

**TITLE**  
**WET LANDS RESTORATION**



Figure 1

EAST KOLKATA WET LANDS (EKWL) was declared by the government of India as wetlands of International importance under RAMSAR CONVENTION in 2003.

**AUTHOR:** Umamaheshwari Chakilam

**CONTACT:** Sri Sri Institute of Agriculture Sciences and Technology Trust of Art of Living, Hyderabad, Telangana State, India - 500011, [uma6408@gmail.com](mailto:uma6408@gmail.com)

**Acknowledgement:**

- With Gratitude and reverence, I dedicate this paper to my Guru H.H. Sri Sir Ravishankar Ji, a Global Humanitarian and a spiritual leader, founder of Art of Living Organization, for the opportunity given to me to work as director projects in Sri Sri Institute of Agriculture sciences and Technology Trust (SSIAST Trust), one of the Trust founded under the Aegis of Art of Living.
- I thank the Ministry of Environment, Government of West Bengal, India for awarding a project as a pilot with 6 months' timeline.
- My Sincere Thanks to Mrs.Shahsi Nowlakha, with whose support the pilot project could be carried out meticulously.
- My special thanks to my son Abhishek for all the encouragement and support given to me to pursue the work which is close to my heart.

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## HEADING I: ABSTRACT

### **Wet Lands restoration with bio remediation and Phyto remediation**

#### **I. Introduction:**

1. Wetlands are in a precarious condition world over; the condition is worsening. Over the years, these wetlands have faced continuing threats and encroachment, rendering it polluted and threat to the ecology of wetlands, the flora, fauna and biodiversity.
2. There are many wetlands which come under the purview of the Ramsar convention.
3. One such is the East Kolkata Wet lands, near Kolkata City, 45 minutes' drive from Kolkata Airport, spanning around 12500 Ha of land, with a human population of 40000
4. There are about 100 plant species, which have been recorded in and around the East Calcutta Wetlands.
5. The Local farmers and fishermen use water hyacinth to create a buffer between land and water to minimize erosion.
6. The area is also home to large numbers of coconut and betel nut trees Many varieties of vegetables are farmed here, including cauliflower, eggplant, pumpkin, sunflower and sacred basil. Tracts of land are dedicated to paddy cultivation as well.
7. Role in climate mitigation: Sewage fed - aquaculture based artificial wetlands like East Kolkata Wetland (EKW), is a robust example of potential carbon sink and spin-off.

8. Land encroachment and real estate expansion has altered the wetlands demography and it is disturbing the ecology, making it vulnerable to the plant and aquatic species.
9. Presently the farmers are practicing farming with chemical fertilizers and pesticides, which is causing deterioration of the wetlands affecting the land and aquatic species. The poor quality of fish production has affected the livelihood of the fishermen.
10. Restoration of the wetlands to its original ecology by bringing back the flora, fauna, bio diversity and making it a natural carbon sink improving the livelihood of farmers cultivating in the wetlands, fishermen, enabling better quality of fish and farm produce for the citizens of Kolkata city.

## **II. Background/ Context and Literature Review:**

Over the years, these wetlands have been facing continuing threats and encroachment. In many instances, the original petitioner, the General public had to go to court (High Court, Supreme Court, the National Green Tribunal) to argue on the basis of the 1992 judgment and later EKW Act had to ward off project proposals that were in fact disguised attempts at land-grabbing. While minor encroachments continue even today, the East Kolkata Wetlands still survive. The Government of West Bengal has constituted various committees from time to time and taken various steps to conserve the wetlands.

**A. Conservation Methods by Government of West Bengal State:** 1.To demarcate the boundaries of the East Kolkata wetlands on the field. 2. To take measures or make an order to stop, undo and prevent any unauthorized development project in, or unauthorized use of, or unauthorized act on, the East Kolkata wetlands. 3. To make an order directing demolition or alteration of any hoarding, frame, post, kiosk, structure, neon-signed or sky-sign, erected or exhibited illegally for the purpose of advertisement on any land within the East Kolkata wetlands.4. To make an order to prevent, prohibit or restrict any mining, quarrying, blasting, or other operations for the purpose of protecting or conserving the East Kolkata wetlands. 5. To take measures to abate pollution in the East Kolkata wetlands and conserve the flora, fauna and biodiversity in general. 6. To promote basic conservation principles like sewage fed pisciculture and eco-tourism in the East Kolkata wetlands. 7.To detect changes of ecological character and in land use in the East Kolkata wetlands. 8. To establish network with other Ramsar Sites in India

**B.** The Government of India has also come under pressure in UN Climate change conference in December 2019 to protect these wetlands which come under the Ramsar convention. Hence The Ministry of Environment has engaged with various NGOs/Agencies to raise awareness about the utility of the wetlands in general and the East Kolkata wetlands in particular and implement programmes to dissuade farmers and fishermen from using chemical fertilizers and pesticides, use organic feed for the fish and also prohibit any sort of land encroachment, building construction etc.

**III. Research Aims:** Bringing awareness to the farming community and fishermen in Khyada I and II of EKWLs, with workable solutions to address the restoration of EKWLs ecology, improve the quality of fish, livelihood of fishermen, dissuade farmers for using chemical fertilizers and pesticides grow chemical free food, herbs and upkeep the flora, fauna and biodiversity of the area with bio remediation and Phyto remediation.

**IV. Research Methods:** Implementation of Phytoremediation - plant based approach which involves plants to extract and remove elemental pollutants or lower their bioavailability in soil. This method is used to remove heavy metals from agricultural soils combined with bio remediation. Bioremediation is a branch of biotechnology that employs the use of living organisms, like microbes and bacteria, in the removal of contaminants, pollutants, and toxins from soil, water, and other environments. This method is cheaper than classical traditional physical and chemical methods.

**V. Expected Deliverables:** Reduction in the chemical and heavy metal contamination in the sewage filled waters of EKWLs and the improvement in fish quality in 6 months' time.

**VI. Suitability for Research:** This is suitable for research as wetlands all over the world are exploited by the mindless greed of man. More and more scientific research is required to validate and offer a workable and cost-effective solution.

## HEADING II - INTRODUCTION

Art of Living is a largest volunteer-based NGO with global presence, founded in 1981 by His Holiness Sri Sri Ravishankar Ji. It has also been recognised as "*special consultative status with the UN's Economic and Social Council*".

The agriculture programs are organised and conducted through Sri Sri Institute of Agriculture Sciences & Technology Trust (SSIAST), one of the Trusts set up under the agies of Art of Living.. SSIAST Trust has trained over 2.2 million farmers in chemical free farming with the help of 1'500 trainers in India. The idea is to combine traditional practices and support farmers in building a steady income by helping them reduce costs effectively. This institution collaborates with many other organisations to reach as many farmers as possible across the country. Their main co-operators are the Trust Art of Living, International Association of Human Values (IAHV), Vyakti Vikas Kendra India.

The theoretical part is based on scientific articles as well as some information provided by the Indian government websites, organisations, research papers and with my first-hand experience of implementation of project in East Kolkat wetlands.

SSIAST Trust collaborations and presence:

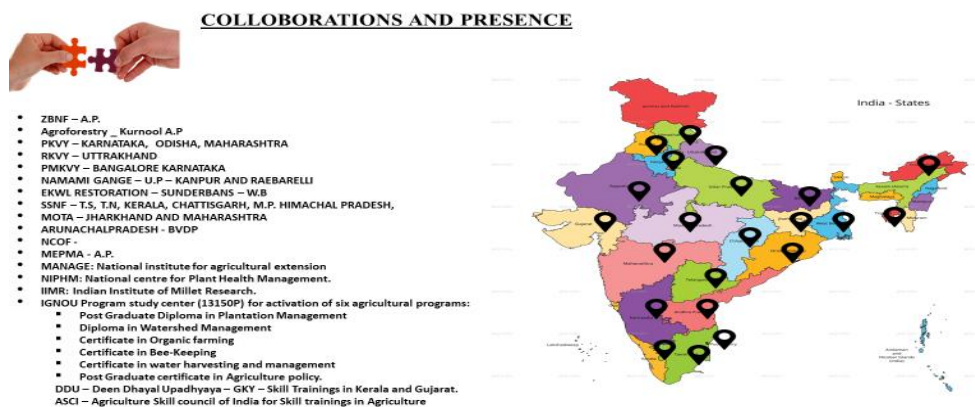


Figure 2 Source: SSIAST PPT

Number of farmers and acreage covered in the country

SL.NO	STATES	NO OF I.Gs	TOTAL AREA	TOTAL FARMERS	CERTIFICATES ISSUED	SCHEME
1	KARNATAKA	800	1600	5200	5000	PRVY
2	UTTARAKHAND	100	2000+	5000	SUPPORT AGENCY	NAMAMI GANGE
3	MAHARASHTRA	300	6000	3000+10000	SUPPORT AGENCY	PRVY-MOTA
4	ANDRA PRADESH	100	2200	24200	SUPPORT AGENCY	NON SCHEME
5	TELANGANA	10	80	1100	SUPPORT AGENCY	NON SCHEME
6	UTTAR PRADESH	170	3400	6800	1200	PRVY
7	PUDUCHERRY	26	520	1041	SUPPORT AGENCY	PRVY
8	madhya pradesh	20	40	300	SUPPORT AGENCY	NON SCHEME
9	CHATTISGARH	100	2000	4000	SUPPORT AGENCY	NON SCHEME
10	ODISHA	30	600	1500	SUPPORT AGENCY	PRVY
11	HARYANA10	60	300	2400	SUPPORT AGENCY	NON SCHEME
12	JHARKHAND	40	200	5000	SUPPORT AGENCY	MOTA
13	BIHAR	10	100	200	SUPPORT AGENCY	NON SCHEME
14	JAMMU & KASHMIR	10	80	200	SUPPORT AGENCY	NON SCHEME
15	ASSAM	5	20	300	SUPPORT AGENCY	NON SCHEME
16	GUJARAT	10	80	2200	SUPPORT AGENCY	NON SCHEME
17	WEST BENGAL	1	6	2500	5	NON SCHEME
18	HIMACHAL PRADESH	0	1600	1000	TRAINED ON ORGANIC	NON SCHEME
TOTAL	18	1792	31226	75941		

A LARGE NUMBER OF FARMERS ARE COVERED UNDER RIVER REJENUATION PROGRAMME OF AOL IN THE STATES OF KARNATAKA – VEDAVATHI & KUMUDAVATHI, 6 RIVERS IN A.P., MAHARASHTRA, NAGANADHI AND KOUSIGI IN T.N. WHERE WE TRAIN IN CHEMICAL FREE FARMING AND EDUCATE IN WATER LITERACY, AFORESTATION AS A PART OF ECORESTORATION.

Figure 3 Source: SSIASST PPT

One of the projects I have handled as director projects is the restoration of wetlands of East Kolkata, India which is a part of Sundarbans stretching across 12500 Ha. Situated between 22°27'00” N and 88°27'00” E Source: <http://ekwma.in>



Figure 4



Figure 5

- Mouzas (revenue villages) in the districts of North and South 24 Parganas in West Bengal make up the wetlands. The administration of the area spans 2 municipal bodies and 7 panchayats (rural governance bodies).
  - Population: 40000
  - There are about 100 plant species, which have been recorded in and around the East Calcutta Wetlands.

- Local farmers and fisher folk use water hyacinth to create a buffer between land and water to minimize erosion.
- The area is also home to large numbers of coconut and betel nut trees. Many varieties of vegetables are farmed here, including cauliflower, eggplant, pumpkin, sunflower and sacred basil. Tracts of land are dedicated to paddy cultivation as well.
- Role in climate mitigation:
- Sewage fed aquaculture based artificial wetland, like East Kolkata Wetland (EKW), is a robust example of potential carbon sink and spin-off.
- East Kolkata Wetlands (EKW) lock down over 60 percent carbon from sewage
- This water body not only filters and purifies the sewage water like a kidney, but also provides livelihoods to the people and various ecosystem services (provisioning, supporting, regulating & aesthetic/cultural) to the citizens of Kolkata about which most of the citizens are not aware about.
- EKW is the world's largest resource recycling ecosystem which helps to treat around 600 million liters of sewage and wastewater daily.
- East Kolkata Wetlands that provide many ecosystem services needs to be preserved to meet the SDGs and to mitigate the effect of global warming.
- This goal is for building resilience to adapt to climate-induced events in different countries. One way of doing this is by maintaining the natural safeguards like wetlands for sponging floods and forests to stop soil erosion.

### **The ecosystem services of EKW**

- Wastewater can be an alternative source of water for fish culture and crop cultivation. EKW has been using this unique system for almost a century now. The cleaning of the water is basically done by oxidation, radiation and biological breakdown of organic waste (Mukherjee 2006) and all this is done with the help of photosynthesis. The fish farms are kept very shallow to allow the rays of the sun to pass through them. Once the effluents settle, the water is channeled into the maturation ponds where fishes are grown. Maturation ponds also help in nutrient cycling (Chakraborty 2013).

- Apart from these, EKW acts as a retention basin in general. The tilt of the land is towards the east, so water inevitably flows towards the wetlands by gravity. But with urban growth, the wetlands on the east have been reclaimed, many have atrophied or converted into residential areas. This causes flooding in the city after a heavy downpour. The EM Bypass acts as a virtual dike cutting natural spill basin in the erstwhile salt lake swamps and stops the smooth flow of the storm water into the wetlands (Ghosh 1993).
- EKW came under the Ramsar Convention in 2003. Wise use of wetlands as defined by Ramsar in the case of EKW are quite a few. It provides direct employment for 70,750 men and women who maintain fishponds, catch fishes, grow paddy and vegetables (Mukherjee 2006, 106). These wetlands also supply affordable and fresh fish and vegetables to markets serving poor communities. The water resources, if managed properly, mitigate environmental degradation and reduce public health risks (Bunting et al. 2010) thus both ecologically and economically very important.
- References: Chatterjee, Nandini. “Marshes to a Township: A Case study of Salt Lake City, East Calcutta”. In Calcutta: Land and People. Calcutta: Department of Geography, The Geographical Society of India, 1993.

### **Problematic aspect:**

EKW displays a bouquet of ecosystem services from microclimate regulation to livelihood generation, especially through agriculture and pisciculture services. It happens to be one among the largest single-stretched waste-water fed aquaculture belts (locally known as *bheries*) in the world ([Raychaudhuri et al., 2008](#)). The fragile ecosystem presents a unique case study of being an archetype of resilient eco-culture in the world. However, increasing urban spaces, agricultural activities, pollution of ecosystems, industrialization, oil-spills, overfishing have left an indelible mark on aquaculture sector. Fishes constitute an important portion of the people inhabiting in lower Gangetic delta. Easy availability of large variety of fishes, that are rich in omega fatty acids, protein and low density lipoprotein are key factors for healthy heart. However, fishes are more prone to water pollution and bioaccumulation due to direct contact with water. Even smaller concentrations of heavy metal if consumed repeatedly by fishes might wreak havoc in human body. Heavy metal concentration in fishes



are being studied by ecologists across the globe ([Dhanakumar et al., 2015](#), [Hosseini et al., 2015](#), [Jia et al., 2017](#), [Ahmed et al., 2019](#)).

- Land encroachment and real estate expansion has altered the wetlands demography and disturbing the ecology making it vulnerable to the plant and aquatic species.
- Field and lab-based investigations were carried out using three commonly edible carp variety of fishes such as Rohu (*Labeorohita*), Catla (*Catlacatla*) and Nile Tilapia (*Oreochromis niloticus*) collected from ponds (bheries) of the wetland located on the eastern fringes of Kolkata, India.
- Rapid urbanization and rampant industrialization activities provoke the rapid increase in concentration of heavy metals along with the sediments of river banks especially in developing economies where the environmental management aspects in the industrial sector are still in its' infancy ([Chen et al., 2004](#)). The analysis of variation of heavy metal accumulation across the seasons and years in water and sediments is discussed). The results reveal that when  $F_{cal} \geq F_{crit}$  at ( $P < 0.05$ ), it is highly significant indicating the toxic heavy metal accumulation much beyond the recommended limits. However, when  $F_{cal} \leq F_{crit}$  at ( $P < 0.05$ ), the results are not significant indicating no significant contamination beyond recommended limits.
- Mercury is an important and the most toxic of all the heavy metals with documented toxicological effects on human health. The source of Pb, Cd, and Cr are majorly the vehicular exhaust, automobile emissions, pesticides, tanneries in the adjoining areas, electroplating industries, dye and paint factories as well as glass and ceramic workshops.

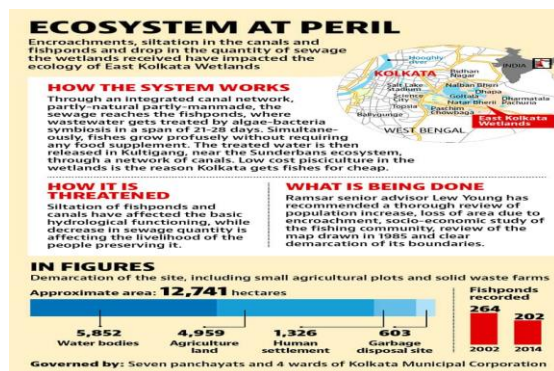


Figure VII

<https://www.hindustantimes.com/india-news/east-kolkata-wetlands-the-wonder-threats-and-battle-to-preserve-it/story-EcdihvGXGSsm6gl45lhTHL.html>

<https://www.ias.ac.in/article/fulltext/jess/123/04/0729-0740>



Figure VIII Statistics of the dumping, vegetables, fish produced etc.

Wetlands are nature’s kidneys that regulate the toxic pollutants and helps in purification of the ecosystem congenial to flora and fauna as well as the environment as a whole.

The *peri*-urban wetlands such as EKW also provides buffer between terrestrial and nearby marine environment; trapping and stabilizing sediments, nutrients, and several types of conservatives. pollutants (Dutta et al., 2017, Dutta et al., 2016, Dutta et al., 2019). Thus, helping to maintain the soil health and water quality optimal for consumption in agriculture as well as domestic activities. It is therefore pertinent to understand the significance of wetlands as primary service providers to terrestrial as well as coastal populations. It is further crucial to record the health parameters that act as ecosystem indicators.

Mandate of the Government of India and of the state government of west Bengal is to restore the EKW to do so, A body called East Kolkata Wetlands management authority was formed in the year 2006 to put checks and balances in place, initiate legal action against encroachers, educate the farmers and fishermen and restore ecosystem of the wetlands. Since then, a number of punitive legal cases have been initiated and the cases are pending against the perpetrators in various courts in the state of West Bengal, India.

One of the initiatives was to award a pilot project with 6 months’ time line to SSIASST Trust vide letter dated 19.02.2020 from the Ministry of Environment, West Bengal The task of Restoration of the wetlands to its original ecology by bringing back the flora, fauna, bio

diversity and making it a natural carbon sink improving the livelihood of farmers cultivating in the wetlands, fishermen, enabling better quality of fish and farm produce for the citizens of Kolkata city.

### **Case study**

Pilot project on wetland restoration undertaken by SSIAST Trust became a proof of concept. The project started in January 2020. The scope of the project was to cover 2 areas viz: Khyada- I where predominantly Agriculture is the livelihood for the inhabitants and Kyada – II where Pisciculture is the main livelihood for the inhabitants. Our team comprised of experienced, committed, dedicated instructors and volunteers to carry forward the project effectively and efficiently. I led the team and started the project along with the following members from Kolkata, India.

1. Shri Swapna Kundu – Member, Agri Apex Body, West Bengal.
2. Shri Santanu Banerjee, Member, VVKI Apex Body, West Bengal.
3. Shri Subrata Kumar Pal, Member, AOL Apex Body, West Bengal.
4. Shri Rohan Agarwal, coordinator, Project Bharat.
5. Shri Sumanta Roy, Master trainer in Agriculture.
6. Shri Amit Chaterjee, YLTP – rural youth coordinator,
7. Chandas Biswas, BLRO Officer, Govt of W.B.
8. Purba Ganguly, WDO, Govt of W.B.
9. Siddhartha Gupta, WDO, Govt of W.B.
10. Bipul Mondal, Rural youth leader from EKWLs

As Art of Living volunteers / Instructors we are trained to transform societies by instilling a vision, making role models, promoting a sense of community and giving people a voice. Our practical training sessions transform young men and women in villages and tribal communities into socially and economically self-reliant residents with the confidence, energy and enthusiasm to create change. We do this by reviving their human values, invigorating their mental capacity, enhancing their physical health, developing their vocational skills and sensitizing them to the sustainable management of natural resources.

### **Strategy adopted:**

Sensitizing the community, Conducting Base line survey, Cluster formation, Training in Natural farming and Pisciculture, Improve the quality of the grains, vegetables, fishes and the fish feed.

Restoration of the ecology of the EKWLs –

- a. Improve the quality of water by Bio remediation
- b. detoxifies the wetlands through Phyto remediation.

### Agriculture in Kyada – I

Crops grown are The crops grown are Rice, Pulses, Oil seeds, Jute, Roselle, Sugarcane, Coconut and Turmeric. Cash Crops like Tea and Cotton , Horticulture crops: Vegetables and Medicinal herbs.

Step 1. To Wean farmers away from practicing chemical farming which is causing deterioration of the wetlands affecting the land and aquatic species by teaching chemical free farming, provide environmental friendly alternatives without disturbing their livelihood.

Step 2. Ensure the yield of the produce, create a market linkage to the Organic/ chemical free produce.

Step 3. Remedy the chemical/ heavy metal laden land restore the ecology of the wetlands. mitigate environmental degradation and reduce public health risks thus both ecologically and economically.

### Pisciculture in khyada- II

Fishing is the main occupation of the inhabitants of the EKWL, The current deterioration of the wet lands has rendered the water unfit for aquaculture, this has resulted in less production and poor quality of fish production thus affecting the livelihood of the fishermen and rendering fish unfit for human consumption. The deliverables:

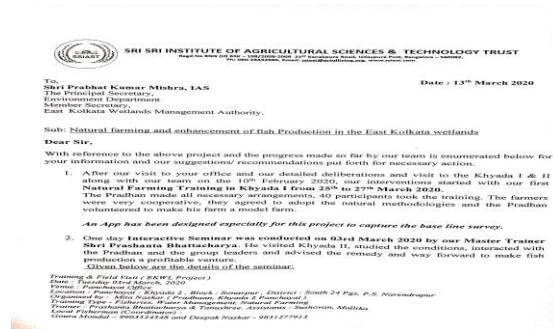


Figure IX Letter from SSIASST Trust to the Ministry of Environment, Government of West Bengal state. Figure X Letter from the Ministry of Environment, Government of West Bengal state to SSIASST Trust.



Figure XI photos of the training conducted for Natural farming and fisheries for the select two villages covered under the pilot project. Source: SSIAS Trust PPT

### HEADING III Methodology

For Kyada I - predominantly agriculture clusters our task was to Train, handhold farmers for one crop season, prescribe complete package of practices, register for organic certification and enable market linkages. Training in Traditional ecological knowledge to do farming using the animal waste and plant base. This knowledge is mentioned in the treatise called VRIKSHAYURVEDA which is a part of Ayurveda . Bio fertilizers, bio pesticides, growth promoters, bio weedicides and formulations to treat the seeds are taught in this training. Training also included Phyto remedial measures to be incorporated while planning the crops.

**What is Phytoremediation:** Phytoremediation is defined as the use of green plants to remove pollutants from the environment or render them harmless. This cost-effective plant-based approach of remediation takes advantage of the remarkable ability of plants to concentrate elements and compounds from the environment and to metabolize various molecules in their tissues. Toxic heavy metals and organic pollutants are the major targets for phytoremediation. Phyto-(or green-plant based-) remediation is not a new concept. About 300 years ago, plants were proposed for use in the treatment of wastewater. *Thlaspi caerulescens* and *Viola calaminaria* were the first plant species documented to accumulate high levels of metals in leaves. Plants are solar-driven pumping and filtering systems that have measurable loading, degrading and fouling capacities. Similarly, root may be described as exploratory, liquid-phase extractors that can find, alter and/or translocate elements and compounds against large chemical gradients. Therefore, plants can also be a cost-effective alternative to physical remediation systems.

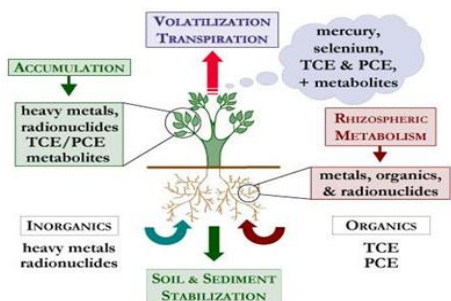


Figure X

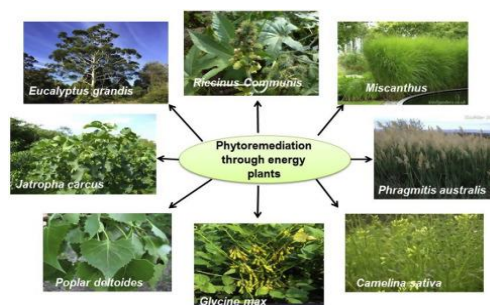


Figure XI

Source: [http://rydberg.biology.colostate.edu/Phytoremediation/2008%20websites/BZ572\\_Radionuclides%20website\\_Tom%20Grant/UGA\\_phyto\\_fig.jpg](http://rydberg.biology.colostate.edu/Phytoremediation/2008%20websites/BZ572_Radionuclides%20website_Tom%20Grant/UGA_phyto_fig.jpg)

**List of some plants used in phytoremediation**

<b>Plant</b>	<b>Metal</b>	<b>Method of Phytoremediation</b>
Brassica juncea	Lead	Chelate-assisted phytoextraction
Thlaspi caerulescens	Cadmium	Continuous phytoextraction
Silense vulgaris	Zinc	Continuous phytoextraction
Brassica oleracea	Zinc	Continuous phytoextraction
Raphanus sativus	Cadmium	Continuous phytoextraction
Thlaspi caerulescens	Nickel	Continuous phytoextraction
Alyssum lesbiacum	Copper	Continuous phytoextraction
Alyssum murale	Lead	Continuous phytoextraction
Arabidopsis thaliana	Chromium	Continuous phytoextraction
Brassica juncea	Selenium	Continuous phytoextraction
Ipomea alpine	Copper	Continuous phytoextraction
Haumaniastrum robertii	Cobalt	Continuous phytoextraction
Sebertia acuminata	Nickel	Continuous phytoextraction
Agrotis tenuis	Lead	Phytostabilization
Festuca arundinacea	Boron	Phytovolatilization
Hibiscus cannibus	Boron	Phytovolatilization

**Source:**<http://www.biotecharticles.com/Environmental-Biotechnology-article/Phytoremediation-Use-of-green-plants-to-remove-pollutants-704.html> ENVIS Centre, Ministry of Environment & Forest, Govt. of India.

The plants prescribed in the said project was Sunflower - *Helianthus annuus* L , Indian Grass – *sorghastrum nutans*, *Datura stramonium*, *Hibiscus cannibus* , *Brassica Juncea*, *Jatropha integerrima*, *calotropis procera* & water hyacinth. These plants can be easily procured, grown and suitable in most of the agroclimatic zones in India . They have allelopathic qualities and are widely prescribed in Vkrish Ayurveda for making plant-based bio pesticide and weedicide formulations. Most of the best practicing Natural farming farmers invariably grow it along the farm borders.



Figure XII Common Plants available locally used for phytoremediation

Dates, Alfaalfa, corn are also used to reclaim contaminated soil – a cheap, clean and sustainable process

**Bermuda grass** which is also called **Druva** grass - ***Cynodon dactylon***, it is different from the normal grass, widely grown in India and has spiritual and Ayurvedic significance. It can be grown at different metal contaminated sites potentially accumulates various metals (As, Pb, Zn, Cd, Cu, Cr, Co, Mn, Ni, and Fe) and widely used for the phytoremediation of metal contaminated sites.

## HEADING IV - Strategy adopted for EKWL

In the said project phytoremediation was coupled with bio remediation with fruit enzyme famously called the garbage enzyme to enhance the process of remediation and speeden the process to deliver the project within the prescribed time lines. Bio remediation with garbage enzyme for waste water treatment as well as removal of heavy metals from the landfills and chemically contaminated farm lands. Art of Living has used it extensively to contain the stench and treat the water in the river Yamuna in 2016 during the 3 days mega World culture festival.

Bioremediation can be defined as the methodology to remove or neutralizes waste and toxic substances in the environment with the help of microorganism and plants. In other words, it is the process to detoxify the pollution from the environment with the help of microorganisms, plants, or microbial or plant enzymes. Enzymes have several beneficial characteristics. They are the main effectors of all the transformations occurring in the biota. They are catalysts with either narrow (chemo-, region- and stereo-selectivity) or broad specificity and, therefore, they can be applied to a large range of different compounds in mixture, as well. They may produce extensive transformations of structural and toxicological properties of contaminants, and even their complete conversion into innocuous inorganic end products. They may perform processes for which no efficient chemical transformations have been devised.

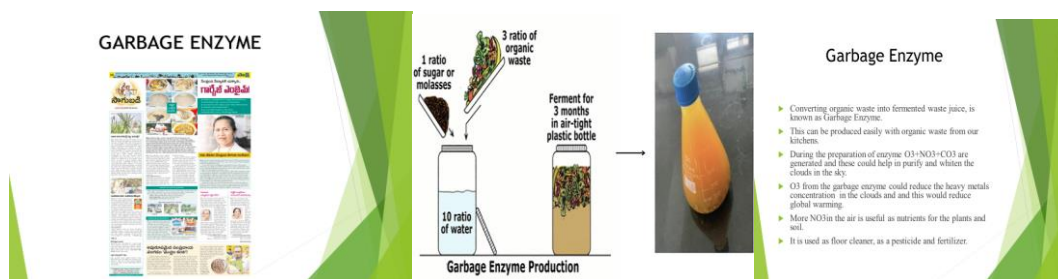


Figure XIII SSIASST PPT slides (Source : SSIASST Trust PPT)

**Garbage Enzyme:** Introduction Garbage Enzyme is a concentrated, complex liquid, a product of a 3-month fermentation process made from kitchen waste (fruits and vegetables peels), sugar (black sugar/ jaggery and molasses) in water. Garbage Enzyme was first reported by Dr. Rosukon Poompanvong, an alternative health-care practitioner from Thailand. Detoxification Processes



with microbial activity - degradation of organic wastes can usually be broken down or even consumed as food by some organisms. When degraded, the waste may be made less toxic and its harmful effects reduced. Remineralization is the complete breakdown of an organic chemical (for example, into its basic components such as carbon dioxide, nitrogen, phosphorus, and water), such as may occur by microbial digestion. Remineralization completely destroys toxicity inherent in such waste. Most remineralization is conducted by microbes (primarily bacteria and fungi). The ability of microbes to metabolize and remineralize different wastes is highly variable. Remineralization depends on the type and number of microbes in the total community that are capable of degrading a particular waste.

## HEADING V - Corroborative CASE STUDY Test to confirm the effectiveness of G.E for bio remediation

Art of Living has done a lot of work in waste water treatment with Garbage enzyme (GE). Vyakti vikas Kendra India (VVKI) Trust of Art of Living has revived 78 ponds and 11 temple tanks in Chennai city of India in collaboration with the Madras Municipal corporation. Another Case Study to establish the fact that G.E can be used to treat waste/Grey water and revive the aquatic life.

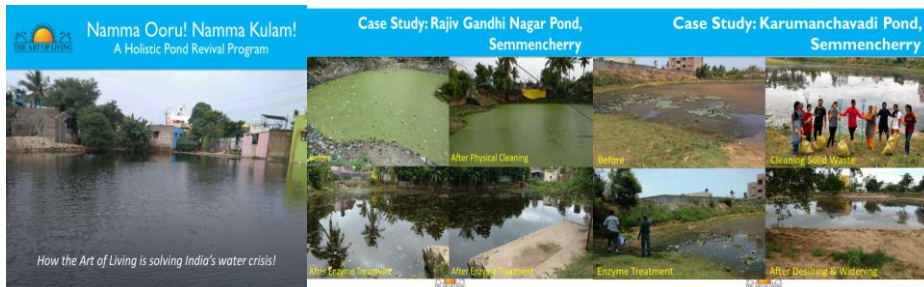


Figure XIV VVKI PPT slides

### Case Study: Karumanchavadi Pond, Semmencherry

## Impact Analysis

<p><b>Water Quality* has improved by 60% or more in 45 days.</b></p> <ul style="list-style-type: none"> <li>• BOD (@ 20° for 5 days) reduced from 39.5 mg/L to 16 mg/L.</li> <li>• COD reduced from 123 mg/L to 40 mg/L.</li> <li>• DO increased from 0.5 mg/L to 2.37 mg/L.</li> <li>• Reached permissible levels.</li> </ul>	<p><b>Desilting, Widening and Bund Strengthening.</b></p> <ul style="list-style-type: none"> <li>• Storage Capacity of the Pond increased- Widened by 10 feet all along the perimeter.</li> <li>• Ground Water levels recharge has improved in 1 km radius.</li> </ul>	<p><b>Physical Cleaning, Awareness Campaign and Tree Plantation.</b></p> <ul style="list-style-type: none"> <li>• Bottles, Plastic, Cloth, Paper Products were removed from Pond and its Banks.</li> <li>• Increased sensitivity and vigilance in local community has reduced misuse of the Pond by miscreants.</li> <li>• Tree Plantation will provide green cover, reduce soil erosion and make the surroundings cooler.</li> </ul>
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\* Water Samples from the Pond have been tested by CVR Labs, a NABL Certified Lab in Chennai.

### Reviving Fish Life in Sengeni Amman Temple Pond, Neelankarai

- SOS received from Chennai Corporation of a few 100 fishes dying every day.
- Guided Corporation to give water samples for testing and aerate the Pond.
- Treated the Pond with Enzyme within 24 hours.
- Death of Fishes stopped within a day and the foul smell disappeared.
- Corporation gave after treatment water samples for testing within a week.
- BOD (57.1 to 19 mg/L), COD (195 to 72.3 mg/L) and DO (0.13 to 2.8 mg/L) improved significantly.
- In 10 days shoals of small fishes were seen thriving in the Pond.

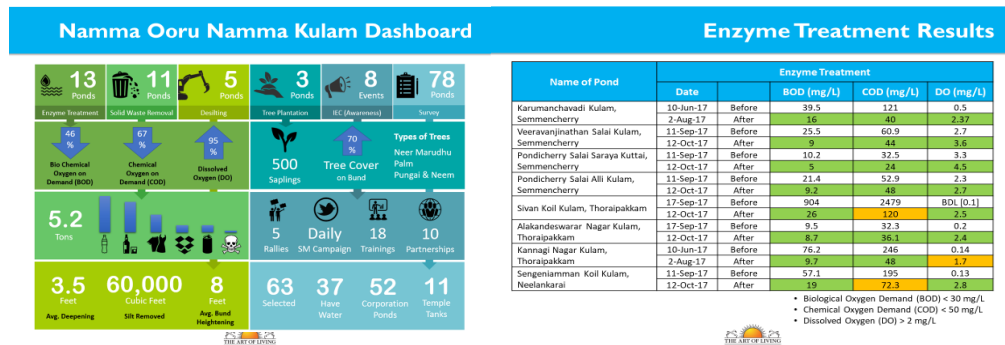


Figure XV Slides from VVKI PPT Source : VVKI PPT

Garbage enzymes effectively regulated the succession of enzymatic activities and the bacterial community during sewage sludge composting.

### Highlights:

As it can be seen from the above case BOD – Biological oxygen demana, COD – chemical oxygen demand and DO – dissolved oxygen of the water improved, Heavy metal concentration reduced and water became fit for aquatic life.

Effect of garbage enzymes on enzymes and bacterial community were investigated. GE addition increased three enzymatic activities during the whole process. GE addition reduced by 66.5% NH<sub>3</sub> emission, and increased by 39.2% TN content. GE increased the abundance of Firmicutes during thermophilic and cooling phases. Enzyme was secreted by Bacillus in GE, while by norank\_f\_Methylococcaceae in CK. The selected factors affected the bacterial community composition in the following order: NH<sub>4</sub>-N > TOC > FDA > TN > C/N. Network analysis also showed that the enzymes were secreted mainly by Bacillus and norank\_f\_Caldilineaceae in GE, while they were secreted primarily by norank\_f\_Methylococcaceae in CK during the composting process.

The sludge stabilization method aims to reduce organic ingredients and improves hygiene by reducing the pathogen in them Stabilization can be achieved by a biological, chemical (lime addition) or thermal process. Chemical and thermal stabilization methods are expensive, producing operator handling problems and generate fatal air pollution. This requires the selection of the correct method focusing on efficient, environmentally safe treatment and disposal.

In biological method microbial hydrolytic enzymes play important role in dewatering and reduction of solids content of sludge by reducing the organic compounds, remove pathogenic organisms and odor.

Source: <https://www.sciencedirect.com/science/article/abs/pii/S0960852421001310>

**Advantages of bioremediation:** Bioremediation being a natural process is accepted by the public as waste treatment method for contaminated material such as soil. Microbes capable of degrading

the contaminant, increase in numbers and produce harmless products. The residues for the treatment are normally harmless products such as carbon dioxide, water, and cell biomass.

**Complete destruction:** Bioremediation is employed for the complete destruction of a wide variation of contaminants. Many hazardous compounds can be transformed to non-toxic products. This reduces the chance of future responsibility related with treatment and disposal of contaminated material. Enzymes are generally produced from animals, plants or microbes. Among them enzymes from plant source are relatively cheaper and have easier extraction and purification step. The garbage enzyme functions similarly to enzymes in achieving a high degree of degradation within a shorter time. Researchers suggested that this enzyme can function in four categories: **Decompose, Compose, Transforms and Catalysis** (Joean oon, 2008). It can be utilized as a low-cost alternative to improve wastewater treatment processes through the removal of impurities, harmful sludge and bacteria, which in turn promotes recycling of waste back into the earth (Bhavani Prakash, 2011). Nazim and Meera (2013) produced garbage enzyme for treatment of synthetic grey water using 5 and 10% garbage enzyme solution.

**Conclusion:** The versatile nature of G.E and the various uses to which it is put to was our first option to remedy land and treat water in the said project study. We have used 10 to 15 % Solution to achieve the deliverable in a short span of 18 to 20 weeks' time. Bioremediation with Garbage enzyme and Phyto remediation with Mustard, Sunflower, Hibiscus, Bermuda – Druva grass and Indian Grass the EKWLs could be remedied and the ecology of the wetlands could be restored. The flora and fauna of the wetlands could be restored. The aquatic life could be revived and the natural carbon sink phenomenon of the wetlands could be restored. To conclude, the application of ammonia and nitrite-oxidizing bacterial cultures directly into the aquaculture tanks is a promising, economical and eco-friendly approach to reduce the level of pollutants, improve the water quality, and promote the growth of cultured aquatic species. The present study provides an excellent management approach for upgradation of economic value and ecological aspect of EKWL in the near future.

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Tel: 024.35772143/41

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