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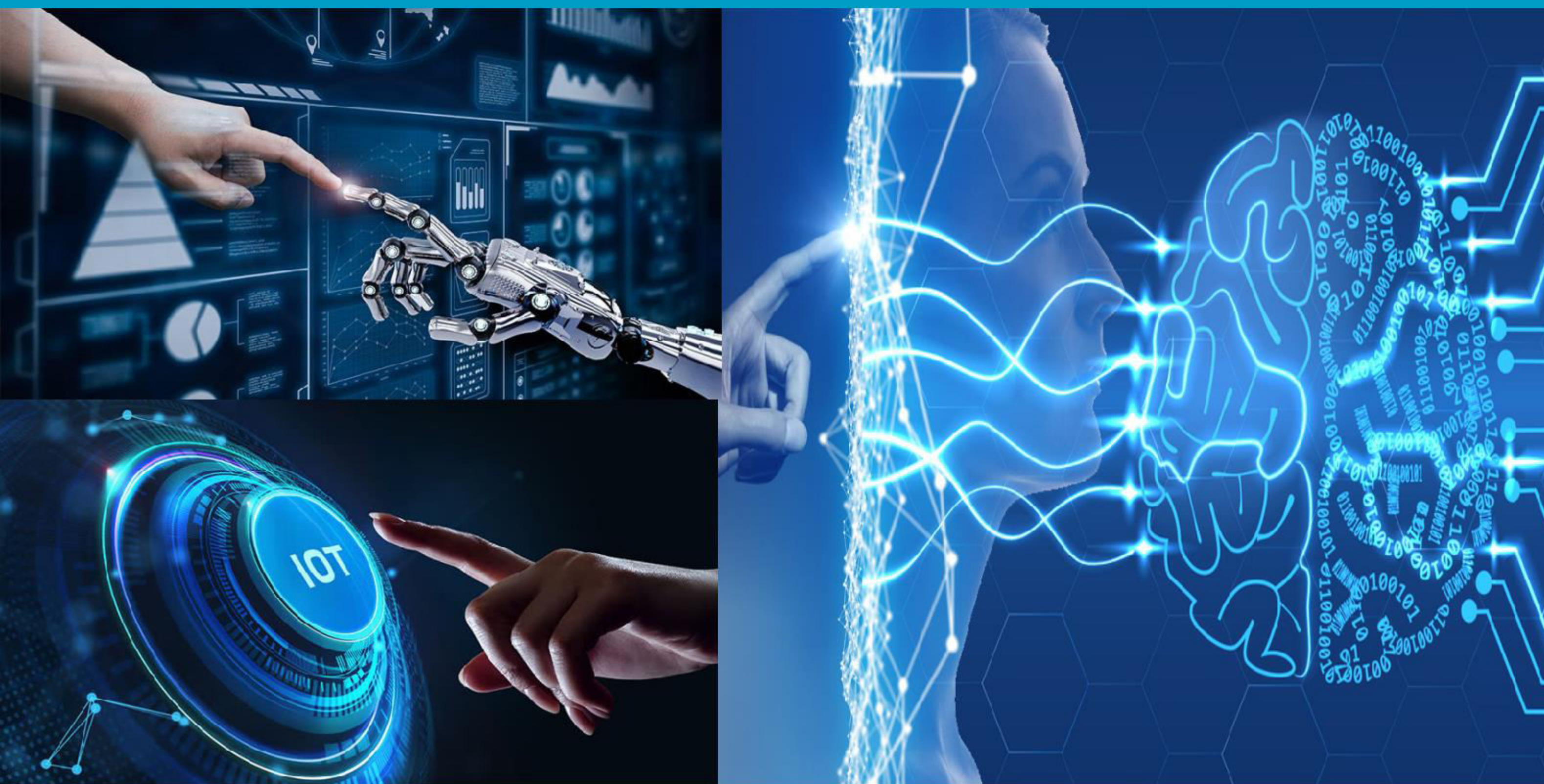

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Treatment of Lake Water by Using Aquatic Weeds in India

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ABSTRACT- Aquatic weeds are those unwanted vegetation which grow in water and hamper its use. Out of about 160 aquatic weeds, Eichhornia crrassipes, Ipomoea aquatica, Typha angustata, Ceratophyllum demersum, Salvinia molesta, Nelumbo nucifera, Alternanthera philoxeroides, Hydrilla verticillata, Vallisneria spiralis, Chara spp., Nitelia spp., Potamogeton spp. are of primary concern in India. Weeds enhance rates of evaporation many folds through evapotranspiration than that of open surface, thus cause great loss of water. Water hyacinth makes water unfit due to eutrophication and slows down the flow rate of water besides causing many health associated problems. Aquatic weeds can be controlled by several methods like biological, chemical and physical. Each method has its benefits and drawbacks. There are several popular control mechanisms for preventing the spread or eradication of aquatic weeds. Physical methods are suitable only for small scale infestation but when applied in large water bodies become ineffective due to high cost and regrowth. Chemical control has been practiced against aquatic weeds since long time in India but it is not prevalent. Control of small infestations with herbicides has often been very effective, but is heavily dependent on skilled operators who maintain longterm vigilance for appearance of regrowth or seedlings. In recent decades, there has been a significant increase in the level of nutrients dumped into water from industrial and domestic sources as well as from land where fertilizers are used or where clearance has caused an increase in run-off. Successful attempts have been made to control water hyacinth and water fern by use of exotic weevil Neochetina spp. and Cyrtobagaus salvinae in different parts India but for several other aquatic weeds, suitable bioagents are not available. Some species of herbivorous fishes (Tilapia spp. and Ctenopharyndon idella) have been utilized to control some submerged weed especially Hydrilla spp. with varying degree of success. This paper describes the treatment of lake water by using aquatic weeds in India. The ability of a mixture of Typha angustifolia and Eichhornia crassipes to remove organics, nutrients, and heavy metals from wastewater from a futala lake water were studied. Changes in physicochemical properties of the wastewater including pH, temperature, chemical oxygen demand, dissolved oxygen, biochemical oxygen demand (BOD), total P, TOC, conductivity, total Kjeldahl nitrogen, $NO3^{-}$-N, NH3-N, and metal (Pb, Cd, and Zn) concentrations were monitored.

KEYWORDS- Wastewater Treatment, Aquatic Weeds, Lake Water, Constructed Wetlands, BOD, COD

I. INTRODUCTION

Water is an integral constituent of life and one of the most important natural resources. The present domain of life existing on earth has evolved in water (Hosetti. 2002). It has been the cause of rise and fall of many civilizations, which flourished along fresh water bodies and perished when they dried (Dayananda et al., 2002). All early civilization such as Babylon, Egypt, Chinese and Indian flourished around Euphrates, Nile, Yongtzekiag and Indus-Ganga basin respectively. Water presents a wonderful picture, where thousands of living genera, ranging from microscopic to macroscopic including chemo-synthetic bacteria, saprophytic fvmgi, micro and macro invertebrates, vertebrates, algae and higher aquatic plants live. From biological point of view, it is the most abundant part of the living and as such performs important role in metabolism. From the ecological point of view, it is chiefly a limiting factor among land animals in which the amount is subjected to great fluctuations. Aquatic animals also maintain a proper balance of water to live safely in different categories of water.

1.1 AIM OF THE PROJECT

The aim of the project treating lake water involves natural wetlands and to remove contaminants from the wastewater.

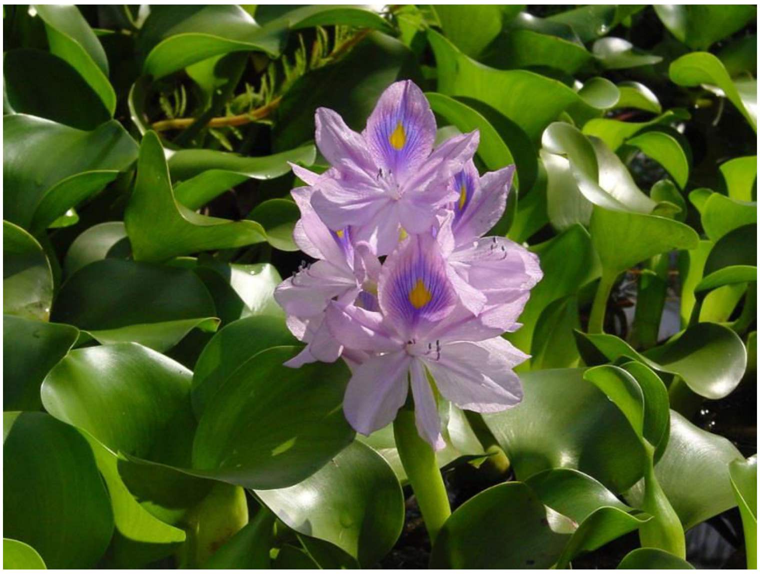
1.2 OBJECTIVES OF THE PROJECT

- Natural Treatment of Sonegaon lake water by using water hyacinth.
- Aquatic plants help keep the sediment at the bottom of a lake, improving water clarity.
- Aquatic vegetation influences the oxygen levels within a water body and absorbs pollutants from contaminated water.
- Low Cost & Eco-Friendly to Environment.
- Waste stabilization and nutrient removal.
- Constructed wetlands and natural water treatment systems aim to control and optimize the ability of a wetland to remove or transform wastewater pollutants.

EICHHORNIA CRASSIPES (WATER HYACINTH)

Pontederia crassipes (formerly Eichhornia crassipes), commonly known as common water hyacinth is an aquatic plant native to South America, naturalized throughout the world, and often invasive outside its native range. It is the sole species of the subgenus Oshunae within the genus Pontederia. Anecdotally, it is known as the "terror of Bengal" due to its invasive growth tendencies.

Water hyacinth is a free-floating perennial aquatic plant (or hydrophyte) native to tropical and subtropical South America. With broad, thick, glossy, ovate leaves, water hyacinth may rise above the surface of the water as much as 1 m (3 ft) in height. The leaves are 10–20 cm (4–8 inches) across on a stem, which is floating by means of buoyant bulb-like nodules at its base above the water surface. They have long, spongy, bulbous stalks. The feathery, freely hanging roots are purple-black. An erect stalk supports a single spike of 8–15 conspicuously attractive flowers, mostly lavender to pink in colour with six petals. When not in bloom, water hyacinth may be mistaken for frog's-bit (Limnobium spongia or Amazon frogbit (Limnobium laevigatum).



[Figure 1.1: Water hyacinth]

II. LITERATURE REVIEW

[1] Aquatic Weeds and Their Ecological Role in Vasant Sagar, Pusad, Dist. Yavatamal, Maharashtra (Ms) (2022)

- Vasant sagar was constructed on the Pus River. This project comes under watershed area of Pus project, which is in Godavari Valley on 20°1'41"N and 77°27'4"E. The Official Designation of the Project is " Pusad . Locally this is also known as "Pus Dharan / Vasant Sagar, " or "Upper Pus Lake". Project was constructed as part of irrigation projects by the Government of Maharashtra in the year 1971. It is fresh water body. The dam impounds on Pus River. Nearest city to dam is Pusad and it is situated in Yavatmal District of Maharashtra.

- The aquatic weds diversity of Upper Pus Reservoir was studied at four sampling stations during July. 2020 To Jan. 2022. The water body sustains heavy biomass throughout the period of research. Water is the one among the prime necessities of life required for growth and other activity of all living being. Wetland is among the most productive ecosystems in the world. Aquatic weeds always thrive in places of marshy lands and water logged areas of the world. The aquatic plants are the most important component of the aquatic ecosystem.
- Aquatic plants are key components for the well-functioning of wetland ecosystem for biological productivity and support diverse organisms and there by provide lots of goods and services for the dependent people. Due to rapid pace of urbanization formation of new human settlements and Industrialization weeds are in serve threat of extinction. It is there for an urgent and almost need to record and to access diversity potentially of these aquatic plant communities before they will vanish forever. No elaborate study regarding the aquatic weeds or mycrophytes of Pusad taluka Maharashtra has been carried out up to the date.
- So the present work is the first contribution to the biodiversity of aquatic weeds in Vasant Sagar. Pusad. During the present study, 8 species of fresh water aquatic weeds viz. Hydrilla, Eicchornia, Vallisneria, Pistia, Algae, Typha, Nymphaea have been reported.

[2] Microalgae Based Sustainable Bioremediation of Water Contaminated by Pesticides (2022)

- The use of pesticides in agriculture reduces the loss of crops and increases crop productivity. Agricultural discharge into water bodies increases pesticide toxicity in water. A pesticide, when entered into water bodies, attacks non-targeting species, which disturbs the aquatic life. Because of low-cost taking, high material removal efficiency, low sludgy amount, and generated biomass for economic benefit, biological bioremediation methods are mostly preferred. Algae are used to remove pollutants from the environment or to convert them into harmless forms. Bioremediation by algae is highly preferred as biomass generated is used in biogas and biofuel production.
- Algae fix carbon dioxide (CO2) and release oxygen (O2) by photosynthesis and increase BOD (biological oxygen demand) in contaminated water. Therefore, it is necessary to reduce the use of pesticides or dispose of them in the best manner.
- To be on the safer side and make our water bodies less toxic, it is necessary to make efficient water treatment arrangements.
- This review paper is to discuss everything about pesticides and bioremediation, the use of microalgae and fungi for the treatment of water contaminated by pesticides, and the factors affecting pesticide bioremediation.

[3] Pollutant Removal in Wastewater by Vetiver Grass in Constructed Wetland System (2013)

- Constructed wetland technology is one of the emerging and acceptable technologies because it can effectively remove all most all types of pollutants from waste waters without harming the environment. The objective of the present study was to find out the effectiveness of vetiver grass (Vetiveria zizanioides L. Nash) in the pollutant removal from waste water in constructed wetlands. The vetiver plants (Vetiveria zizanioides L.Nash) (ODV-3) were planted (Test group and control group) in the constructed wetland and after 90 days, the test group was divided into three (T1, T2, T3) and were treated with waste water (50% dilution) from automobile service station (W1), spray painting workshop (W2) and sewage (W3) respectively, and allowed to grow for further 15 days.
- At the end of the experiment (on the 15th day of waste water treatment), the treated water from the tanks was collected and analyzed for various chemical attributes. The plants were uprooted, and the plant biometric parameters and nutrient content were also determined. The chemical characteristics of the wastewaters analysed show that all the wastewaters were contaminated, and automobile service station effluent was heavily polluted. More than 50% percentage removal of pollutants especially nutrients after 15 days treatment of waste waters in constructed wetlands was observed, and it showed the efficiency of the vetiver variety for improving the water quality.

[4] Constructed Wetlands – Natural Treatment of Wastewater (2021)

- Constructed wetlands are engineered and managed wetland systems that are increasingly receiving worldwide attention for wastewater treatment and reclamation. Compared to conventional treatment plants, constructed wetlands are cost-effective and easily operated and maintained, and they have a strong potential for application in a small community. Constructed wetlands for wastewater treatment have substantially developed in the last decades.
- As an eco-friendly treatment process, constructed wetlands may enable the effective, economical, and ecological treatment of agricultural, industrial, and municipal wastewater.
- Constructed wetlands are very effective in removing organics and suspended solids, whereas the removal of nitrogen is relatively low, but could be improved by using a combination of various types of constructed

wetlands meeting the irrigation reuse standards. The removal of phosphorus is usually low, unless special media with high sorption capacity are used. Pathogen removal from wetland effluent to meet irrigation reuse standards is a challenge unless supplementary lagoons or hybrid wetland systems are used.
- In this paper studies various case study related to Wetlands in Indian Cities and also described include systems involving both constructed and natural wetlands, habitat creation and restoration.

[5] Phytoremediation: A Promising Approach for Revegetation of Heavy Metal-Polluted Land (2020)
- Heavy metal accumulation in soil has been rapidly increased due to various natural processes and anthropogenic (industrial) activities. As heavy metals are non-biodegradable, they persist in the environment, have potential to enter the food chain through crop plants, and eventually may accumulate in the human body through biomagnification. Owing to their toxic nature, heavy metal contamination has posed a serious threat to human health and the ecosystem. Therefore, remediation of land contamination is of paramount importance. Phytoremediation is an eco-friendly approach that could be a successful mitigation measure to revegetate heavy metal-polluted soil in a cost-effective way.
- To improve the efficiency of phytoremediation, a better understanding of the mechanisms underlying heavy metal accumulation and tolerance in plant is indispensable.
- In this review, we describe the mechanisms of how heavy metals are taken up, translocated, and detoxified in plants.
- We focus on the strategies applied to improve the efficiency of phytostabilization and phytoextraction, including the application of genetic engineering, microbe-assisted and chelate-assisted approaches.

III. PROPOSED METHODOLOGY

3.1 PLANTING TECHNIQUES

- Plants can be introduced to a wetland by transplanting roots, rhizomes, tubers, seedling or mature plants;
- by importing substrate and seed bank from nearby wetlands or;
- by relying completely on seed bank of the original site;
- choosing plants from wild stock is more desirable than nurseries as they are better adapted to environmental conditions in constructed wetlands;
- plants collected from nearby area must be planted within 36 hrs. If nursery plants are used, they should be from similar climatic conditions & should be shipped rapidly to minimize losses;
- if seed are used, they should be evaluated for the species present and their viability.

The macrophyte planting density can be as close as 0.3 m (1ft) centre or as much as 1 m (3ft). The higher the density, the more rapid will be the development of a mature and completely functional wetland system. However, high density plantings will increase construction costs significantly. FWS wetlands should be planted more densely owing to the role of the plants in the treatment process, whereas subsurface systems can be planted less densely. If mechanical equipment is used for planting, the unplanted areas should be kept dry until planting is complete. Since the bottom is sloped toward the discharge end, planting should start at the outlet and proceed toward the inlet. Sprinklers and shallow flooding have been used to keep the planted areas wet. If the FWS wetland is designed to treat a high-strength influent such as primary treated wastewater, a cleaner water source or diluting the wastewater with storm water or well water is recommended for the initial planting and growth period so the plants are not overly stressed. In subsurface systems, it is typical practice to flood the wetland cell to the surface of the media prior to planting and to maintain that level until significant growth has occurred. Later, the water level is lowered to the intended operating level. A layer of straw or hay mulch 15 to 20 cm (6–8 in) in thickness should be placed on the gravel surface to protect the new plants from the high summer surface temperatures that can occur on bare gravel surfaces. The mulch also is useful for providing thermal insulation during the first winter of operation in northern climates.

3.2 AREA REQUIRED FOR CONSTRUCTED WETLANDS

Taking advantage of remediation capability of aquatic plants (emergent macrophytes, free floating macrophytes) and algae, constructed wetlands have been designed and implemented successfully for efficient removal of nutrients (N, P, heavy metals, etc.). Different types of constructed wetlands (sub surface 0.6 m depth, surface: 0.4 m, could be either horizontal or vertical) are given in Figure 1.4. Area required for constructed wetlands depends on the influent sewage quality and expected treatment (BOD removal, etc) is given in equation 1 **(Vymazal et.al, 1998**). Estimates show that to treat 1 MLD influent, area required is about 1.7 hectares.

The proposed design of wetlands to treat 1MLD.

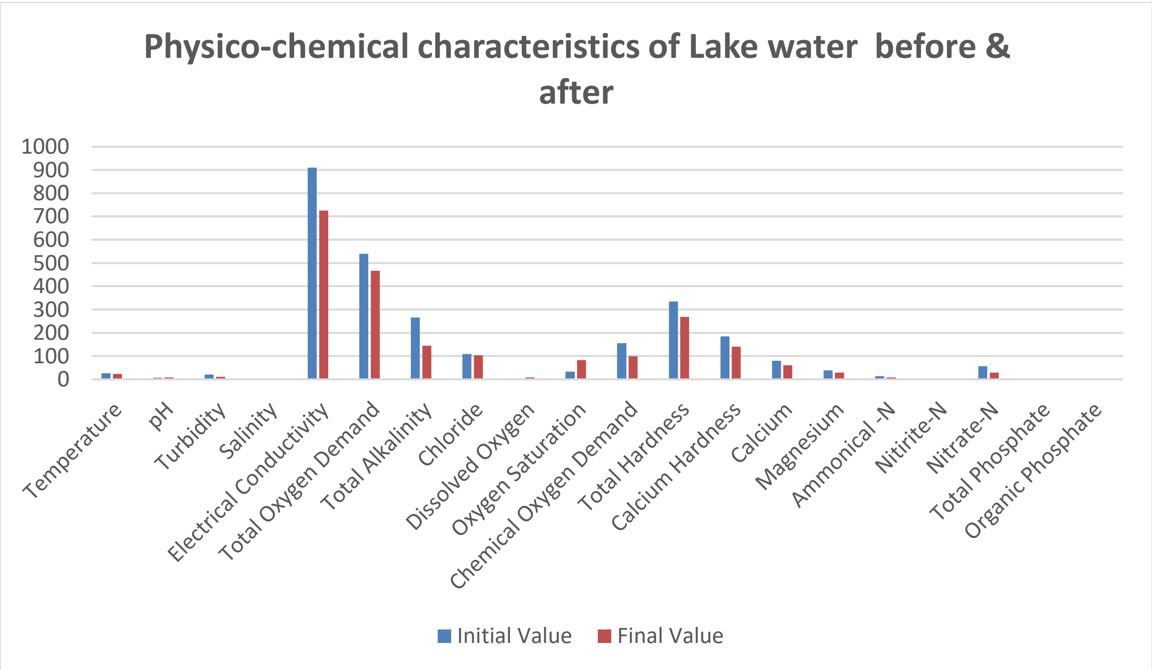
A=Qd(lnCo–lnCt)KBOD
Where, A = area; Qd= ave flow (m3/day); Co & Ct = influent & effluent BOD (mg/L); KBOD = 0.10

For example to treat influent (raw sewage: BOD: 60-80) and anticipated effluent (with BOD 10), area required is about 1.7 to 2 hectares.

IV. RESULTS & DISCUSSION

Table 4.1: Physico-chemical characteristics of Lake water before & after the culture of " Eichhornia crassipes "

S.No.	Parameters	Unit	Initial Value	Final Value
1.	Temperature	Celcius	25.8	23.4
2.	pH	.	6.15	7.625
3.	Turbidity	NTU	20.025	11.1
4.	Salinity	‰ (permil).	0.563	0.459
5.	Electrical Conductivity	Mmhos	910.10	725.30
6.	Total Oxygen Demand	Ppm	540.10	465.90
7.	Total Alkalinity	mgCaCo/L	265	145
8.	Chloride	mg/L	108.59	103.60
9.	Dissolved Oxygen	mg/L	2.8	7.9
10.	Oxygen Saturation	%	33.325	82.02
11.	Chemical Oxygen Demand	mg/L	155	99.285
12.	Total Hardness	mg/L	334.125	267.75
13.	Calcium Hardness	mg/L	184.14	140.58
14.	Calcium	mg/L	80.25	60.12
15.	Magnesium	mg/L	38.12	28.52
16.	Ammonical -N	mg/L	14.025	7.85
17.	Nitirite-N	mg/L	0.275	0.211
18.	Nitrate-N	mg/L	57.05	29.02
19.	Total Phosphate	mg/L	1.657	1.155
20.	Organic Phosphate	Mg/L	0.984	0.694



[Fig.4.1: Physico-chemical characteristics of Lake water before & after]

A minor variation was observed in chloride contents due to its non-utilization by the aquatic plant. In domestic wastewater Dissolved oxygen and Percentage oxygen saturation values were increased significantly, after the experiment, as Hydrilla verticillata Casp played a vital role in oxygen transfer in to water system. Nitrogen contents were examined as Ammonical, Nitrite and Nitrate form. As Nitrate nitrogen is the stable product of oxidation.

1. Water stress has become a perennial concern in most Indian cities and towns. It is often insufficient to meet the growing demand for water by all economic sectors. With a growing population, the per capita availability of water has dropped from 1,816 cubic meters in 2001 to 1,545 cubic meters in 2011 (Central Pollution Control Board (2009) The latest census reported that only 70% of urban households have access to piped water supply. The average per capita supply to these households is well below the recommended 135 liters per day in many cities. With 80 countries and 40% of the world's population facing chronic water problems and with the demand for water doubling every two decades, has made recycling and reuse of sewage important. In India treated sewage is being used for a variety of applications such as Farm Forestry, Horticulture, Toilet flushing, Industrial use, Fish culture and Indirect and incidental uses. CPHEEO has proposed guiding principles for the treated sewage quality to be achieved and recommended for the stated uses.

2. Constructed wetlands (CWs) serve as alternatives to conventional treatment options to eliminate/reduce contaminant and nutrient concentration in wastewaters. They are the artificially created man made systems in which waste water treatment take place by utilizing natural processes by involving soil, vegetation, and microbial communities. They resemble to the natural wetlands in treatment processes but processes are carried out in a controlled environment.Since 1990s the constructed wetlands have been extensively built and operated for treatment of all kind of wastewater such as dairy farm (Sharma et al., 2013, Kato et al., 2013), landfill leachate, runoff, food processing, industrial, agricultural farms, mine drainage and sludge dewatering (Farooqi et al .,2008).

3. In constructed wetland technology, the most efficient removal of pollutants present in wastewater is taking place majorly through processes such as Sedimentation, Absorption, Adsorption, Ammonification, Nitrification, Denitrification, Microbial Degradation & Plant uptake.

4. Constructed wetlands are categorized as surface/free water surface flow and subsurface flow systems. Free Water Surface (FWS) wetlands/ surface flow wetlands are heavily planted systems in which water flow is above the media bed. Subsurface flow treatment wetlands are categorized into Vertical Flow (VF), Horizontal Flow (HF) and Hybrid wetlands on the basis of the direction of water flow. In the past years, modified VF wetlands termed as 'French Systems' and Tidal wetlands have also been introduced as well as adopted for treatment of screened raw wastewater. Some of the Advanced Versions of Constructed Wetland Systems include Baffled Subsurface-flow constructed wetland, Aerated Constructed Wetlands and Multi-tropic Ecological Engineered Wetlands.

5. Horizontal subsurface flow (HSSF) constructed wetland is large gravel and sandfilled basin that is planted with wetland vegetation. As wastewater flows horizontally through the basin, the filter material filters out particles and microorganisms attached to the plant roots and filter media degrade the organics. They can be sized using methods such as P-k-C* approach, rule of thumb (Rousseau et al., 2004) and regression equations (Rousseau et al., 2004)

6. The subsurface vertical-flow constructed wetlands (SSVF CW) are designed for the treatment of wastewater coming from primary treatment mechanism. In this system the wastewater enters through the surface and flows in vertical direction slowly through the supporting filter material and the plant roots, until reaching the bottom outlet zone. VF wetlands can be sized by Equation as per Kikuth (1977) for treating domestic waste water, Rule of thumb (Rousseau et al., 2004) and Based on Specific Area Requirement per population equivalent (1.2 – 5.0 (m2 /PE)-For warm (Hoffmann et al., 2011) and temperate climates (Kadlec and Wallace, 2009).

7. Hybrid constructed wetland are those systems in which various types of constructed wetland system are modulated in a way that it results in high removal rate and purification efficiency. Several combinations of Vertical flow and Horizontal flow constructed wetland systems are VF-VF-HF, VF-HF-VF, VF-HF and HF-VF.

8. Constructed wetland systems performance is influenced by various factors and is difficult to quantify. Basically wetland designs mimic natural wetlands in overall structure but the general design considerations include : Planning (Selecting site,System type and configuration, Determining discharge standards),Site selection (Topography, Land availability, Use and Access),Hydrology (Climate and weather, Hydroperiod, Hydraulic load, Hydraulic residence time, Evapotranspiration, Groundwater Exchange and Water Balance),Structures (Flow control structure, Cells, Liners) and Habitat & shade needs.

9. In-situ remediation processes, such as constructed wetlands, have produced "satisfactory" results (Cao et al., 2012). This manual provides holistic review of few case studies i.e.: Vertical flow subsurface systems (Egypt), Phytorid technology in india developed by NEERI (India), Vertical sub-surface constructed wetland units for treatment of dairy waste water (Dehradun , Uttrakhand), Neela-hauz biodiversity park (New Delhi), 2 MLD Constructed Wetland for sewage Treatment at Indian Agricultural Research Institute (Delhi campus), Constructed wetland system to treat wastewater at Indian Institute of Technology (Powai, Mumbai) and Pilot rural household sewage water treatment system at Mathura by IARI.

10. Constructed wetlands serve from single-family dwellings to large-scale municipal systems. Also they are essential for humans to live and prosper. More than one billion people depend on wetlands for their living. The use of CWs for wastewater treatment provides many environmental, social and economic benefits.

In India, Central Pollution Control Board (CPCB) and MoEF, New Delhi has set standards for discharge of wastewater to the surrounding area including land and water bodies. Thus a constructed wetland system should be designed with proper care so that it could produce the effluent that meets all the discharge standards.

CONCLUSION

In case the third world war happens, (it should not happen) will only be due to water. Water is going to be the future resource of our energy and all related activities for human beings. The shortage of water will be felt by all the continents and people. The depletion of water source will create economy burden on all the nations, so it has become essential and necessary to save water and recycled water. The progress of every country depends upon the smart cities and existing major cities. The population of these cities is growing high and hence the consumption of water also becomes higher. The only solution is to recover and recycle the water spent on domestic consumption and industrial consumption by very good affordable water treatment plants. Aquatic plants which will not affect the deforestation and environment are used for the recovery of water as they are capable of absorbing metallic ions and toxins from the domestic waste water sample. These plants convert all the above unwanted material into useful nutrients for the plants so that the animals can also eat the same. The above plants reduce the higher level concentration which is available in the domestic waste water sample to the minimum acceptable level. This requires further research and observation. The above water become useful and suitable for other purposes.

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