The team surveyed birds in a in the early morning 7:30am and late evening at 4:45pm. Bird species are identified by observing morphological characters such as size, shape and colour of beak, leg, head, and tail.

The standard books referred for identifying birds are "Birds of the Indian Subcontinent" (Grimmett *et al*, 2011) and "A Pictorial Guide to the Birds of the Indian Subcontinent" (Ali and Ripley, 1995). The latter is quite exhaustive with complete descriptive text about a bird along with its status, distribution, and habitat. For quick identification in the field, Grimmett's field guide was used. Binoculars (8x magnification and 42 mm diameter) was the main tool used for bird identification. In addition, a point-n-shoot camera with 83x optical zoom was also used as a tool for recording.

Herpetofauna which includes reptiles (Order Squamata) and amphibians (Order Anura) are cryptic and often difficult to find them in the field. Photography is the main tool to record the secret and fast-moving animals. A field guide by S.R.Ganesh (2015) on

herpetofauna was used in the field for quick identification. Herpetofauna were identified using Daniels (2005), Gosari *et al*. (2022) and Kamdar *et al*. (2022). Fish species around the Bangalore and surrounding were identified using Krishnan *et al*. (2004). Mammals are identified using Bayani *et al.* (2022).

Floral assessments

The wetland and its environs are located in the southern part of the Karnataka state, which has predominant vegetation of Tropical Southern Thorn Forest (Champion and Seth, 1968).

The species composition of a plant community, in its simplest form is discerned by a list of species occurring in the habitat or landscape. An assessment study does not necessitate replicate surveys, but the baseline enumeration has to be conducted intensively. This would result in defining the plant species composition of the habitat. Plant phenological studies are fundamental for understanding the habitat as a resource base for dependent species, populations, and communities, including the invasive plants. Dominant species were considered to be those that were the most abundant in the inventory.

Angiosperms are the higher plants that are identified with the help of standard Flora and other related literature. 'Flora' here refers to the standard and accepted scientific treatise of plants that were present in a particular area or in a specified time period that aid in identification with correct nomenclatures. They are identified to the level of species as taxon. If a plant is unknown of its nomenclature, the plant parts are collected and identified in the lab. While collecting, it is important to gather the reproductive parts such as flowers or fruits apart from recording the characteristic features and habits in the field like presence of spines, fragrance, or glands etc. Floral characters are keys for identification to fix a plant up to species level. The standard Flora referred for accurate morphological identification are Gamble & Fischer (1967), Hooker (1872-1897), Roxburgh (1832) and Brandis (1874). Plant Systematics (Simpson, 2006) and Plant Systematics-theory and practice (Singh, 2020) are the standard books referred for glossary and

terminologies. The recent plant nomenclature followed in this report is based on revised Angiosperm Phylogeny Group classification (APG IV, 2016).

The landscape has been thoroughly assessed for higher plants in the post restoration study period. Flowers and fruits of herbaceous flora and grasses were recorded in this season, which helped higher accuracy in identification in the field itself. The assessment included survey and identification of herbs, grasses, trees, shrubs, climbers, and creepers etc. Hand-held lens and measuring scale have been used in the field as well in the lab as a tool for plant identification. Some flowers of distant or lofty trees are noticed and identified with the help of binoculars. Detailed checklist (species richness) is tabulated. Poaceae is one of the largest Angiospermic families in the country is quite complicated in morphology with intricate floral (flowers and fruits) characters. The species of Poaceae and Cyperaceae are identified and cross verified with specific treatise by Bor (1960) and Moulik (1997) for higher accuracy.

Geographical Information System and mapping

Geographical Information System (GIS) has been used with the help of QGis package and satellite imageries. The base data for mapping has been collected from the field; whereas, the chronological sceneries are obtained from satellite imageries of both landsat-7 and landsat-8. All the analysis has been performed in QGIS and associated Plugins. To delineate the temporal changes, Google Earth satellite imageries (WGS 84 projections) have been processed for various time periods. Processing of satellite images, which includes study area extent was downloaded as high-resolution images from Google Earth Pro as tiles. The former data tile was geo-referenced and was vectorised for various maps preparation.

GIS data sets and techniques include

- GPS Visualizer
- Handheld GPS
- Google Earth Pro
- Open Street Map (OSM)
- DEM SRTM (1 arc Second) used for Hydrological Analysis and Topography.

General steps followed in preparing GIS maps are as follows,

1. Data capture
2. sorting mange data with the study area
3. Reference with the primary data and observation
4. Analysis which includes topography and hydrological mapping
5. Final maps prepared with the layout and design.

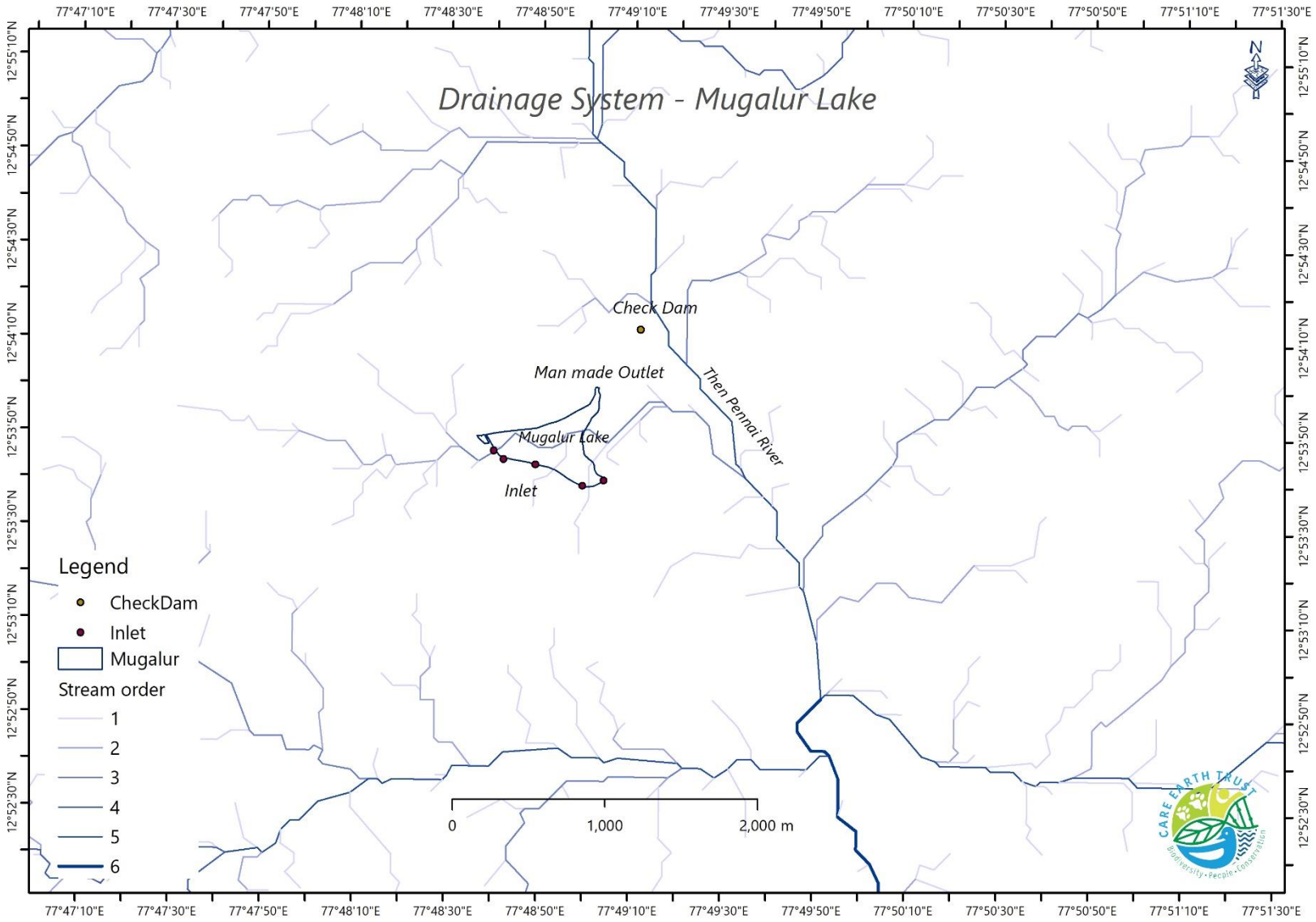
Elevation, topography, and slope

To understand the topography, elevation generated from Google Earth data, the package associated with GPS Visualizer online was downloaded as GPX data; that has been converted to GIS supported file format. This format has been interpolated with IDW (Interpolated Distance Weighted) technique as DEM with 5 m resolution. Slope map has been generated from elevation data. Contour maps are generated using the source data of DEM elevation with 10-meter interval.

Large extent of elevation data was extracted from Google Earth Pro. The mass points are constructed in and around the study area at 10-meter intervals, enabling greater than 5-meter horizontal resolution. The mass points are connected together using Google Earth WGS 84, and the ground elevation is calculated using each point. To verify the extracted elevation values, these are connected with the sample points collected on the field using GPS. After that, mass points are transformed into a TIN (Triangulated Irregular Network) model, and elevation is interpolated using the triangulation method. To visualize and evaluate the distribution of the data in the study area, it was categorized using the geomantic interval method.

Hydrological assessments

The hydrology of the region is presented at the scale of the landscape. The map of the drainage system was created using Aster DEM (Digital Elevation Model) data downloaded from USGS with a spatial resolution of 5 m. The following hydrological techniques were systematically followed in order to extract the stream flow. Initially, fill technique was utilized that fills sinks in a surface raster to remove small imperfections in the data. Secondly, the technique of flow direction was utilized that creates a raster of flow direction from each cell to its steepest down-slope neighbor. Thirdly, flow accumulation technique was utilized that creates a raster of accumulated flow into each cell. A weight factor can optionally be applied; the output is further analyzed using the conditional techniques where it performs a conditional if/else evaluation on each of the input cells of an input raster. The second technique evolves from Strahler method of stream ordering proposed by Strahler in 1952. Stream order only increases when streams of the same order intersect. Therefore, the intersection of a first-order and second-order link will remain a second-order link, rather than creating a third-order link. The final step in the hydrological analysis is the "stream to feature" where it converts a raster representing a linear network to features representing the linear network. Through this approach it was possible to identify the different channels of streams and their relationship or connectivity with wetlands.



Map 2. Drainage pattern in the wetland vicinity

3. Results and Discussion

The result section is arranged in such a way that biodiversity (plants and animal groups) is analysed and summarised first and then followed by GIS interpretations. Floral and faunal assessments are provided as part of the biodiversity documentation.

Plants of the wetland

The field surveys in and along the wetland periphery post restoration yielded 299 species of Angiosperms belonging to 212 Genera and 72 Families. Herbaceous flora that includes grasses, sedges and twiners dominate the landscape (Table 1).

The dominant family is Poaceae (grasses) with 34 species and 26 genera, Fabaceae with 22 species and 15 genera followed by Poaceae with 16 species and 15 genera. 162 genera and 34 families in the site are monotypic, *i.e.*, represented by single species each. Trees and saplings constitute 44 species in the area, which is almost the same as pre restoration survey. Some trees and saplings from the earlier survey got submerged in the water this November.

238 species are indigenous to the country and 61 are non-native, 50 of which have origins from Tropical America. These exotic plants are predominantly naturalized and a very few run invasive. There are some species like *Eucalyptus tereticornis, Grevillea robusta, Tectona grandis* and *Cocos nucifera* grown and raised as plantations along the periphery. *Acacia auriculiformis, Terminalia cuneata, Syzygium cumini, Acacia nilotica* and *Bambusa bambos* are planted in the water holding area of the wetland many years back by the Panchayat.

One of the major biotic factors apart from anthropogenic activities that poses a threat to the ecosystem is the spread of invasive species. The wetland and its moist periphery are subjected to tremendous human pressures that lead to invasive species proliferation. Wetland ecosystems, especially the wetland habitats are highly prone to invasion by exotic and non-native species.

Many of the recorded invasive species earlier have been wiped out with the restoration activities. However, there are few individual plants like *Hyptis suaveolens* and *Lantana camara* along roadside and near bunds that pose a threat in the future as plant invaders. Remnant patch of *Ipomoea carnea* along the western edge of the waterbody might spread faster when the water starts receding.

The landscape is typified by many thorny woody species of Mimosaceae, like *Acacia planifrons* (Umbrella Thorn Babool), *Acacia nilotica* (Indian Gum Arabic Tree) etc. All these armed plants (thorny and spinescent) form the Southern Thorn Forest type (Champion and Seth, 1968) in the region.

Grasses, sedges and reed are commonly seen closer to the water spread area. *Saccharum spontaneum* (Wild sugar cane) and *Typha angustifolia* (Cattail Reed) that are habitat specific growing in moist soil found common in the wetland during January have got submerged in water this November. *Manisuris myurus* is a rare grass of peninsular India having narrower distribution is found on the periphery of the wetland; the grass has another distribution range only at Manipur. Similarly, *Leucas diffusa*, an endemic herb to peninsular India has the next habitat at Delhi.

Majority of the species from the inventory are represented by terrestrial habitats, rather than aquatic. *Fimbristylis ovata* and *Bulbostylis barbata* are some of the few Cyperaceae (Sedges) members recorded from the wetland. *Vernonia cinerea, Senna auriculata, Ipomoea staphylina, Azima tetracantha* and *Senna occidentalis* are the most commonly seen non-woody large plants in the wetland vicinity. *Ipomoea hederifolia* is an elegant vine with its red trumpet like flowers found common along the fences and roadsides. Grass species got vibrant growth post monsoon in the wetland vicinity.

Vegetation status

The wetland and its vicinity have improved in vegetation owing to good rain spell as well as efforts in restoring the inlet canals to the wetland. The last phase of restoration involved in planting new tree species after the fencing activity. 20 species of trees have

been recorded as planted by MYRADA, Karnataka Forest Department and the Rural Development department, out of which six are exotic. Majority of the planted trees is represented by *Tabebuia rosea* saplings, which are hardy durable non-native species. Other planted species surveyed during the first week of November are listed in Table 1. Many of the planted species closer to the wetland bed got drowned and decayed with stagnant water in this monsoon season. The planted species added more diversity to the existing biodiversity. Each sapling is surrounded by thorny Phoenix palm fronds as a protective measure as individual fencing. For strengthening the bund surface, an herbaceous creeper called Chinese Wedelia or *Sphagneticola calendulacea* (L.) Pruski has been planted over the slopes.

Table 1. List of planted saplings in the vicinity of wetland

S.No.	Family	Botanical Name	Tamil Name	Origin
1	Anacardiaceae	***Mangifera indica*** L.	Maa maram	Indigenous
2	Bignoniaceae	***Millingtonia hortensis*** L.f.	Maramalli	Malaysian
3	Bignoniaceae	***Tabebuia rosea*** (Bertol.) Bertero ex A.DC.		Tropical America
4	Combretaceae	***Terminalia catappa*** L.	Natvadumai	Indigenous
5	Fabaceae	***Peltophorum pterocarpum*** (DC.)	Iyalvaagai	Indo-China
6	Fabaceae	***Pongamia pinnata*** (L.) Pierre	Punga maram	Indigenous
7	Fabaceae	***Senna siamea*** (Lam.) H.S.Irwin & Barneby	Manjakondrai	Indo-China
8	Lamiaceae	***Gmelina arborea*** Roxb.	Kumizha maram	Indo-China
9	Malvaceae	***Sterculia foetida*** L.	Pinaari maram	Indigenous
10	Malvaceae	***Thespesia populnea*** (L.) Soland ex Correa	Poovarasu	Indigenous
11	Meliaceae	***Azadirachta indica*** A. Juss.	Vaembu	Indigenous
12	Meliaceae	***Swietenia macrophylla*** King	Periya Mahagani	Tropical America
13	Moraceae	***Artocarpus heterophyllus*** Lam.	Palamaram	Indigenous
14	Moraceae	***Ficus benghalensis*** L.	Aalamaram	Indigenous
15	Moraceae	***Ficus religiosa*** L.	Arasu	Indigenous
16	Moraceae	***Ficus racemosa*** L.	Atthi	Indigenous
17	Muntingiaceae	***Muntingia calabura*** L.	Then pazham	Tropical America
18	Myrtaceae	***Psidium guajava*** L.	Koyya	Tropical America
19	Myrtaceae	***Syzygium cumini*** (L.) Skeels	Navaal	Indigenous
20	Ulmaceae	***Holoptelea integrifolia*** (Roxb.) Planch.	Aya, Aavi	Indigenous

Table 2. Flora life-form

Life form	No. of species	
	Pre restoration	Post restoration
Trees & saplings	45	44
Shrubs	36	33
Climbers & Liane	27	33
Herbs	127	144
Grass & Sedges	28	45

Table 3. Dominant plant families from the wetland environs

Family	No. of species	
	Pre restoration	Post restoration
Acanthaceae	15	11
Amaranthaceae	7	14
Asteraceae	12	16
Euphorbiaceae	14	14
Fabaceae	20	22
Malvaceae	13	18
Poaceae	25	34

Fauna of the wetland

The major habitat types of the wetland have been classified as water logged area, plantation and agriculture field. Given the biogeography, the wetland has the potential of supporting a rich faunal diversity. However, due to the continued human presence and resultant impacts, what the wetland presently supports is only a decimated fauna.

For faunal assessments, we used the standard method called 'all out search' for animal inventory and then carried out plots or black count methods for assessing population density. Transect method was employed to understand the faunal abundance. We recorded selected groups of vertebrates and invertebrates that are highly sensitive to habitat changes.

During the survey, a total of 134 faunal species got recorded. In that, 112 species were recorded before the restoration (January 2022), and 115 species have been recorded after the restoration in November. In all, 93 species were recorded both before and after the wetland restoration.

After restoration, the survey resulted groups of vertebrates and invertebrates with a total of 115 animal species, which includes birds (60), butterflies (33), Mammals (5), Reptiles (4), amphibians (3) and Fishes (5). Also, there are 11 species of recorded Odonata (Dragonflies and Damselflies). All the species observed are widespread in the country and typical of that of secondary degraded landscape, wetland and dry habitats that the wetland supports. Among insects, the Green Jewel bug *Chrysocoris stollii* and Robberfly are found to be common around the wetland.

What is however interesting is that two species of butterflies (Common Pierrot & Danaid Eggfly), one species of reptile (Bengal Monitor Lizard) and one species of bird (Indian Peafowl) are listed in the Schedule I of the Wildlife (Protection) Act 1972 of India. When listed in the Schedule I of the Act, the species enjoy the highest level of legal protection in the country.

A total of 134 faunal species were recorded in the Mugalur wetland, of which 69 bird species and 35 butterfly species are common and most abundant fauna in the habitat. From various survey methods, there found to be 15 bird species that depends primarily the wetland for habitat and foraging. The most common birds like, Red-wattled Lapwing, Black Drongo, Rose-ringed Parakeet, Common Myna and Yellow-billed Babbler were recorded frequently and are found to be in large numbers. Booted Eagle got recorded only once during the survey in November. Shikra, Brahminy Kite and Black Kite are the primary raptor species found in this habitat. In addition, Changeable Hawk-Eagle and Oriental Honey-buzzard shares the hierarchy in the energy pyramid of the wetland.

Eight species of mammals belonging to 5 families and 4 orders were recorded from the site through visual encounter surveys. Indian Grey Mongoose and Common Palm Squirrel are commonly found in the bushes and trees of the wetland vicinity.

Eight fish species belonging to 4 families and 7 orders using secondary literature survey and information from local people *via* nonstructural interviews. Occasion angling of fishes has been a common sight in the wetland bund by the local people. Tilapia is the abundant species. Six species of herpetofauna belonging to 6 families and 2 orders were inventoried from the wetland and its vicinity. The surveys were carried out both during day and night every day. Changeable Lizard or Garden Lizard is most commonly seen during the day time. Common Skittering frog and Common Indian Cricket Frog are common during the night walks in Mugalur Wetland.

GIS Analysis

With the help of data obtained from the field site using geographical positioning system (GPS) and ground truthing observations, the maps are prepared using GIS platforms and plugins.

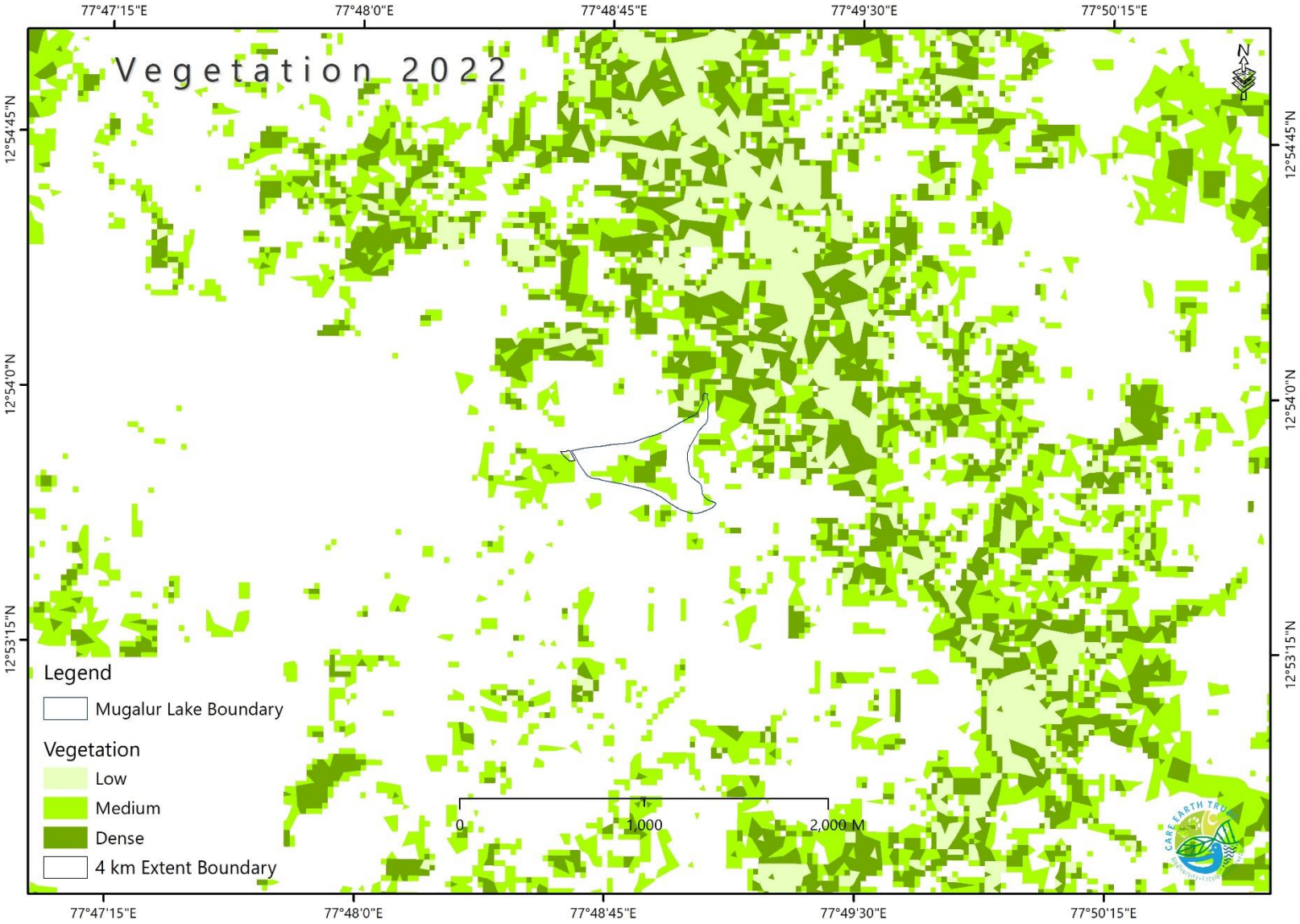
The major source of water flow into the wetland is surface runoff during monsoon; the smaller streams from the wetland joins the farther 7^{th} order streams through Gundur wetland to Kelavarapalli Reservoir. The field survey finds six man-made inlets to the wetland. However, the hydrological analysis using GIS revealed that the natural and large stream inflow is located on the west portion of the waterbody; which is located in between 5^{th} and 6^{th} inlets. The bund for the wetland is raised only on the western side and particular portion would be the best natural outflow for the waterbody, through the agricultural lands. The vegetation is also sparse on the western side. But, if monsoon fails or water scarcity prevails, the western bund could be retained for storing more quantity of water.

Elevation and slope

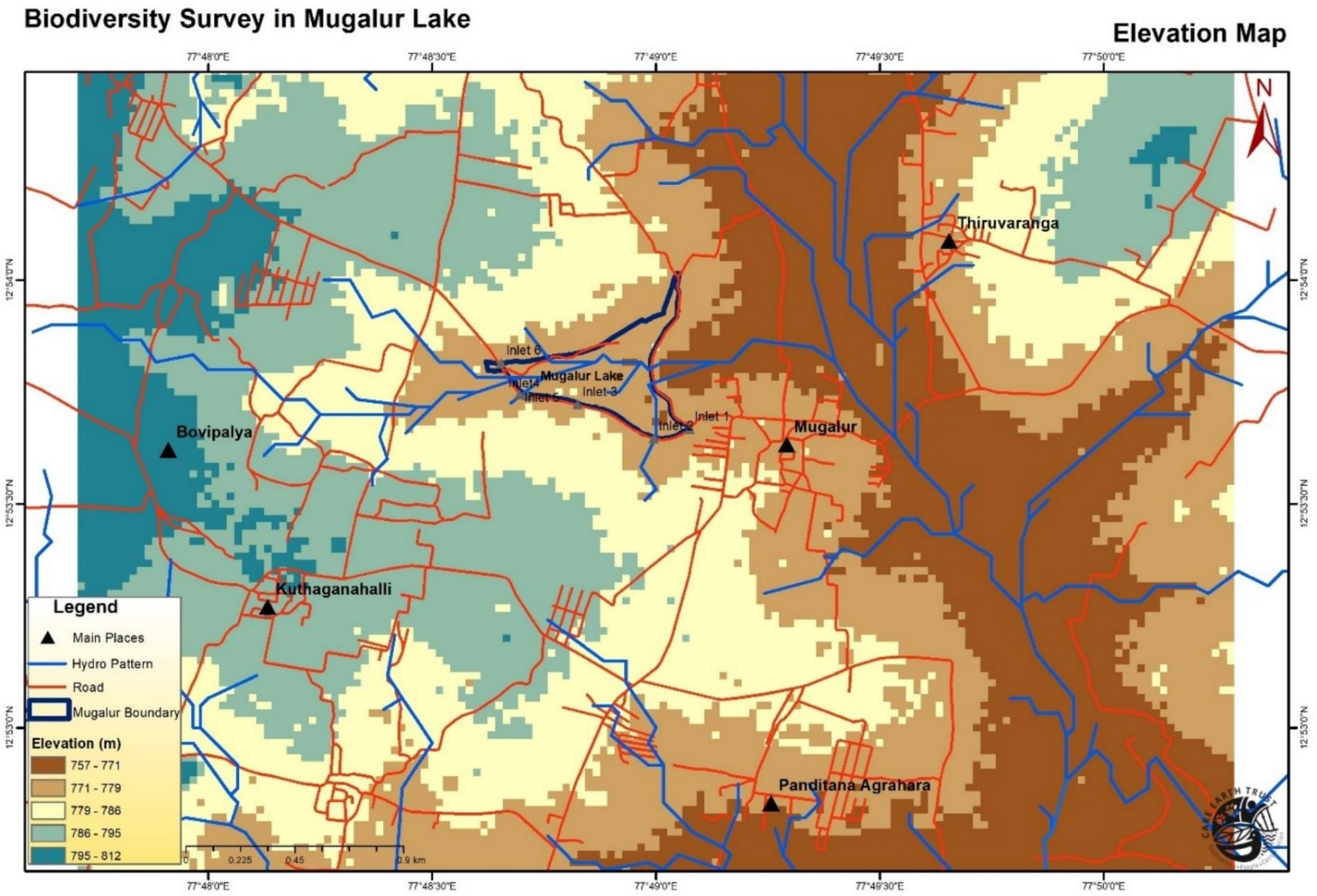
The elevation of the wetland area varies from a minimum of 852 m asl to a maximum of 859 m asl with a mean value of 855 m asl. It is observed that the Southern part of the wetland is low in elevation (852 - 855 m asl). The overall terrain is mostly flat with minimum undulations with the slope varying between a minimum of 1.1 deg to a maximum of 18.05 deg and a mean value of 7.22 deg. It is observed that the Southern part of the wetland is flat in slope, low in elevation. As a result, depth of the water is medium in this part of the wetland, that is, 1-1.5 m deeper than the rest of the wetland. The excess water from the wetland drains in to Then Pennaiyaar River in the east, which is polluted to the hardcore.

Chrysopogon lawsonii – a rare grass in the wetland periphery

Acacia polyacantha – commonly found spinous tree in the neighbourhood

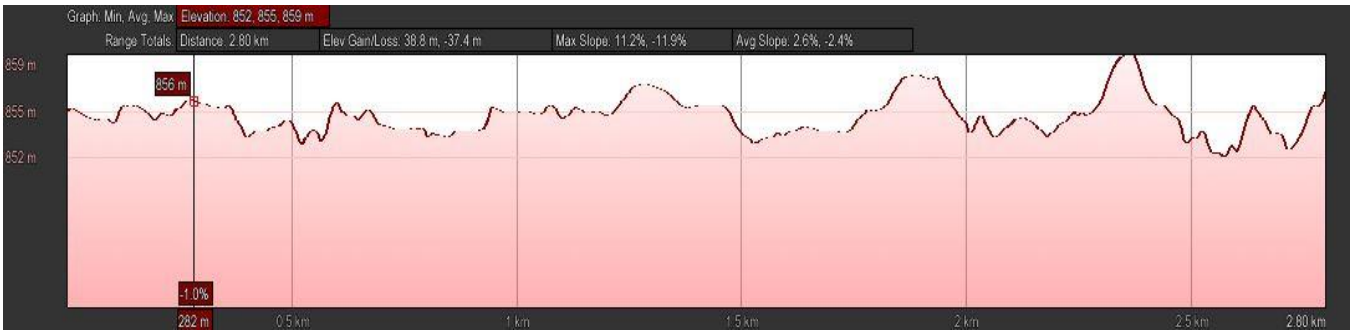


Map 2. Vegetation classification in the wetland and its vicinity



Map 3. Elevation map of the terrain

Elevation profile of wetland



Source: Google Earth Pro

The above map indicates the elevation profile of the wetland from East - West, an elevation of 852 m asl to 859 m asl. It also indicates the length of the wetland – 761 m asl, which is the length that water will flow from one end of the wetland to the other. Approximately at 300 m mark, water stagnates due to the low-lying terrain occurring at that point. It is also a point of low elevation and low slope as indicated.

Hydrological Analysis

This part examines the natural stream flow, watershed area of the wetland and its association with surface topography. Source of the data has been used from Google Earth Pro and GPS Visualiser.

Basic Hydrological details includes,

Watershed area: 63.131 Ha.
Maximum elevation: 812 M
Minimum elevation: 757 M
Length of the major inlet stream: 2.56 km to the wetland

Drainage pattern is rectangular on the origin and end of the stream is like a dendric pattern. Rectangular pattern is typically formed in areas where rock joints form a rectangular pattern. Surface runoff collects in such elongated clefts because the rocks are weathered and eroded along the intersections of joints, cracks, and faults. This the resultant of during precipitation process erosion and deposition leading higher in this place. The dendritic drainage pattern is called a drainage pattern that looks like tree

branches (Map 2). The dendritic drainage systems are not straight and it is the most common type of draining system in our country. Geographically, the dendritic pattern type is the result of rocks that are impervious and non-porous.

Conclusion

The restoration work that has been completed recently along with abundant rainfall this year, has made the wetland hold water to its maximum level after 35 years. Local people celebrated this achievement with a boat (theppam) festival in the wetland. Consequently, there has been improvement in overall biodiversity with more species of grasses and herbaceous coming up, increasing the productivity of the wetland. Many birds started visiting the wetland, as it is the starting of migratory season in the region. The waterbody has been completely fenced after restoration of the inlet canals. Many of the original land parcels has been brought under the current waterbody survey in this project. One such linear land parcel is located on the northern portion of the wetland, abutting an erstwhile farm land. This part of the wetland has not been dredged and so, it is shallower and the elevation is closer to the adjacent landscape. The same northern portion, which already has lot of planted saplings, harbours more biodiversity in terms of herbaceous species and passerine birds. There is a small land portion in the southern side behind the road, which has been recovered from encroachment is also the part of the wetland legally. Many saplings have been planted in the wetland bed area and open spaces for improving the greenery for the wetland; however, much of the saplings got immersed in the water after monsoon. The wetland periphery has many saplings planted in single rows with an espacement of five feet linearly, which are establishing themselves stronger. The analysis of remote sensing data suggests the drainage of the wetland towards the river happens eastwards and not the traditional outlet direction as practiced now. The wetland is also an important site for migratory bird species.

Table 4. List of Angiosperms from the study site

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
1	Acanthaceae	***Andrographis echioides*** Nees	Gopuram thaangi	Herb	Indigenous
2	Acanthaceae	***Barleria mysorensis*** Heyne ex Roth		Herb	Indigenous
3	Acanthaceae	***Barleria prionitis*** L.	Kattukanagambaram	Shrub	Indigenous
4	Acanthaceae	***Blepharis maderaspatensis*** (L.) Heyne ex Roth	Nethira moolli	Herb	Indigenous
5	Acanthaceae	***Dipteracanthus patulus*** (Jacq.) Nees	Vedichchedi	Herb	Indigenous
6	Acanthaceae	***Dipteracanthus prostratus*** (Poir.) Nees	Pottakanchi	Herb	Indigenous
7	Acanthaceae	***Hygrophila schulli*** (Hamilt.) M.R.Almeida & S.M.Almeida	Neermulli	Herb	Indigenous
8	Acanthaceae	***Justicia prostrata*** (Roxb. ex Clarke) Gamble		Herb	Indigenous
9	Acanthaceae	***Justicia tranquebariensis*** L.f.	Thavasi murungai	Herb	Indigenous
10	Acanthaceae	***Peristrophe paniculata*** (Forssk.) Brummitt	karakkanciram	Herb	Indigenous
11	Acanthaceae	***Ruellia tuberosa*** L.		Herb	Indigenous
12	Agavaceae	***Agave angustifolia*** Haw.	Kathazhai	Shrub	Tropical America
13	Aizoaceae	***Trianthema portulacastrum*** L.	Sharanai	Herb	Indigenous
14	Aizoaceae	***Zaleya decandra*** (L.) Burm.f.	Charanai	Herb	Indigenous
15	Alangiaceae	***Alangium salvifolium*** (L.f.) Wang.	Azhinjil	Tree	Indigenous
16	Amaranthaceae	***Achyranthes aspera*** L.	Sennaiyuruvi	Herb	Indigenous
17	Amaranthaceae	***Aerva lanata*** (L.) Juss. ex Schultes	Sirupeelai	Herb	Indigenous
18	Amaranthaceae	***Alternanthera ficoidea*** (L.) P.Beauv.		Herb	Tropical America
19	Amaranthaceae	***Alternanthera philoxeroides*** (C. Martiu) Griseb.		Herb	Tropical America
20	Amaranthaceae	***Alternanthera pungens*** Kunth		Herb	Tropical America
21	Amaranthaceae	***Alternanthera sessilis*** (L.) R.Br. ex DC.	Ponnanganni	Herb	Indigenous
22	Amaranthaceae	***Amaranthus blitum*** L.	Aarumathathandu	Herb	Mediterranean
23	Amaranthaceae	***Amaranthus spinosus*** L.	Mullukkeerai	Herb	Indigenous
24	Amaranthaceae	***Amaranthus viridis*** L.	Kuppai keerai	Herb	Indigenous
25	Amaranthaceae	***Celosia argentea*** L.	Pannai keerai	Herb	Indigenous
26	Amaranthaceae	***Celosia polygonoides*** Retz.		Herb	Indigenous
27	Amaranthaceae	***Gomphrena globosa*** L.	Vaadamalli	Herb	Tropical Africa

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
28	Amaranthaceae	***Gomphrena serrata*** L.		Herb	Tropical America
29	Amaranthaceae	***Pupalia lappacea*** (L.) Juss.	Adai-otti	Herb	Indigenous
30	Apocynaceae	***Wrightia tinctoria*** (Roxb.) R.Br.	Nilapaalai	Tree	Indigenous
31	Araceae	***Zantedeschia aethiopica*** (L.) Spreng.		Herb	Tropical Africa
32	Arecaceae	***Cocos nucifera*** L.	Thennei	Tree	Indigenous
33	Arecaceae	***Phoenix pusilla*** Gaertn	Eechai	Tree	Indigenous
34	Aristolochiaceae	***Aristolochia indica*** L.	Aadagam	Twiner	Indigenous
35	Asclepiadaceae	***Asclepias curassavica*** L.		Herb	Tropical America
36	Asclepiadaceae	***Calotropis gigantea*** (L.) R.Br.	Erukku, Puzhagu	Shrub	Indigenous
37	Asclepiadaceae	***Pergularia daemia*** (Forrsk.) Chiov.	Uthamani	Climber	Indigenous
38	Asclepiadaceae	***Sarcostemma secamone*** (L.) Bennet	Oosippalai, Kalappalai	climber	Indigenous
39	Asclepiadaceae	***Tylophora indica*** (Burm.f.) Merr.	Naippalai	Climber	Indigenous
40	Asparagaceae	***Asparagus racemosus*** Willd.	Thaneer vitaan kizhangu	Climber	Indigenous
41	Asteraceae	***Ageratum conyzoides*** L.	Poom pillu	Herb	Tropical America
42	Asteraceae	***Bidens pilosa*** L.		Herb	Indigenous
43	Asteraceae	***Blumea mollis*** (D.Don) Merr.	Suvattru mullangi	Herb	Indigenous
44	Asteraceae	***Blumea obliqua*** (L.) Druce		Herb	Indigenous
45	Asteraceae	***Chromolaena odorata*** (L.) King & Robinson		Shrub	Tropical America
46	Asteraceae	***Conyza bonariensis*** (L.) Cronquist		Herb	Tropical America
47	Asteraceae	***Crassocephalum crepidioides*** (Benth.) S.Moore		Herb	Tropical Africa
48	Asteraceae	***Emilia sonchifolia*** (L.) DC.		Herb	Indigenous
49	Asteraceae	***Parthenium hysterophorus*** L.	Mookithipoo	Herb	Tropical America
50	Asteraceae	***Sonchus asper*** (L.) Hill		Herb	Mediterranean
51	Asteraceae	***Spilanthes calva*** DC.	Akkarakaaram	Herb	Indigenous
52	Asteraceae	***Synedrella nodiflora*** (L.) Gaertn.		Herb	Tropical America
53	Asteraceae	***Tridax procumbens*** L.	Vettukkaaya-thazhai	Herb	Tropical America
54	Asteraceae	***Vernonia cinerea*** (L.) Less.	Mookutthipoondu	Herb	Indigenous
55	Asteraceae	***Wedelia chinensis*** (Osbeck) Merr.	Manjal Karisalankanni	Herb	Indigenous
56	Asteraceae	***Xanthium indicum*** Koen.	Marul oomatham	Herb	Tropical America

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
57	Bignoniaceae	***Millingtonia hortensis*** L.f.	Kattumalli, Maramalli	Tree	Malaysian
58	Bignoniaceae	***Tecoma stans*** (L.) Kunth	Nagashenbagam	Shrub	Tropical America
59	Boraginaceae	***Coldenia procumbens*** L.	Seruppadai	Herb	Indigenous
60	Boraginaceae	***Heliotropium bracteatum*** R. Br.	Siru thael kodukku	Herb	Indigenous
61	Boraginaceae	***Trichodesma indicum*** (L.) R. Br.	Kali thumbai	Herb	Indigenous
62	Boraginaceae	***Trichodesma zeylanicum*** (Burm.f.) R. Br.		Herb	Indigenous
63	Brassicaceae	***Brassica juncea*** (L.) Czern. & Coss.	Kadugu	Herb	Indigenous
64	Caesalpiniaceae	***Chamaecrista pumilla*** (Lam.) K. Larsen		Herb	Indigenous
65	Caesalpiniaceae	***Pterolobium hexapetalum*** (Roth.) Santapau & Wagh	Kaarindu	Climber	Indigenous
66	Caesalpiniaceae	***Senna auriculata*** (L.) Roxb.	Avaram	Tree	Indigenous
67	Caesalpiniaceae	***Senna hirsuta*** (L.) Irwin & Barneby		Shrub	Indigenous
68	Caesalpiniaceae	***Senna occidentalis*** (L.) Link	Peiyavarai	Tree	Tropical America
69	Caesalpiniaceae	***Senna uniflora*** (Mill.) H.S.Irwin & Barneby		Herb	Tropical America
70	Caesalpiniaceae	***Tamarindus indica*** L.	Puliya maram	Tree	Indigenous
71	Cannaceae	***Canna indica*** L.	Kal vaazhai	Herb	Tropical America
72	Capparidaceae	***Capparis zeylanica*** L.	Athondai	Climber	Indigenous
73	Capparidaceae	***Cleome aspera*** Koen ex. DC.		Herb	Indigenous
74	Capparidaceae	***Cleome viscosa*** L.	Nai kadugu	Herb	Indigenous
75	Capparidaceae	***Senna obtusifolia*** (L.) H.S.Irwin & Barneby		Shrub	Tropical America
76	Caricaceae	***Carica papaya*** L.	Pappali	Tree	Tropical America
77	Caryophyllaceae	***Polycarpaea corymbosa*** (L.) Lam.	Nilaisedachi	Herb	Indigenous
78	Chenopodiaceae	***Chenopodium ambrosioides*** L.		Herb	Tropical America
79	Combretaceae	***Combretum albidum*** G. Don	Vennaangu kodi	Shrub	Indigenous
80	Combretaceae	***Terminalia cuneata*** Roxb.	Neer Marudhu	Tree	Indigenous
81	Commelinaceae	***Commelina attenuata*** Koen var. Vahl		Herb	Indigenous
82	Commelinaceae	***Commelina benghalensis*** L.	Kanaangozhai	Herb	Indigenous
83	Commelinaceae	***Commelina diffusa*** Burm		Herb	Indigenous
84	Commelinaceae	***Cyanotis cristata*** (L.) D. Don		Herb	Indigenous
85	Convolvulaceae	***Argyreia elliptica*** (Roth) Choisy	Thaali vendaankodi	Climber	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
86	Convolvulaceae	***Evolvulus alsinoides*** (L.) L.	Vishnukarandi	Herb	Indigenous
87	Convolvulaceae	***Evolvulus nummularius*** (L.) L.		Herb	Indigenous
88	Convolvulaceae	***Ipomoea carnea*** Jacq.		Climber	Tropical America
89	Convolvulaceae	***Ipomoea hederifolia*** L.	Kanavalikkodi	Climber	Tropical America
90	Convolvulaceae	***Ipomoea marginata*** (Desr.) Verdc .	Thalikkeerai	Climber	Indigenous
91	Convolvulaceae	***Ipomoea obscura*** (L.) Ker-Gawl.	Siru thali	Twiner	Indigenous
92	Convolvulaceae	***Ipomoea quamoclit*** L.	Mayilmanickam	Twiner	Tropical America
93	Convolvulaceae	***Ipomoea staphylina*** Roem. & Schultes	Onaan kodi	climber	Indigenous
94	Convolvulaceae	***Merremia emarginata*** (Burm.f.) Hall.f.	Perettaikkeerai	Herb	Indigenous
95	Convolvulaceae	***Merremia quinquefolia*** (L.) Hall.f.		Climber	Indigenous
96	Convolvulaceae	***Merremia tridentata*** (L.) Hall.f.	Avvaiyaar koondhal	Herb	Indigenous
97	Convolvulaceae	***Rivea hypocrateriformis*** (Desr.) Choisy	Boodhikeerai	Climber	Indigenous
98	Cucurbitaceae	***Coccinia grandis*** (L.) Voigt	Kovai	Climber	Indigenous
99	Cucurbitaceae	***Corallocarpus epigaeus*** (Rottl. & Willd.) Clarke	Garudan kizhangu	Climber	Indigenous
100	Cucurbitaceae	***Diplocyclos palmatus*** (L.) Jeffrey		Climber	Indigenous
101	Cucurbitaceae	***Mukia maderaspatana*** (L.) M. Roem.	Musundai	Climber	Indigenous
102	Cyperaceae	***Bulbostylis barbata*** (Rottb.) Clarke		Sedge	Indigenous
103	Cyperaceae	***Cyperus bulbosus*** Vahl	Koraikizhanghu	Sedge	Indigenous
104	Cyperaceae	***Cyperus compressus*** L.		Sedge	Indigenous
105	Cyperaceae	***Cyperus diffusus*** Vahl.		Sedge	Indigenous
106	Cyperaceae	***Cyperus distans*** L.		Sedge	Indigenous
107	Cyperaceae	***Cyperus iria*** L.		Sedge	Indigenous
108	Cyperaceae	***Cyperus rotundus*** L.	Kaanikorai	Sedge	Indigenous
109	Cyperaceae	***Fimbristylis falcata*** (Vahl.) Kunth		Sedge	Indigenous
110	Cyperaceae	***Fimbristylis ovata*** (Burm. F.) Kern		Sedge	Indigenous
111	Cyperaceae	***Kyllingia nemoralis*** (J.R. & G.Forst.) Dandy ex Hutchinson & Dalziel		Sedge	Indigenous
112	Cyperaceae	***Mariscus clarkei*** (Cooke) T. Koyama		Sedge	Indigenous
113	Dioscoreaceae	***Dioscorea oppositifolia*** L.	Kaattu valli kizhangu	Climber	Indigenous
114	Dracaenaceae	***Sansevieria roxburghiana*** Schultes & Schultes	Marun	Herb	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
115	Euphorbiaceae	***Acalypha indica*** L.	Kuppaimeni	Herb	Indigenous
116	Euphorbiaceae	***Croton bonplandianum*** Baill.	Rail poondu	Herb	Tropical America
117	Euphorbiaceae	***Euphorbia antiquorum*** L.	Sadura-kalli	Tree	Indigenous
118	Euphorbiaceae	***Euphorbia heterophylla*** L.		Herb	Tropical America
119	Euphorbiaceae	***Euphorbia hirta*** L.	Ammanpacharisi	Herb	Indigenous
120	Euphorbiaceae	***Flueggea leucopyrus*** Willd.	Pulanji	Shrub	Indigenous
121	Euphorbiaceae	***Jatropha gossypifolia*** L.	Kaatu-amanakku	Shrub	Indigenous
122	Euphorbiaceae	***Phyllanthus amarus*** Schum. & Thonn.	Kizha-nelli	Herb	Tropical America
123	Euphorbiaceae	***Phyllanthus debilis*** Klein ex Willd.		Herb	Indigenous
124	Euphorbiaceae	***Phyllanthus maderaspatensis*** L.	Mevanelli	Herb	Indigenous
125	Euphorbiaceae	***Phyllanthus reticulatus*** Poir.	Inki pazham	Shrub	Indigenous
126	Euphorbiaceae	***Phyllanthus virgatus*** Forst.		Herb	Indigenous
127	Euphorbiaceae	***Ricinus communis*** L.	Amanakku	Tree	Tropical America
128	Euphorbiaceae	***Tragia involucrata*** L.	Chenthatti	Climber	Indigenous
129	Fabaceae	***Abrus precatorius*** L.	Kundumani	Shrub	Indigenous
130	Fabaceae	***Aeschynomene aspera*** L.	Attrunetti	Shrub	Indigenous
131	Fabaceae	***Alysicarpus monilifer*** (L.) DC.		Herb	Indigenous
132	Fabaceae	***Cajanus scarabaeoides*** (L.) Thouars		Twiner	Indigenous
133	Fabaceae	***Clitoria ternatea*** L.	Sangu poo	Climber	Tropical America
134	Fabaceae	***Crotalaria hebecarpa*** (DC.) Rudd		Herb	Indigenous
135	Fabaceae	***Crotalaria pallida*** Dryand.		Herb	Indigenous
136	Fabaceae	***Crotalaria retusa*** L.	Kilukiluppai	Herb	Indigenous
137	Fabaceae	***Dalbergia sissoo*** Roxb.	Sisu, Gette, Nookam	Tree	Indigenous
138	Fabaceae	***Desmodium triflorum*** (L.) DC.	Sirupulladi	Herb	Indigenous
139	Fabaceae	***Indigofera colutea*** (Buem. F.) Merr.		Herb	Indigenous
140	Fabaceae	***Indigofera linifolia*** (L.f.) Retz.	Neelilai Neelamari	Herb	Indigenous
141	Fabaceae	***Indigofera linnaei*** Ali		Herb	Indigenous
142	Fabaceae	***Macroptilium atropurpureum*** (DC.) Urban		Climber	Tropical America
143	Fabaceae	***Pongamia pinnata*** (L.) Pierre	Punga maram	Tree	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
144	Fabaceae	***Rhynchosia aurea*** (Willd.) DC.		Herb	Indigenous
145	Fabaceae	***Rhynchosia minima*** (L.) DC.		Climber	Indigenous
146	Fabaceae	***Stylosanthes fruticosa*** (Retz.) Alston	Musalmasaal	Shrub	Indigenous
147	Fabaceae	***Tephrosia pumila*** (Lam.) Pers.		Herb	Indigenous
148	Fabaceae	***Tephrosia purpurea*** (L.) Pers.	Kozhinji	Herb	Indigenous
149	Fabaceae	***Tephrosia villosa*** (L.) Pers.	Poonaikaai vetthalai	Herb	Indigenous
150	Fabaceae	***Zornia diphylla*** (L.)	Arundhalai otti	Herb	Indigenous
151	Gentianaceae	***Canscora decussata*** (Roxb.) Schultes & Schultes		Herb	Indigenous
152	Lamiaceae	***Anisomeles indica*** (L.) Kuntze		Herb	Indigenous
153	Lamiaceae	***Hyptis suaveolens*** (L.) Poit.	Seema Thulasi	Shrub	Tropical America
154	Lamiaceae	***Leucas aspera*** (Willd.) Link	Thumbai	Herb	Indigenous
155	Lamiaceae	***Leucas biflora*** (Vahl) R.Br.		Herb	Indigenous
156	Lamiaceae	***Ocimum americanum*** L.	Ganjaankorai	Herb	Indigenous
157	Lamiaceae	***Ocimum tenuiflorum*** L.	Thulasi	Herb	Indigenous
158	Lemnaceae	***Lemna perpusilla*** Torrey		Herb	Indigenous
159	Lemnaceae	***Spirodela polyrhiza*** (L.) Schleiden		Herb	Indigenous
160	Loranthaceae	***Dendrophthoe falcata*** (L.f.) Etting.	Pulluruvi	Shrub	Indigenous
161	Malvaceae	***Abutilon hirtum*** (Lam.) Sweet	Thuthi	Shrub	Indigenous
162	Malvaceae	***Abutilon indicum*** (L.) Sweet.	Perun thuthi	Shrub	Indigenous
163	Malvaceae	***Gossypium hirsutum*** L.	Paruthi	Shrub	Tropical America
164	Malvaceae	***Hibiscus lobatus*** (Murr.) Kuntze		Herb	Indigenous
165	Malvaceae	***Hibiscus lunariifolius*** Willd.		Herb	Indigenous
166	Malvaceae	***Hibiscus micranthus*** L.f.	Sitraamutti	Herb	Indigenous
167	Malvaceae	***Hibiscus rosa-sinensis*** L.	Sembaruthi	Shrub	Tropical Africa
168	Malvaceae	***Malvastrum coromandelianum*** (L.) Garcke		Herb	Indigenous
169	Malvaceae	***Pavonia odorata*** Willd.	Peramutti	Herb	Indigenous
170	Malvaceae	***Pavonia zeylanica*** (L.) Cav.	Mammatti	Herb	Indigenous
171	Malvaceae	***Sida acuta*** Burm.f.	Arival mooku poondu	Herb	Indigenous
172	Malvaceae	***Sida cordata*** (Burm. f.) Borssum	Pazhampaasi	Herb	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
173	Malvaceae	***Sida cordifolia*** L.	Nilatutthi	Herb	Indigenous
174	Malvaceae	***Sida mysorensis*** Wight & Arn.		Herb	Indigenous
175	Malvaceae	***Sida spinosa*** L.	Arival manai poondu	Herb	Indigenous
176	Malvaceae	***Thespesia populnea*** (L.) Soland ex Correa	Poovarasu	Tree	Indigenous
177	Malvaceae	***Urena lobata*** L. subsp. ***Lobata***	Ottatthi, Ottu thuthi	Shrub	Indigenous
178	Malvaceae	***Urena lobata*** L. subsp. ***sinuata*** (L.) Borssum	Ottatthi, Ottu thuthi	Shrub	Indigenous
179	Meliaceae	***Azadirachta indica*** A. Juss.	Vaembu, Vaeppam	Tree	Indigenous
180	Menispermaceae	***Cocculus hirsutus*** (L.) Diels	Kattukodi	Climber	Indigenous
181	Menispermaceae	***Pachygone ovata*** (Poir.) Miers ex Hook.f. & Thoms.	Siru Kattukodi	Climber	Indigenous
182	Menispermaceae	***Tinospora cordifolia*** (Willd.) Miers ex Hook.f. & Thoms.	Seendhil	Climber	Indigenous
183	Mimosaceae	***Acacia auriculiformis*** A. Cunn ex Benth.	Maankaadhu	Tree	Australia
184	Mimosaceae	***Acacia nilotica*** (L.) Willd. ex Del.	Karuvelam	Tree	Indigenous
185	Mimosaceae	***Acacia polyacantha*** Willd.	Parambai	Tree	Indigenous
186	Mimosaceae	***Albizia lebbeck*** (L.) Willd.	Vaagai	Tree	Indigenous
187	Mimosaceae	***Albizia saman*** (Jacq.) F.v. Muell.	Thoongu moonji	Tree	Tropical America
188	Mimosaceae	***Dichrostachys cinerea*** (L.) Wight & Arn.	Vidathalam thazhai	Tree	Indigenous
189	Mimosaceae	***Mimosa pudica*** L.	Thotaal surungi	Herb	Indigenous
190	Mimosaceae	***Pithecellobium dulce*** (Roxb.) Benth.	Kodukkaai puli	Tree	Tropical America
191	Mimosaceae	***Prosopis juliflora*** (Sw.) Dc.	Velikkaathaan	Tree	Tropical America
192	Molluginaceae	***Gisekia pharnaceoides*** L.	Manal keerai	Herb	Indigenous
193	Molluginaceae	***Mollugo cerviana*** (L.) Ser.	Parpaadagam	Herb	Indigenous
194	Molluginaceae	***Mollugo nudicaulis*** Lam.		Herb	Indigenous
195	Molluginaceae	***Mollugo pentaphylla*** L.	Parpaadagam	Herb	Indigenous
196	Moraceae	***Artocarpus heterophyllus*** Lam.	Palamaram	Tree	Indigenous
197	Moraceae	***Ficus benghalensis*** L.	Aalamaram	Tree	Indigenous
198	Moraceae	***Ficus elastica*** Roxb. ex Hornem.		Tree	Malaysian
199	Moraceae	***Ficus racemosa*** L.	Atthi	Tree	Indigenous
200	Moraceae	***Ficus religiosa*** L.	Arasu	Tree	Indigenous
201	Moraceae	***Streblus asper*** Lour.	Kuruvipala	Tree	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
202	Musaceae	***Musa parasidiaca*** L.	Vaazhai	Herb	Indigenous
203	Myrtaceae	***Eucalyptus tereticornis*** Sm.	Thaila maram	Tree	Australia
204	Myrtaceae	***Syzygium cumini*** (L.) Skeels	Navaal	Tree	Indigenous
205	Nyctaginaceae	***Boerhavia diffusa*** L.	Mookarattai	Herb	Indigenous
206	Nyctaginaceae	***Boerhavia erecta*** L.	Seemai mookarattai	Herb	Tropical America
207	Nyctaginaceae	***Commicarpus chinensis*** (L.) Heimerl	Saatathanai	Herb	Indigenous
208	Oleaceae	***Jasminum auriculatum*** Vahl	Mullai	climber	Indigenous
209	Onagraceae	***Ludwigia hyssopifolia*** (G. Don) Exell	Neer kirambu	Herb	Indigenous
210	Papaveraceae	***Argemone mexicana*** L.	Braman Thandu	Herb	Tropical America
211	Passifloraceae	***Passiflora foetida*** L.	Siruppoonaikkaali	Climber	Tropical America
212	Pedaliaceae	***Pedalium murex*** L.	Perunerunji	Herb	Tropical America
213	Periplocaceae	***Hemidesmus indicus*** (L.) R.Br.	Nannaari	Twiner	Indigenous
214	Plumbaginaceae	***Plumbago zeylanica*** L.	Chitthiragam	Herb	Indigenous
215	Poaceae	***Apluda mutica*** L.	Moongil pul	Grass	Indigenous
216	Poaceae	***Aristida adscensionis*** L.	Oosi pullu	Grass	Indigenous
217	Poaceae	***Aristida setacea*** Retz.		Grass	Indigenous
218	Poaceae	***Bambusa bambos*** Voss	Moongil, Periya moongil	Grass	Indigenous
219	Poaceae	***Brachiaria ramosa*** (L.) Stapf	Sanam pul	Grass	Indigenous
220	Poaceae	***Brachiaria remota*** (Retz.) Haines		Grass	Indigenous
221	Poaceae	***Cenchrus ciliaris*** L.	Kolukkattai pullu	Grass	Indigenous
222	Poaceae	***Chloris barbata*** Sw.	Kodai Pullu, Sevarugu	Grass	Indigenous
223	Poaceae	***Chrysopogon fulvus*** (Spreng) Choiv.	Valichanpullu	Grass	Indigenous
224	Poaceae	***Chrysopogon lawsonii*** (Hook.f.) Veldkamp		Grass	Indigenous
225	Poaceae	***Cymbopogon flexuosus*** (Nees ex Steud.) Wats.		Grass	Indigenous
226	Poaceae	***Cynodon dactylon*** (L.) Pers.	Arugam pullu	Grass	Indigenous
227	Poaceae	***Dactyloctenium aegyptium*** (L.) Willd.	Perumatthangapullu	Grass	Indigenous
228	Poaceae	***Dichanthium annulatum*** (Forssk.) Stapf		Grass	Indigenous
229	Poaceae	***Digitaria ciliaris*** (Retz.) Koeler		Grass	Indigenous
230	Poaceae	***Dinebra retroflexa*** (Vahl) Panzer		Grass	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
231	Poaceae	***Eleusine coracana*** (L.) Gaertn.	Ragi, Kelvaragu, Kapai	Grass	Indigenous
232	Poaceae	***Eleusine indica*** (L.) Gaertn	Thippa ragi	Grass	Indigenous
233	Poaceae	***Eragrostis gangetica*** (Roxb.) Steud.		Grass	Indigenous
234	Poaceae	***Eragrostis tenella*** (L.) P.Beauv ex Roem. & Schultes.		Grass	Indigenous
235	Poaceae	***Eragrostis viscosa*** (Retz.) Trin.		Grass	Indigenous
236	Poaceae	***Hackelochloa granularis*** (L.) Kuntze		Grass	Indigenous
237	Poaceae	***Heteropogon contortus*** (L.) P Beauv	Oosipillu	Grass	Indigenous
238	Poaceae	***Leptochloa pluriflora*** (E.Fourn.) P.M.Peterson & N.Snow		Grass	Tropical America
239	Poaceae	***Mnesithea laevis*** (Retz.) Kunth		Grass	Indigenous
240	Poaceae	***Ophiuros exaltatus*** (L.) Kuntze	Kinangu pullu	Grass	Indigenous
241	Poaceae	***Panicum brevifolium*** L.		Grass	Indigenous
242	Poaceae	***Panicum repens*** L.	Moonja pullu	Grass	Indigenous
243	Poaceae	***Panicum trypheron*** Schultes	Samai-karumai	Grass	Indigenous
244	Poaceae	***Pennisetum pedicellatum*** Trin.		Grass	Indigenous
245	Poaceae	***Perotis indica*** (L.) Kuntze.	Narival	Grass	Indigenous
246	Poaceae	***Rhynchelytrum repens*** (Willd.) Hubbard		Grass	Indigenous
247	Poaceae	***Saccharum spontaneum*** L.	Naanal	Grass	Indigenous
248	Poaceae	***Tragus roxburghii*** Panigrahi		Grass	Indigenous
249	Polygalaceae	***Polygala arvensis*** Willd.		Herb	Indigenous
250	Polygalaceae	***Polygala javana*** DC.		Herb	Indigenous
251	Polygonaceae	***Polygonum glabrum*** Willd.	Aattralari	Herb	Indigenous
252	Polygonaceae	***Polygonum plebeium*** R. Br.		Herb	Indigenous
253	Portulacaceae	***Portulaca pilosa*** L.		Herb	Tropical America
254	Primulaceae	***Lysimachia arvensis*** (L.) U.Manns & Anderb.		Herb	Indigenous
255	Proteaceae	***Grevillea robusta*** A. Cunn. ex R. Br.	Savukku-maram	Tree	Australia
256	Rhamnaceae	***Ziziphus mauritiana*** Lam.	Illandhai	Tree	Indigenous
257	Rhamnaceae	***Ziziphus oenoplia*** (L.) Mill.	Soorai pazham	Shrub	Indigenous
258	Rubiaceae	***Benkara malabarica*** (Lam.) Tirvengadum	Mul pavattai	Shrub	Indigenous
259	Rubiaceae	***Canthium coromandelicum*** (Burm. F.) Alston	Nalla kaarai	Shrub	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
260	Rubiaceae	***Hedyotis corymbosa*** (L.) Lam.		Herb	Indigenous
261	Rubiaceae	***Hedyotis herbacea*** L.		Herb	Indigenous
262	Rubiaceae	***Mitracarpus villosus*** (Sw.) DC.	Kuruvelli	Herb	Indigenous
263	Rubiaceae	***Morinda pubescens*** J.E. Smith.	Manjanatti	Tree	Indigenous
264	Rubiaceae	***Spermacoce articularis*** L.f.	Nathaichoori	Herb	Indigenous
265	Rubiaceae	***Spermacoce hispida*** L.	Nathaichoori	Herb	Indigenous
266	Rubiaceae	***Tarenna asiatica*** (L.) Kuntze ex K. Schum.	Therini	Shrub	Indigenous
267	Rutaceae	***Limonia acidissima*** L.	Vila	Tree	Indigenous
268	Rutaceae	***Murraya koenigii*** (L.) Spreng.		Tree	Indigenous
269	Sapindaceae	***Cardiospermum canescens*** Wall.	Kaattu mudakkaruthaan	Climber	Indigenous
270	Sapindaceae	***Sapindus emarginatus*** Vahl	Boondhikkottai	Tree	Indigenous
271	Sapotaceae	***Manilkara zapota*** (L.) P. Royen	Sapota	Tree	Tropical America
272	Scrophulariaceae	***Lindernia dubia*** (L.) Pennell		Herb	Indigenous
273	Scrophulariaceae	***Scoparia dulcis*** L.	Sarakkotthini	Herb	Tropical America
274	Solanaceae	***Datura innoxia*** Mill.	Oomatthai	Herb	Tropical America
275	Solanaceae	***Lycopersicon esculentum*** Mill.	Thakkaali	Herb	Tropical America
276	Solanaceae	***Physalis angulata*** L.		Herb	Tropical America
277	Solanaceae	***Solanum americanum*** Mill	Manatakkali	Herb	Tropical America
278	Solanaceae	***Solanum seaforthianum*** Andr.		Shrub	Tropical America
279	Solanaceae	***Solanum torvum*** Sw.	Chundai	Shrub	Tropical America
280	Solanaceae	***Solanum violaceum*** Ortega	Karimulli, Mulli	Shrub	Indigenous
281	Sterculiaceae	***Waltheria indica*** L.	Chembudu	Herb	Indigenous
282	Tiliaceae	***Corchorus aestuans*** L.	Pinaaku poondu	Herb	Indigenous
283	Tiliaceae	***Corchorus tridens*** L.		Herb	Indigenous
284	Tiliaceae	***Corchorus trilocularis*** L.		Herb	Indigenous
285	Tiliaceae	***Grewia hirsuta*** Vahl.	Thavannu	Shrub	Indigenous
286	Tiliaceae	***Muntingia calabura*** L.		Tree	Tropical America
287	Tiliaceae	***Triumfetta rhomboidea*** Jacq.	Ottu pullu	Herb	Indigenous
288	Tiliaceae	***Triumfetta rotundifolia*** Lam.		Herb	Indigenous

S.No.	Family	Botanical Name	Tamil Name	Habit	Origin
289	Typhaceae	***Typha angustifolia*** L.	Sambu	Herb	Indigenous
290	Ulmaceae	***Holoptelea integrifolia*** (Roxb.) Planch.	Aya maram	Tree	Indigenous
291	Verbenaceae	***Lantana camara*** L.	Unnichedi	Shrub	Tropical America
292	Verbenaceae	***Premna latifolia*** Rozb.	Erumai munnai	Tree	Indigenous
293	Verbenaceae	***Premna tomentosa*** Willd.	Kozhukkattai thekku	Tree	Indigenous
294	Verbenaceae	***Stachytarpheta jamaicensis*** (L.) Vahl	Seemai nayuruvi	Herb	Indigenous
295	Verbenaceae	***Tectona grandis*** L.f.	Thekku	Tree	Indigenous
296	Violaceae	***Hybanthus enneaspermus*** (L.) F.v.Muell.	Orilai thamarai	Herb	Indigenous
297	Viscaceae	***Viscum orientale*** Willd.	Pulluruvi	Shrub	Indigenous
298	Vitaceae	***Cissus quadrangularis*** L.	Pirandai	Shrub	Indigenous
299	Zygophyllaceae	***Tribulus lanuginosis*** L.	Nerunji	Herb	Indigenous

The wetland brimming with water

Table 5. Faunal Species recorded from the wetland and its vicinity

Mammals

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Indian Palm Squirrel	*Funambulus palmarum*	*	*
2	Lesser Bandicoot Rat	*Bandicota bengalensis*	*	*
3	Greater Bandicoot Rat	*Bandicota indica*	*	*
4	House Mouse	*Mus musculus*	*	
5	Little Indian Field Mouse	*Mus booduga*	*	
6	House Shrew	*Suncus murinus*	*	
7	Fruit Bat	*Cynopterus* sp.	*	*
8	Indian Grey Mongoose	*Herpestes edwardsii*	*	*

Birds

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Indian Peafowl	*Pavo cristatus*	*	*
2	Grey Francolin	*Ortygornis pondicerianus*	*	*
3	Rock Pigeon	*Columba livia*	*	*
4	Eurasian Collared Dove	*Streptopelia decaocto*	*	
5	Spotted Dove	*Spilopelia chinensis*	*	*
6	Laughing Dove	*Spilopelia senegalensis*	*	*
7	Greater Coucal	*Centropus sinensis*	*	*
8	Asian Koel	*Eudynamys scolopaceus*	*	*
9	Blue-faced Malkoha	*Phaenicophaeus viridirostris*	*	*
10	Pied Cuckoo	*Clamator jacobinus*	*	*
11	Common Hawk-Cuckoo	*Hierococcyx varius*		*
12	Little Swift	*Apus affinis*	*	*
13	Asian Palm-Swift	*Cypsiurus balasiensis*	*	*
14	Jerdon's Nightjar	*Caprimulgus atripennis*	*	
15	Little Grebe¯	*Tachybaptus ruficollis*	*	*
16	Red-wattled Lapwing	*Vanellus indicus*	*	*
17	Common Sandpiper¯	*Actitis hypoleucos*	*	
18	Cattle Egret¯	*Bubulcus ibis*	*	*
19	Little Egret¯	*Egretta garzetta*	*	*
20	Common Coot¯	*Fulica atra*		*
21	Indian Pond-Heron¯	*Ardeola grayii*	*	*

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
22	White-breasted Waterhen¬	*Amaurornis phoenicurus*		*
23	Oriental Darter¬	*Anhinga melanogaster*	*	*
24	Little Cormorant¬	*Microcarbo niger*	*	*
25	Great Cormorant¬	*Phalacrocorax carbo*	*	
26	Spotted Owlet	*Athene brama*	*	*
27	Black-winged Kite	*Elanus caeruleus*	*	*
28	Painted stork¬	*Mycteria leucocephala*		*
29	Crested serpent eagle	*Spilornis cheela*		*
30	Oriental Honey-buzzard	*Pernis ptilorhynchus*	*	
31	Booted Eagle	*Hieraaetus pennatus*	*	
32	Changeable Hawk-Eagle	*Nisaetus cirrhatus*		*
33	Shikra	*Accipiter badius*	*	*
34	Besra	*Accipiter virgatus*		*
35	Black Kite	*Milvus migrans*	*	*
36	Brahminy Kite	*Haliastur indus*	*	*
37	Common Kingfisher¬	*Alcedo atthis*		*
38	White-throated Kingfisher¬	*Halcyon smyrnensis*	*	*
39	Green Bee-eater	*Merops orientalis*	*	*
40	Indian Roller	*Coracias benghalensis*	*	*
41	Coppersmith Barbet	*Psilopogon haemacephalus*	*	*
42	Rose-ringed Parakeet	*Psittacula krameri*	*	*
43	Black-headed Cuckooshrike	*Lalage melanoptera*	*	*
44	Indian Golden Oriole	*Oriolus kundoo*	*	*
45	Black-hooded Oriole	*Oriolus xanthornus*		*
46	Oriental magpie-robin	*Copsychus saularis*		*
47	Pied Bush Chat	*Saxicola caprata*		*
48	Black Drongo	*Dicrurus macrocercus*	*	*
49	Rufous Treepie	*Dendrocitta vagabunda*	*	*
50	House Crow	*Corvus splendens*	*	*
51	Large-billed Crow	*Corvus macrorhynchos*	*	*
52	Jerdon's Bushlark	*Mirafra affinis*	*	
53	Common Tailorbird	*Orthotomus sutorius*	*	*
54	Ashy Prinia	*Prinia socialis*	*	*
55	Plain Prinia	*Prinia inornata*	*	*
56	Zitting Cisticola	*Cisticola juncidis*	*	
57	Blyth's Reed Warbler	*Acrocephalus dumetorum*	*	*
58	Barn Swallow	*Hirundo rustica*	*	
59	Red-vented Bulbul	*Pycnonotus cafer*	*	*
60	Red-Whiskered Bulbul	*Pycnonotus jocosus*	*	*
61	White-browed Bulbul	*Pycnonotus luteolus*	*	*

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
62	Yellow-billed Babbler	*Argya affinis*	*	*
63	Common Myna	*Acridotheres tristis*	*	*
64	Purple-rumped Sunbird	*Leptocoma zeylonica*	*	*
65	Purple Sunbird	*Cinnyris asiaticus*	*	*
66	Baya Weaver	*Ploceus philippinus*	*	*
67	Indian Silverbill	*Euodice malabarica*	*	*
68	House Sparrow	*Passer domesticus*	*	*
69	White-browed Wagtail	*Motacilla maderaspatensis*	*	*

Reptiles

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Garden Lizard	*Calotes versicolor*	*	*
2	South Indian Rock Agama	*Pssamophilus* cf. *dorsalis*	*	
3	Bengal Monitor Lizard	*Varanus bengalensis*	*	*
4	Indian Cobra	*Naja naja*	*	*
5	Common Dotted Garden Skink	*Riopa punctata*		*

Amphibians

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Common Indian Toad	*Duttaphrynus melanostictus*	*	*
2	Common Skittering Frog	*Euphlyctis cyanophlyctis*	*	*
3	Common Indian Cricket Frog	*Minervarya agricola*	*	
4	Common Indian Tree Frog	*Polypedates maculatus*		*

Fishes

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Common carp	*Cyprinus carpio*	*	*
2	Common Spiny Loach	*Lepidocephalus thermalis*	*	
3	Cat Fish	*Clarias batrachus*	*	*
4	Singee	*Heteropneustes fossilis*	*	
5	Western Mosquito fish	*Gambusia affinis*	*	*
6	Green Chromide	*Etroplus suratensis*	*	
7	Mozambique Tilapia	*Oreochromis mossambicus*	*	*

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
8	Spotted Snakehead	*Channa punctata*	*	*

Butterflies

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Common Bushbrown	*Mycalesis perseus*	*	*
2	Common Grass Yellow	*Eurema hecabe*	*	*
3	Mottled Emigrant	*Catopsilia pyranthe*	*	*
4	Lemon Pansy	*Junonia lemonias*	*	*
5	Angled Castor	*Ariadne ariadne*		*
6	Small Grass Yellow	*Eurema brigitta*	*	*
7	Forget-me-not	*Catochrysops strabo*		*
8	Common Mormon	*Papilio polytes*	*	*
9	Tawny Coster	*Acraea terpsicore*	*	*
10	Plain Tiger	*Danaus chrysippus*	*	*
11	Blue Tiger	*Tirumala limniace*	*	*
12	Crimson Rose	*Pachliopta hector*	*	*
13	Common Rose	*Pachliopta aristolochiae*		*
14	Common Emigrant	*Catopsilia pomona*		*
15	Common Cerulean	*Jamides celeno*	*	*
16	Grass Jewel	*Freyeria trochylus*		*
17	Blue Pansy	*Junonia orithya*	*	*
18	Psyche	*Leptosia nina*	*	*
19	Common Lime Butterfly	*Papilio demoleus*	*	*
20	Common Evening Brown	*Melanitis leda*	*	*
21	Yellow Pansy	*Junonia hierta*	*	*
22	Danaid Eggfly	*Hypolimnas misippus*	*	*
23	Tiny Grass Blue	*Zizula hylax*	*	*
24	Common Pierrot	*Castalius rosimon*	*	*
25	Crimson Tip	*Colotis danae*		*
26	Little Orange-tip	*Colotis etrida*		*
27	Common Jezebel	*Delias eucharis*	*	*
28	Common Gull	*Cepora nerissa*	*	
29	Indian Pioneer	*Belenois aurota*	*	
30	Indian Wanderer	*Pareronia hippia*	*	*
31	White Orange-tip	*Ixias marianne*	*	*
32	Rice Swift	*Borbo cinnara*	*	*
33	Asian Grizzled Skipper	*Spialia galba*		*
34	Plains Cupid	*Chilades pandava*	*	*

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
35	Common Pierrot	*Castalius rosimon*	*	*

Odonata

S.No.	English Name	Scientific Name	Before Restoration	After Restoration
1	Chalky Percher	*Diplacodes trivialis*	*	*
2	Common Clubtail	*Ictinogomphus rapax*		*
3	Common Picture Wing	*Rhyothemis variegata*	*	*
4	Coromandel Marsh Dart	*Ceriagrion coromandelianum*	*	*
5	Ditch Jewel	*Brachythemis contaminata*	*	*
6	Golden Dartlet	*Ischnura aurora*	*	*
7	Greater Crimson Glider	*Urothemis signata*	*	*
8	Green Marsh Hawk	*Orthetrum sabina*	*	*
9	Long-legged marsh Glider	*Trithemis pallidinervis*		*
10	Pygmy Dartlet	*Agriocnemis pygmaea*	*	*
11	Wandering Glider	*Pantala flavescens*		*

Interesting flora of the wetland

Abutilon hirtum

Ipomoea hederifolia

Hibiscus lunariifolius

Malvastrum coromandelianum

Lysimachia arvensis

Hibiscus lobatus

Interesting fauna of the landscape

Common Clubtail

Black Drongo

Greater Coucal

Crimson Tip

Crimson Rose

White-browed Bulbul

Landscape features

Near Field Agricultural lands

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SUSTAINABLE WATER MANAGEMENT PROJECT – ALWAR

Project of

Augmenting of the Natural replenishment of groundwater

Location : Police Parade Ground

Submitted By: Ambuja Cement Foundation

1 CONTENTS

2. SUMMARY :

The Alwar district is located in the north eastern part of Rajasthan and extends between north latitude 27°03' and 28°14' and east longitude 76°07' and 77°13'. The project area falls under the **semi-arid agro-climatic zone**. It receives the annual precipitation from the South-West monsoon, and rainy season normally starts after mid-June and ends in September, but the onset and withdrawal have started becoming erratic during the last decade. The average annual rainfall of the last 30 years was 722 mm, with a maximum 55% deviation on either side from the long-term hydrological cycle during the period. **The average rain days in last 30 years have been 32**. As per the subject said Augmenting of the Natural replenishment of groundwater, for increase the groundwater by the surface area recharging of specific Police parade Ground. The main objectives as under –

- To drain and collect excess water in underground aquifers during times of surplus monsoon season that can be recovered during periods of water scarcity.
- To increase the water level of groundwater
- Collect excess amount of water in monsoon period with proper utilization of ground in tapper manner

➢ BACKGROUND : -

The Parade Ground of Police Training Centre is located in the middle part of Alwar district, whose present condition is not good and the land is also undulated situation. Due to which, the rainwater stops at different places during the monsoon season and any kind of activity may not perform. As shown in figure this is undulated parade ground police training centre at Alwar. In current situation all the water dump in a scattered manner and drain out from the ground through drainage channel.

Total 18400 sqm undulated area need to be levelled in tapper manner to recharge by runoff water of catchment area by making proper drainage channel and recharging shaft with filter unit in operational tube well in ground. As per calculation, Total lump sum 73 lac liters per annum water every season comes and drain out due to its undulated topography, no proper recharging system available.

➢ POPULATION RESIDE: -

In the surrounding area of Police parade Ground, 200 families reside in that area. If solution will provide for the replenishment of groundwater, 200 families will benefit by this and this

will improve the water level of groundwater. Details of families as under –

S.No.	purpose	Households	No. of members	Total beneficiaries
1	Groundwater recharging work at Police parade ground	200	5	1000
2	Other reside members		22	22
Total				**1022**

3. PRE – STATUS:

In the past condition of Police Parade ground, in rainy session rainwater matched into ground surface only. In the 200 mm rainfall the ground filled by 2 feet of rainfall. The ground was undulated with various depletion and due to lose soil strata mud spots took place. The total area of ground was unlevelled with muddy water pots.

4. GIVEN SOLUTIONS:

In the areas where source of water is available either for some time or perennially e.g. base flow, springs etc. the recharge shaft can be constructed. For the purpose of groundwater recharging, recharging pits has been implemented with proper drainage line and ground levelling work also done with proper tapper manner. This is the most efficient and cost-effective structures to recharge the aquifer directly. The Following solutions has been provided for groundwater recharging

- Land Levelling in tapper manner to collect the maximum runoff
- Proper drainage line to reduce the maintaining the uniform slope
- To collect runoff water, need to construct Recharging Pit
- For collection of maximum runoffs, manage soil into tapper manner

➢ GROUND LEVELLING: -

We have covered total ground levelling work with crusher sand in two parts. Total 8000 Sqm area of ground has been levelled with JCB then crusher sand has been implemented on the

ground surface with the help of Karali and tractor. Total area of ground attained plain by the help of roller. Total 2150 Ton GSB crusher sand of 300 mm has been used in the ground

Area	8000 Sqm	
Total volume	**2400**	**Cum**
1 phase	691.10 Ton	783.01 cum
2 phase	103.46 Ton	116.90 cum
3 phase	1374.01	1552.6 cum
Total		**2452.51**

➢ JCB EARTHWORK: -

Earthwork through JCB to provide proper drainage channel and Civil work for Recharging Pit provided. 02 recharging pit has been constructed in Police parade ground by maintaining proper drainage channel of the tapper ground level for collecting rainwater in pits for recharging purpose.

➢ PAINTING & WRITING WORK: -

The walls of Police parade ground were constructed and painted years ago. Without proper maintenance they are in need of painting work for increase the beautification and aesthetic scenario of the ground. Details of painting work with weather cost as under –

Particulars	Length (Ft)	Height (Ft)	Total Area (Sqft)
Painting work on the walls of ground	1759	7.77	13667

5. AL & POLICE DEPARTMENT VISIT:

For the quality inspection purpose, and detailing of the work. Ashok Leyland team and DSP (Mrs. Sarita Yadav) also visited the ongoing work of Police Parade Ground. They also suggested new particulars and area of improvements in ongoing work.

6. PRE & POST SITUATION:

Pre-Condition of Police parade Ground

Post Condition of Police parade Ground 1

Previously in monsoon period, the ground was filled with water and had no use of it Even Department of Police were also unable to do their daily routine physical trainings.

After the making of recharging pit in the ground for increasing water level at the recharging shaft, rainwater stores in the recharging pits and percolate in ground for increasing the groundwater level.