Natural Waste Water Treatment To Combat Climate Change

Prof. Rajendrakumar V Saraf, the Chairman of Viraj Envirozing, India, shares some insights on how urban areas can tackle its sewage generation, collection, treatment and disposal methods systematically. From various biological treatment to types of Phytoremediation, such important treatment methods for urban agglomeration is shared.

More than half of the entire humanity live in cities around the globe. By 2030, 6 out of 10 people will be urban dwellers. In India, 31% of the total population live in urban areas & 17% of the urban population lives in slums. By 2030 India will have 7 megacities with a population of over 10 million. India is home to about 1.21 billion people, representing about 17% of the earth's population is going through the fastest transformation of rural to urban India. Urban India continues to grow in a haphazard fashion without the availability of basic amenities like water supply & sewerage system.

With the development and population growth, Gram Panchayat gets to transform into an urban agglomeration named Nagar Panchayat then a Municipal Council & finally Municipal Corporation. Besides, urban areas are spreading by the inclusion of nearby villages. The growth of urban agglomeration is converting agricultural land into non-agriculture purposes. Growth has also encroached on natural water bodies and forest land. Pune, Mumbai, Bangalore are the best examples. Change in land use pattern cease natural sequestration of Carbon dioxide and production of Carbon dioxide begins due to domestic, commercial & Industrial activities.

Carbon Sequestration

Carbon sequestration is a process through which carbon from the atmosphere is absorbed by trees, plants, and crops with the help of photosynthetic reactions. This carbon can be extracted as stored

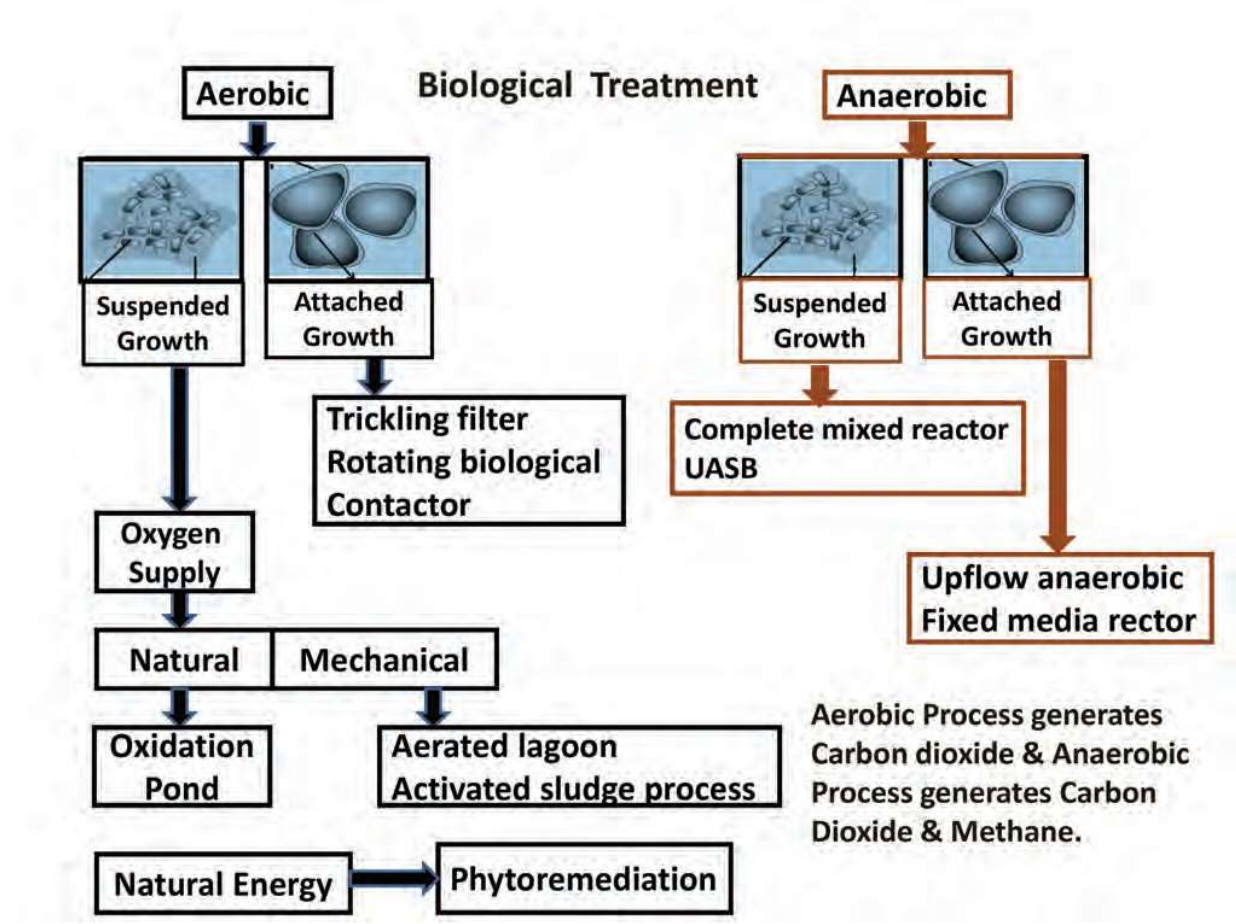


Figure 1 – Types of Biological Treatment

energy from plants in form of biomass. It includes crops and their residues, plant parts, animal wastes. Sequestration of Carbon dioxide is most essential & useful to reduce the increasing level of carbon in the atmosphere. This is an ongoing process on land, wetland & water bodies.

Present Status of Sewage Generation, Collection, Treatment & Disposal

Treatment of industrial wastewater is compulsory by law. However untreated sewage is discharged into receiving water bodies. Collection, treatment & disposal of sewage are very serious problems faced in newly expanded urban areas. If sewerage system is not provided residential complexes collect the wastewater and partially treat in the septic tank under anaerobic condition. The overflow from the septic tank either goes to the soak pit or joins the nearby mullah. Drawbacks of this system are Partial Treatment, Causes of smell; Sludge gets accumulated & requires removal once in 2 to 3 years & Causes water-logging in the soak pit if the percolation rate of the soil is poor.

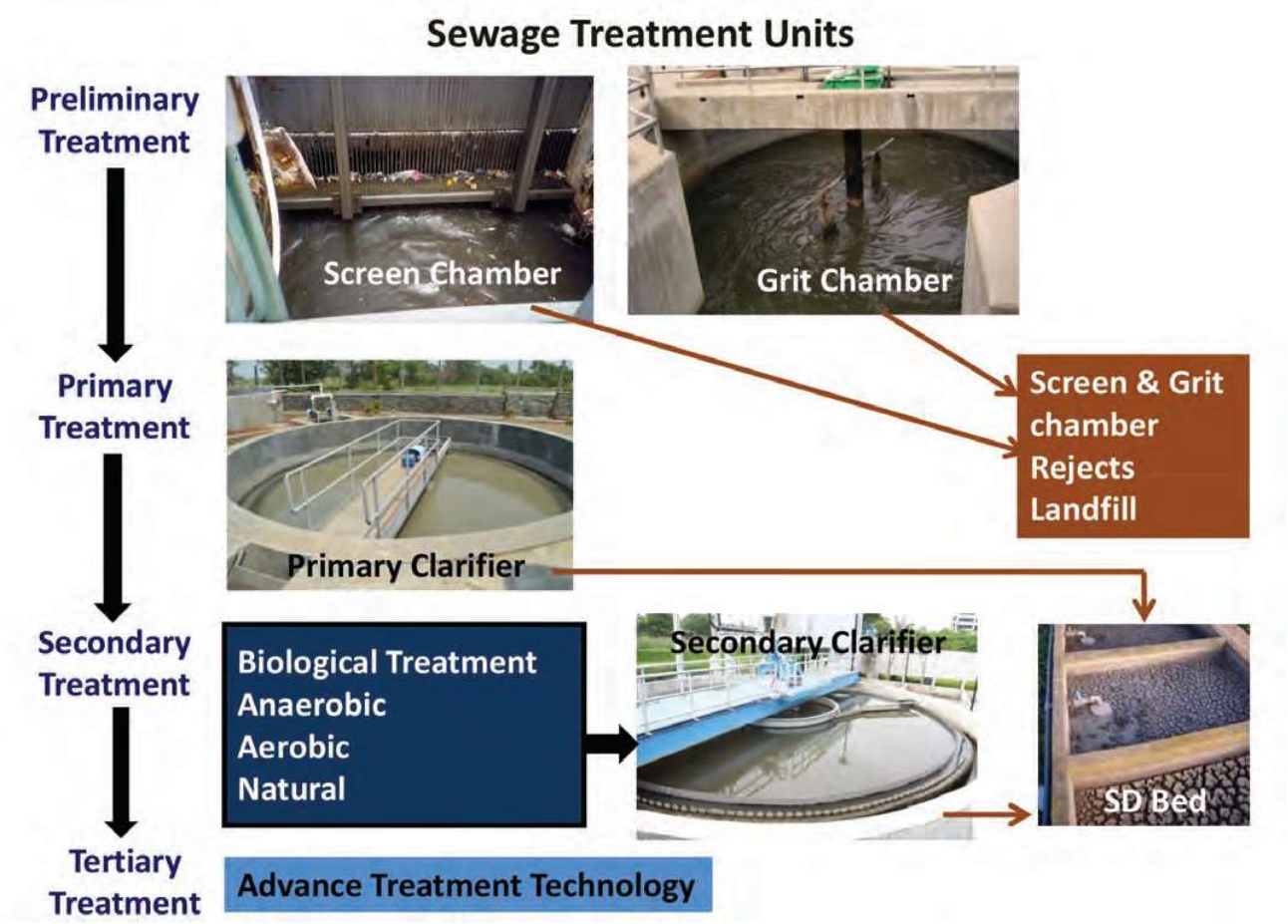


Figure – 2 Treatment Units in Sewage Treatment Plant

Where sewerage system is laid down, sewage is collected & directly disposed of into receiving water bodies or treated by conventional treatment methods.

A commonly used Process for Sewage Treatment is the Activated sludge process & its modifications. The aerated lagoon is not common for Sewage Treatment. Treatment processes based on attached growth are Trickling Filter & Rotating Biological Contactor. Trickling Filter use is not very common. Rotating Biological Filter is used for Small Flow. The modifications are Moving Bed Bioreactor, Membrane Bioreactor, and Sequential Bioreactor, etc.

Conventional treatment system requires capital cost, energy to operate the system, skill manpower & maintenance cost for mechanical equipment. This ultimately results in the direct and indirect generation of Carbon dioxide. It also has a bigger Carbon Foot print as it requires energy to run & generates Carbon Dioxide & Methane as a product of biodegradation that adds to Green house gases.

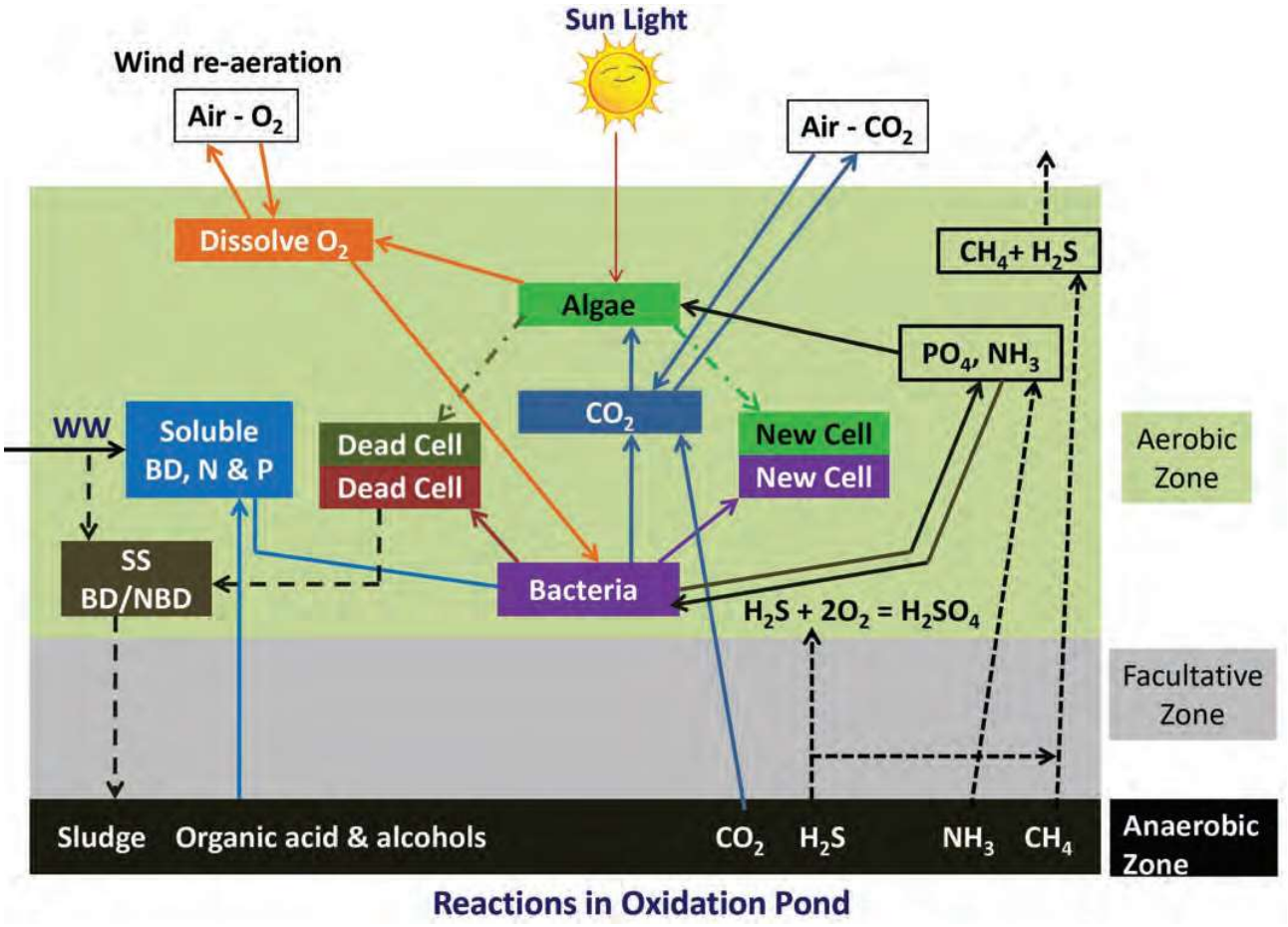


Figure – 3 Reactions in Oxidation Pond

India is blessed with Ample of Solar Energy. Solar energy through photo synthesis generates oxygen and fixes carbon dioxide in form of biomass. However, the inherited natural technology like Stabilization ponds and Wetland Treatment has almost forgotten with the pretext that it requires a large area and may generate the off smell.

Oxidation Pond

Ample sunlight couple with the availability of nutrients in sewage promotes the rich growth of algae. Algae supply oxygen to microorganisms for the growth and biodegradation of organic matter. Physical, chemical & biological reactions in the Oxidation pond are given in Figure – 3

The oxidation Treatment pond does not require electricity. If it is properly operated it does not generate smell. It also fixes carbon dioxide in the form of algae as Biomass. Fundamental factors for design are Sunlight & sunny days, Lagoon depth, Composition of wastes, Amount of wastes, Temperature, pH within 6-8, Pretreatment

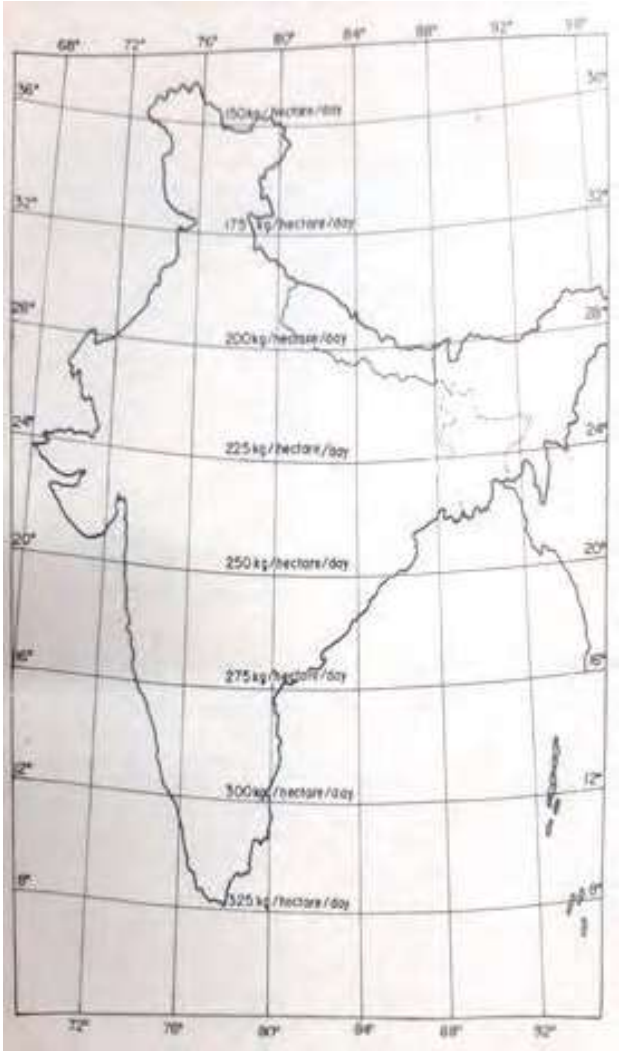


Figure – 4 Organic Loading Rate in India for Oxidation Pond

& Bacterial species. Organic loading as Kg/hectare & detention time is the main design parameters to find out the size required for the Oxidation Pond. A typical loading value in India is given in Figure 4

Detention time is 2 to 10 days. Depth of Tank is 1.2 to 1.8 M. Algae measure as chlorophyll – 500 to 1500 microgram/l. Typical design of Oxidation pond for a population of 25000 – It will generate 2500

Figure -5 Use of Oxidation Pond for River Purification

m3 /d sewage @ 100 lpcd. BOD of sewage is 150 mg/l. The total BOD load will be 375 kg/d. Select Organic loading rate 225 kg/ Ha/d. The total area required is 1.67 Ha. Depth is 1.5 M. Total; the volume of tank is 25000 m3. Retention time is 10 days.

The sequence of Oxidation pond – Maturation pond – Fish Pond will generate revenue by harvesting Algae & Aquatic animals like fish. Oxidation pond is the most appropriate Technology for the urban agglomeration like Nagar Panchayat and Municipal Council.

Diffuse pollution in rivers is extremely difficult to control & often results in serious degradation of water quality. Polluted river water can be treated by the development of large impounded lakes to remove & degrade the residual pollution. Such lakes are similar to maturation ponds. The use of an Oxidation Pond for River Purifications is as shown in Figure 5.

Phytoremediation

Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and destroy contaminants in the soil and water.

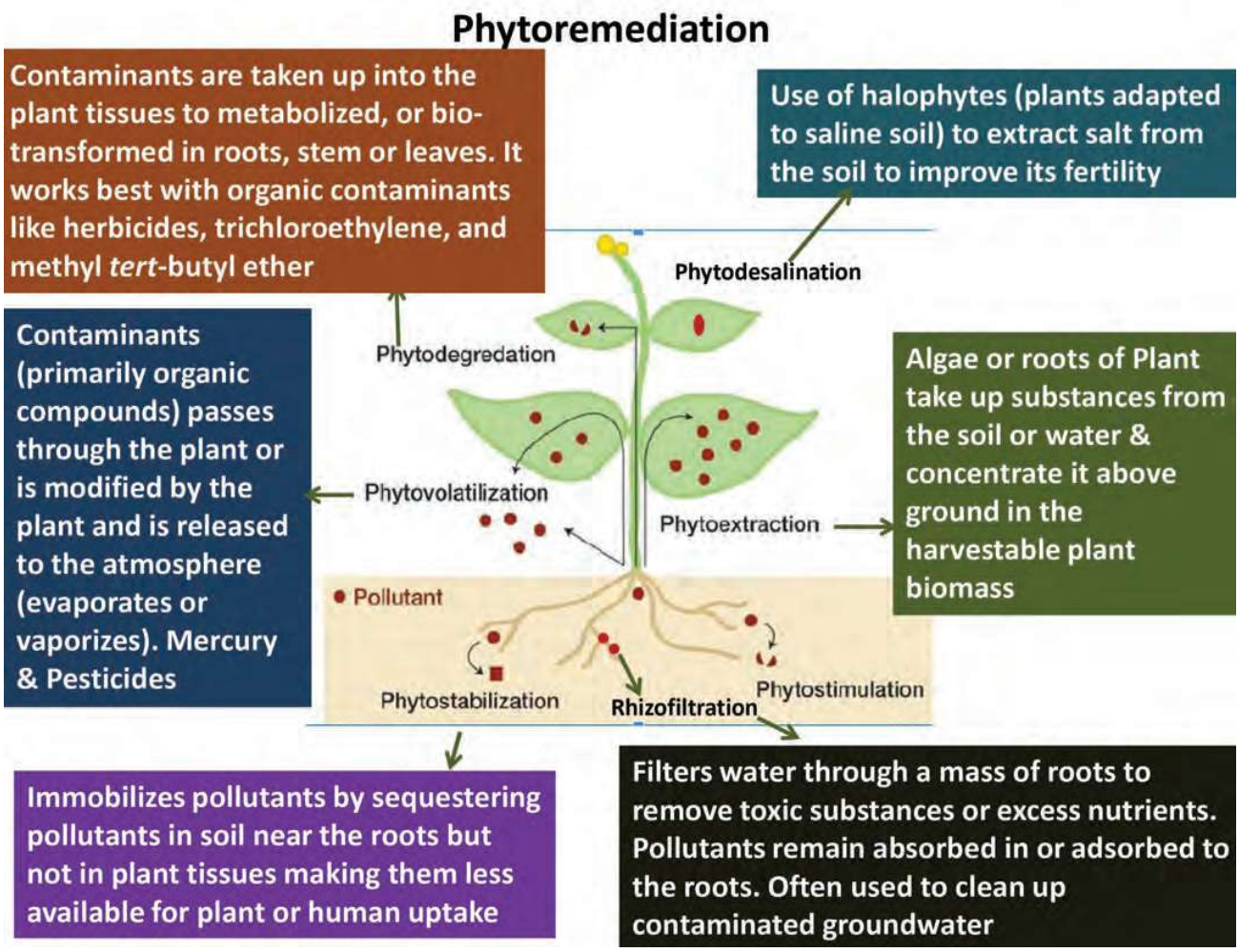


Figure -6 Different Types of Phytoremediation

Common Application of Phytoremediation is by using Floating aquatic plants in water bodies, Wetland and the use of shrubs and trees in the soil. Wetlands treatment can be described as the biological and microbiological treatment of wastewater resulting from the use of pollutants as food for living organisms in natural or artificial wetlands. The Ramsar Convention has adopted a very inclusive definition of a wetland.

Indian Experience for use of Wetland

Use of wetland for waste water treatment plant is known to central & southern part of India for a long time. Waste water from the Bathroom and kitchen goes to a place where Colocasia esculenta (Hindi - Aravi, Marathi - Alu) is grown. It has a lot of advantages like it uses plants, microbes, sunlight and gravity, Microorganisms growing on the roots of Plant help in

degrading the organic matter in the wastewater, Eliminates off smell, water-logging of water & growth of mosquitoes, Leaves & & corns (roots) are used to make dishes in the kitchen, Chemicals, energy and maintenance are not required, Highly effective & eco-friendly and Adds green cover. Wet Land treatment is also known as Phytoremediation or Root Zone Cleaning System.

Working of WetLand Treatment

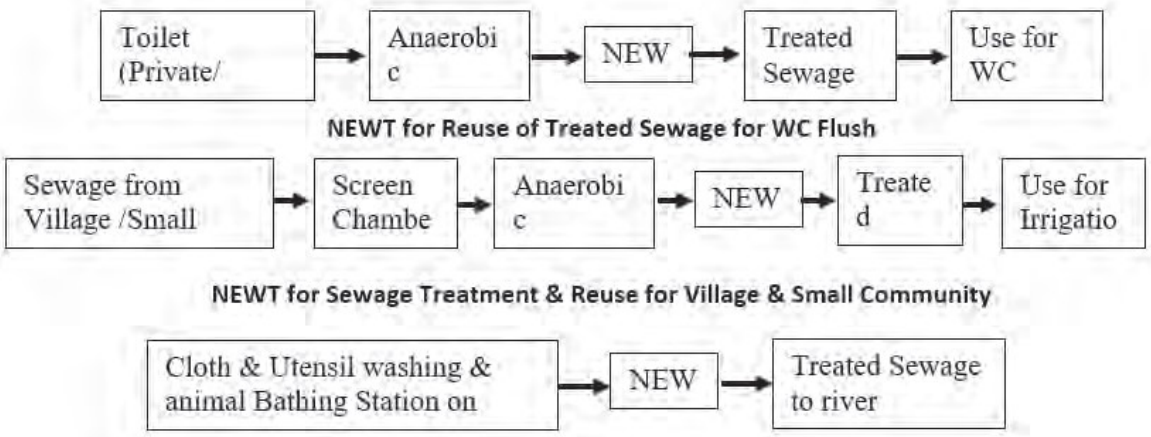
It consists of biological, chemical, and physical reactions. It includes physical filtration and sedimentation, biological uptake, the transformation of nutrients by bacteria (anaerobic and aerobic), plant roots and metabolism, as well as chemical processes (precipitation, absorption, and decomposition).

Development of Constructed Wetlands for Sewage Treatment

A constructed wetlands can be classified as constructed habitat wetlands, constructed flood control wetlands, constructed aquaculture wetlands, and constructed wastewater treatment wetlands. Constructed wetlands are more efficient than natural wetlands because they are designed for optimum performance of the particular function.

Natural Energy Waste Water Treatment

Since 1998 Author carried out extensive research on Waste water Treatment by Constructed Wet Land. 35 wetland plants were scanned for their performance. Experiments were carried out with Laboratory scale and Bench scale model. Design parameters for a very efficient system with modified media, flow pattern, uniform distribution, water depth, water holding capacity, Hydraulic and Organic loading rate & retention time are



NEWT for Reuse of Treated Sewage for WC Flush

Figure – 7 Application of NEWT

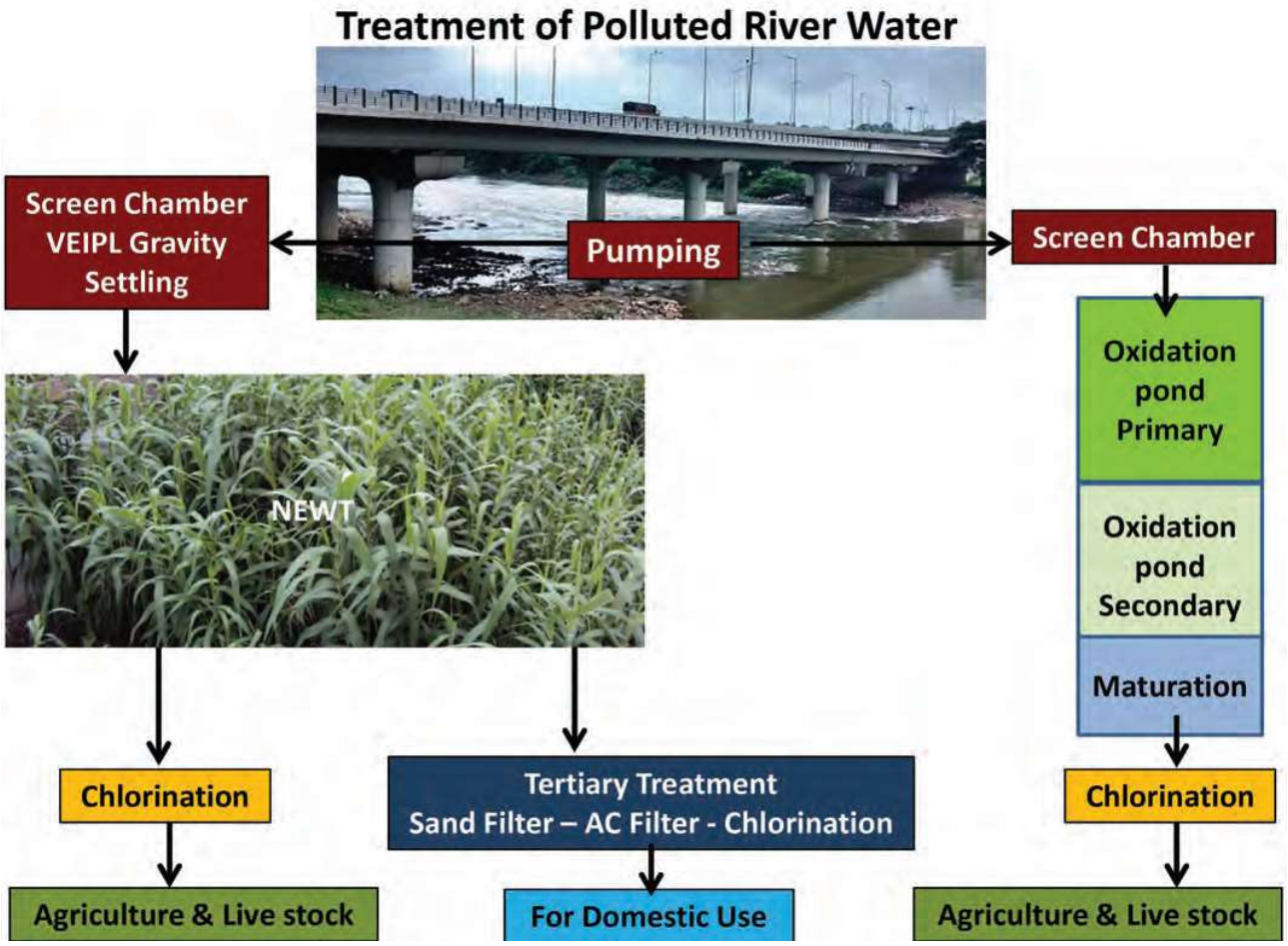


Figure – 8 Treatment of Polluted River water by Natural Treatment

developed. The Technology developed is named Natural Energy Waste Water Treatment (NEWT) (Patent No. 350396). The findings of the working plant are presented in National & International conferences.

Performance of NEWT at Field

The treated sewage has BOD less than 5 mg / l and Turbidity less than 10 NTU. The process does not generate any off smell & treated sewage does not have any off smell. It doesn't require any chemical or energy input & skilled & unskilled manpower. It is sturdy and resistant to flow variation and shock loading. However, the removal of dead culms is advisable. Treated sewage can be directly used for WC flush & irrigation of the green areas. It can handle a minimum of 10 to 1 million litres of Sewage per day. Some of the Applications for treatment & reuse are given in Figure 7.

NEWT is incorporated in Three-Tier System Developed & Implemented by

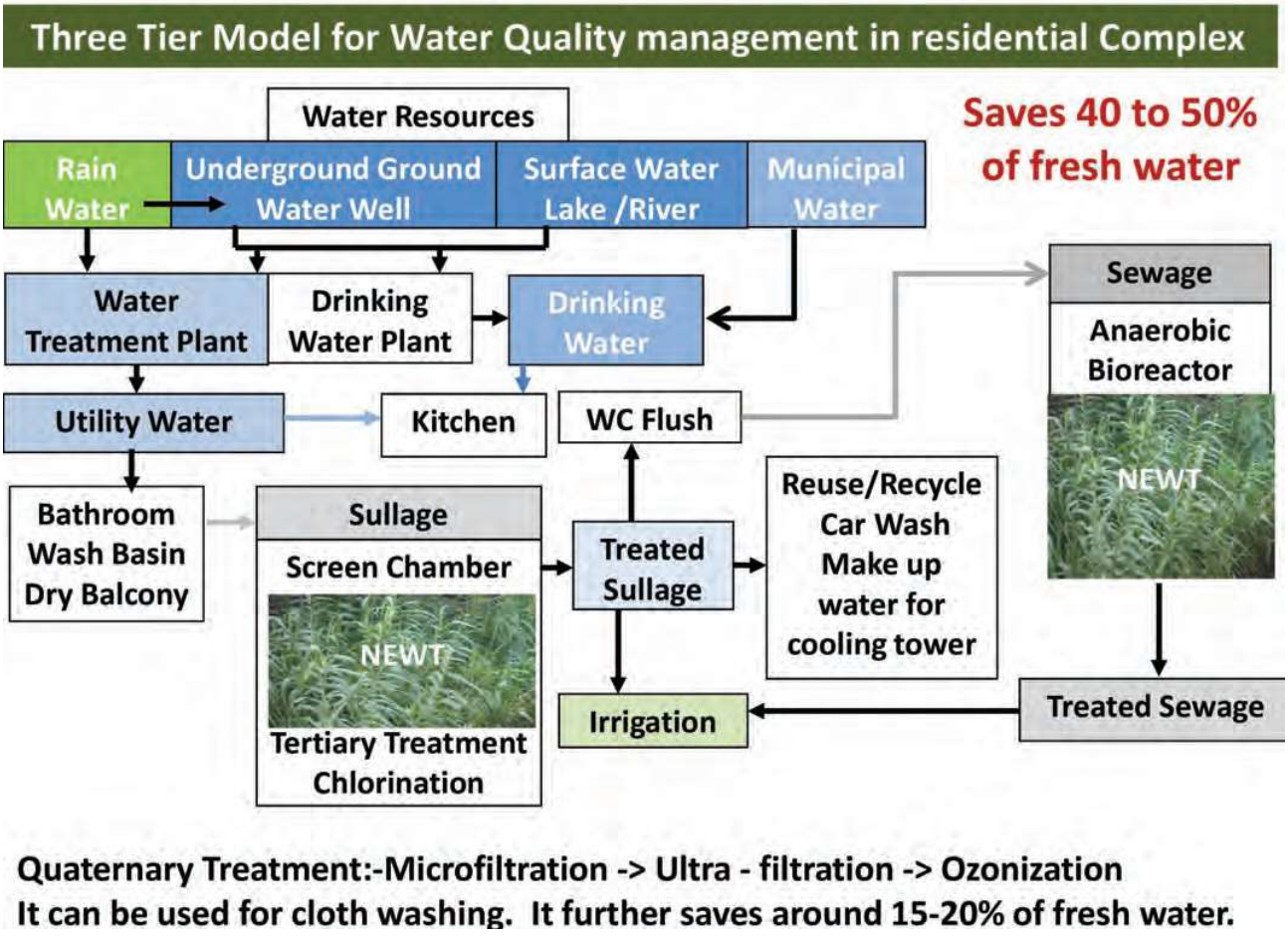


Figure - 9 Application of NEWT in Three Tier System

Author for Residential complex with Population up to 2000 is shown in Figure 9. It eliminates the use of Drinking water for Flushing Toilet and saves 40% of fresh water.

Urban Floods caused due to Change in Land use & Rain Fall Pattern. NEWT will be the best option for Stormwater Collection Treatment & Disposal. It will remove a wide range of storm water pollutants from land development sites, provide wildlife habitat, add to aesthetic features & reduce peak runoff rates.

Water and Food Security can be achieved for small municipal councils of up to 50000 populations. Sewage generated will be collected in Treated in Oxidation Pond or NEWT. Fully treated be sewage will be store and distributed to the Farmers downstream.

Carbon Dioxide Generation & Sequestration

In the aerobic process production of

Process	Green House Gas produced	Sequestration of CO2
Activated sludge Process	The basic reactions involve the breakdown of the organic matter (represented by 5 day Biochemical Oxygen Demand and the formation of cell mass (activated sludge) and by-products carbon dioxide and water. Equivalent Carbon Dioxide is also generated due Electricity require to run the system	Carbon Dioxide is release to Environment
Oxidation Pond	As Shown in Figure 3 Carbon Dioxide is utilized by algae to produce Oxygen and New cells. Very little CO2 & methane may get release to environment	Large amount of Carbon Dioxide is sequestered
NEWT	Spectrum of reaction occurs and carbon and nutrients are converted to Biomass. Very little CO2 & methane may get release to environment	Large amount of Carbon Dioxide is sequestered

Table – 4 Green House Gas Produced & Sequestration of Carbon Dioxide

Carbon Dioxide is attributed to two main factors: biological treatment process and electricity consumption. In the mainstream of the WWTP, the organic carbon of wastewater is either incorporated into biomass or oxidized to CO2. In the sludge line, it is converted mainly to CO2 and CH4 during anaerobic digestion and, finally, methane is oxidized to CO2 during biogas combustion.

Carbon Dioxide Generation & Sequestration by Activated Sludge Process & NEWT

A residential complex having two hundred tenements and 1250 residents is considered for the Case Study. Total water demand @ 135 lpcd is 168750 l/d. Water demand for WC flushes @ 45 lpcd is 56250 l/d. For drinking, cooking, washing and bathing is 112500 l/d. Black water (Sewage) from WC flush (95%) is 53438 l/d & Grey Water (Sullage) from other activities (85%) is 101250 l/d. Total waste water generated will be 154688 l/day. Assuming BOD 250 mg/l. The total BOD load is 38.7 kg/d.

Treatment by NEWT - Blackwater is separately collected & treated in an Anaerobic bioreactor and then along with Grey water in NEWT. The total area required will be 386.7 m2 which will fix carbon dioxide through the wetland plants.

Activated Sludge Process (ASP) - Total Oxygen demand will be 77.4 kg/d (3.2kg/

Details	NEWT	ASP
Aerator, 3 HP, Run hour 24 hr./day, KWh /year	0	19710
Recirculation Pump, 1 HP 12 hr./day, KWh/year	0	6570
Total KWh per year (Approx.)	0	26280
Total CO2 equivalent, T/year @0.93kg/ KWh (6)	0	24.4
Area required for NEWT, m2	386.7	NA
CO2 Sequestration, T year @ 1.68 kg/m2/year	0.65	0

Table – 5 Generation & Sequestration of Carbon Dioxide in NEWT & Activated Sludge Process

hr). Assuming the oxygen Transfer Efficiency of the Surface aerator is 1.1 kg oxygen / Hphr, the Aerator required will be of 3 HP. It will also require a Re-circulation pump of 1 HP. Both will run for 24 hr/day

Natural Energy Waste Water Treatment sequestrates and Activated sludge process generates Carbon dioxide. Besides Activated Sludge Process generates sludge that needs further treatment like anaerobic digestion or composting. This will further add methane and Carbon dioxide. Treated sewage from NEWT can be used directly for WC flush. Tertiary Treatment Plant to reuse sewage is required for further treatment of effluent from Activated Sludge Process. This needs additional energy to run.

Sewage is the evident output of Urbanization. In peri-urban areas & urban agglomeration, collection treatment & disposal of sewage is a severe problem. Urban agglomeration can be planned with an allocated space for Natural Treatment like oxidation pond & Natural Energy Waste Water Treatment (NEWT). Natural Treatment Processes has very low operation & maintenance cost does not require manpower. It does not require Electricity so the equivalent amount of carbon dioxide generated for electricity consumed for conventional sewage treatment plants is eliminated.

At present, the trend is to opt for Energy-intensive technologies for Sewage Treatment. Energy & Carbon footprint is not taken into consideration in the selection process. Besides the technologies (Conventional and modified Activated Sludge Process) generates carbon dioxide as a product of biodegradation. For a Population of 1250 Total carbon dioxide Equivalent to Electricity consumption is 24.4 MT /year.

In the Case of Natural Energy Waste Water Treatment sequestration of Carbon Dioxide is 0.65 MT per year. It is recommended to consider carbon dioxide generation & sequestration for evaluation of the treatment process. ■

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