International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

A Review on Phytoremediation A Sustainable Solution for Treatment of Kitchen Wastewater

Neharika Chandekar[1], Buddharatna J. Godboley[2]

[1] PG Student, Department of Civil Engineering, G.H. Raisoni College of Engineering Nagpur, India

[2]Assistant Professor, Department of Civil Engineering, G.H. Raisoni College of Engineering Nagpur, India

Abstract: ***Water contamination is a major problem world is facing today and the kitchen waste is one of the important factors. The kitchen waste water contamination consists of mainly micro-organisms, toxic organic and inorganic matter. It is found that phytoremediation is one of the effective methods for the removal of pollutants from water and soil. Phytoremediation consist of media beds, plants, micro-organisms which is mainly depends on physical, chemical and biological activity to remove the contaminants. Phytoremediation reduce the pollutant concentration, such as Biochemical Oxygen Demand, Chemical Oxygen Demand, total dissolved solid, Total Solids solid, Total Phosphorus, Total nitrogen from the kitchen wastewater as plants play a great role in the removal of pollutants. This paper focused on the treatment of kitchen wastewater by phytoremediation.***

Keywords: plants, phytoremediation, HRT, kitchen wastewater, pollutants

1. Introduction

Water is most important for the existence of all living forms. It is an easy solvent, enabling most pollutants to dissolve in it easily and contaminate it. Increasing population, urbanisation and industrialisation has led to the deterioration of water. Water pollution is directly suffered by the organisms and vegetation that survive in water, including amphibians. Domestic and industrial waste is the most common cause for water pollution. In domestic waste kitchen is one of the important factors for water pollution. When kitchen waste enters water bodies it dissolves in water and it results in the deterioration of water quality. As Kitchen play an important role in daily life, mainly educational and professional organizations and large quantity of liquid organic waste are generated from kitchen and food services are polluting water bodies. Kitchen wastewater contains Solid food particles; oil and grease stick inside of the pipe which clogs the pipes in the facility. Kitchen waste is a left-over organic matter, washing soap and detergent from restaurants, hotels and households in which restaurants plays major role in discharging kitchen waste in to the environment. In India restaurant industry is growing at a faster rate with wide range of cuisines and the diverse cooking techniques (13).

Kitchen wastewater is the raw sewage contains high organic, suspended solids, oil and grease which cause harm to the environment and human health. Pollutants can also affect the ground waters. When water is contaminated with organic matter the mosquito larvae will survive may increases because organic matter provides food for larvae to eat. Drinking contaminated water can cause serious health problems like diarrheal diseases, Cholera, and other illnesses such as Guinea worm disease, Typhoid, and Dysentery. It is difficult to identify excess nitrogen containing water because of its colourless tasteless property. This type of water may not cause sudden adverse effects but gradually reacts with haemoglobin & reduces the oxygen in the body. Some of the serious illness caused by nitrate that are listed in various studies such as chronic inflammatory, blue-baby cancer, enema of eyelids, tumour, congestion of nasal mucous membranes and pharynx, stuffiness of the head and gastrointestinal, muscular, reproductive, neurological and genetic malfunctions. It is important to control kitchen waste water for the betterment of the society and our future. The wastewater is treated by three methods such as physical, chemical and biological process in the transformation and consumption of organic matter.

Term „phytoremediation" derived from the Greek prefix phyto (plant) and Latin remedium (to correct or remove an evil). It is an eco-friendly biological treatment method suitable for kitchen wastewater treatment. In this method contaminants are removed by macrophytes. Plants absorb the pollutants along withwater andother nutrients. The contaminant mass is not destroyed but ends up in the plant shoot and leaves. It is a natural wastewater treatment method and cost effective. Phytoremediation technology has been widely applied for sewage treatment, pollution control and environmental improvement (20). The removal of extra nutrients and pollutants from wastewater occurs through various processes such asreduction,precipitation, filtration, settling,oxidation, sedimentation, nitrification, adsorption and denitrification. It acts as a biological filter by removing pollutants such as organic materials and nutrients from the wastewater. This domestic waste consists of organic and inorganic waste includes waste oils, food scraps and detergent (13) it is a natural wastewater treatment method and cost effective

2. Plants Role in Phytoremediation

The plants play an important role in purifyingwastewater by removing organic and inorganic contaminants. The aquatic plants are harvestable as well as economic product. The plants provide a large surface area for the better results and growth of micro- organisms. The aquatic plants remove of pollutants and up taking of nutrients and breakdown the organic and in organic matter from wastewater [8]. The capacity of wetland plants uptake for nutrients depend on the species of plants, quality of sewage, the growth rate and

depth of roots .The oxygen carrying capacity and water conduction of root zone are related to the development of root system [20]. The plants fit for local condition and fast developed of root system, those have economic values and decontamination efficiency. A dense root system has a high potential to reduce the pollutants by controlling water table.

3. Filter Media Role in Phytoremediation

Gravel and soil is the most commonly used growth media in phytoremediation processes. Gravel is an extremely effective filter media, it hold the ability to precipitate the contaminated water. Sand and gravel layer remove the bacteria and other small practical from wastewater. Gravel filters are very effective in removing sediment and heavy metals from contaminated water and less effective in removing dissolved nutrients. Gravels are used for purification of water.

4. Mechanism of Phytoremediation

There are various forms of phytoremediation technology which are applicable in treatment of wastewater. Uptake mechanisms of plant help in remediating organic and inorganic contaminants from wastewater in Phytoremediation method. (Barceló and Poschenrieder2003).

4.1 Phytoextration- In this processes plants uptake the contaminants by the root and translocate it to the above parts of the plants by absorbing, concentrating and precipitating the pollutant from contaminated zone.

4.2 Phytodegradation- In this metabolic process breakdown the pollutants in the soil. Microorganisms consume nutrients from the organic substances.

4.3 Phytovolatization- Plants absorb pollutants from water as well as soil and then release or supply to the atmosphere in the form of vapour at low concentrations through the leaves.

4.4 Rhizofiltration- Removal of the pollutants in surface water by precipitation and adsorption using plant roots.

4.5 Phytostabilization- Plantsimmobilize orsolidify the pollutants in the water and soil throughaccumulation and absorption in plant.

4.6 Phytotransformation- The use of plant to the uptake and transformation of contaminant from soil. The plants release natural enzymes that cause fast chemical reaction to take place. Break down contaminated by metabolic processes.

4.7 Hydrolic control- To control the water table. Dense root large volume of water absorbs and reduces infiltration of precipitation.

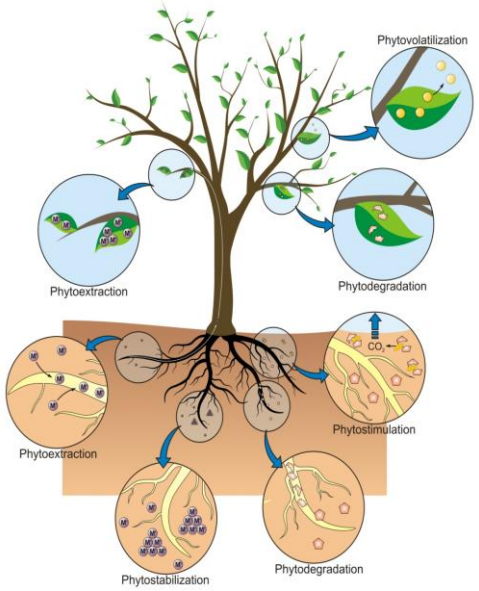

Figure 1: Processes of phytoremediation

5. The Contaminants Removal Mechanisms in Phytoremediation

Wastewater constituents	*Removal Mechanisms*
Suspended solid	• Sedimentation • Filtration
Soluble organics	• Aerobic and Anaerobic microbial degradation
Phosphorus	• Matrix sorption • Plant uptake
Nitrogen	• Nitrification • Denitrification • Plant uptake • Matrix adsorption
pathogen	• Sedimentation • Filtration • Predation • UV irradiation • Excretion of antibiotics from root of macrophytes

6. Literature Review

Sr No.	*Author*	*plants*	*Type of flow*	*Media*	*HRT*	*Result*	*Remark*
1	Namratha,Harshini, Hamsalekha, et. al	Canna	VSSF	Sand and gravel	3 days	COD -90.6% BOD- 87.9%, NH3-N- 66.7% TN- 63.4% TP- 92.6%	Plantation of canna is a good option in wetland development for better efficiency.
2	A.V. Chopra et al.	Typha	HFCW	Sand,soil	-	TDS-15% TN-40% BOD-65%	Pollutant removal efficiency is good in typha plant.

			VFCW	,gravel		COD-60%	
3	Sara G. Abdelhakeem , Samir A. Aboulroos	PhragmitesAustralis	VSSF	Gravel	-	COD- 75% 29% BOD- 84% 37% TSS- 75% 42% NH4- 32% 26% TP- 22% 17% planted and unplanted bed	Pollutant concentration of each effluent is directly related to influent pollutant load.
4	Oladejo, O. Seun,Owoade, Nelson Adeshina et. al	Pistia Stratiotes and Eichhornia- crassipes	VF	Sand and aggregate	10 days	pH 60.5% D.O 77.5% nitrate 66.7% sulphate,93.3%, turbidity,80% color, 43.6% chloride 34.6% magnesium 70%	In kitchen waste water ckeanup water hyacinth is suitable and efficient.
5	Samson O. Ojoawo,GaddaleUdaya kumar	Reed	HSSF	Gravel	3hrs	pH - 6.73 to 6.76 turbidity -30NTU to 20NTU Nitrate-51.9% Phosphate –8.9% Phenolic compounds- 1.0 %	Nitrogen removal efficiency is good in Canna plant,fairly effective in Phosphorus removal and very poor in removing Phenolic compound.
6	Kavya S Kallimani , Arjun S Virupakshi2	PhragmitesAustrails and Canna Indica	HSSF	Gravel and sand	1- 6 days	pH-6.4-7.6 and 6.7-8.1, COD 84% and 76% BOD 71% and 67% Total solid 80%and 81% Dissolved and79% and 75%, Suspended 76% and 74%PhragmitesAustrails and Canna Indica bed	PhragmitesAustrails plant is more efficient than Canna Indica plant in waste water treatment.
7	Xiaoyun Fu ,Xingyuan He	Acoruscalamus, Lythrumsalicaria, Monochoriakorsakowii Alismaorientale and Sagittaria sagittifolia	culture bucket	-	5 days	Total Nitrate A. calamus -97.7% L. salicaria- 94.9% M. korsakowii -96.4% A.orientale-91.2%	Lower TN and TP in vegitation thanunvegetated treatments.
8	Anwaruddin Ahmed Wurochekkea, NurulAzmaHarun	LepironiaArticulata	HSSF	Gravel and sand	3 days	BOD -81.42 % COD - 84.57 % AN- 39.83 % SS- 54.70 % Turbidity- 45.01 %	Media and constructed wetland is suitable for Treatment of greywater.
9	OnanongPhewnil, KasemChunka et al	Typhaangustifolia Linn., Cyperuscorymbosus Rottb., and Canna indica	VFCW	Sand and Gravel	1-71 days	The BOD, TSS removal efficiencies of Typha a, Cyperus, and Canna indica, were 88.47%, 82.16% , and 86.62%, respectively. And 58.77%,48.47% and 47.91% respectively.	Typha shows higher biomass and growth rate.
10	HosseinRezaie et al	PharamitesAustrails and TyphaLotifolia	HSSF	Sand	20 days	PharamitesAustrails and TyphaLotifolia Nitrate- 81.4% & 92.6% Phosphate- 84.66% and 74.24%	The typha and read plants are more efficient in the elimination of nitrate and phosphate, respectively.
11	Mega Anggraeni, et. al	Canna Indica and Cyyperus	HSSF	Gravel and Sand	12days	Removal rate in gravel bed BOD-0.45 COD-0.36 Ammonia-0.49 Nitrate0.60 in sand bed BOD-0.16 COD-0.09 Ammonia -0.20 Nitrites-0.45	As compare with the gravel bed to sand bed as compare with gravel bed, sand bed has decrease in removal rate of pollutants.
12	Arivoli A, Mohanraj R	Typhaaugustifolia	VFCW	Gravel and Sand	12, 24 and 36 hours	The removal efficiency of planted and unplanted TDS- 84.66% and 67.26% Turbidity-92.90% and64.76%, COD- 80.53% and 64.70 %, BOD5 -75.49% and 56.45 %	Maximum removal efficiencies of the pollutants in planted system Compare to unplanted system.

						PO4-83.51% and 64.45%, NO3- 88.48 % and 61.80 %	
13	Xiaoyun Fu ,Xingyuan He	Monochoriakorsakowii And Alismaplantagoaquatica sagittifolia	Water bucket	-	5 days	TN- 94.9% and77.0%	M. korsakowiihad a higher capability to remove nutrients from wastewater.
14	Ramprasad	PharamitesAustrails	SSF	Gravel and Sand	1 day	BOD-90% Nitrogen -63%	Pollutant removal efficiency is good in PharamitesAustrails
15	Suhendrayatna, Marwan et al	Typhalatifolia,saccharumspontaneum	HSSF	Sand and Gravel	1 day	COD-56.41% and 50.15% BOD-37.31% and 56.72% TSS-97.96% and 88.83% saccharumspontaneum and Typhalatifolia	Typhalatifolia plant is more effective than saccharumspontaneum plant in cleanup technology.
16	Yadav S. B. et al	EichhorniaCrassipes	VFCW	-	1 day	BOD-95.89% COD-97% TSS-82% Phosphate-50%	Eichhorniacrassipes reduce organic matter efficiently from wastewater
17	G. Baskar, V.T. Deeptha	PhragmitesAustralis	HF and VF	Sand and Gravel	-	TSS 41% TDS 76% TP 77%, BOD 75% COD 36%	soil layers filtration might have more effected for BOD and COD
18	Gauang sun et al.	PharagmiteAustarils , TyphaLotifolia and AcorusCalamus	HSSF	Sand and Gravel	3,4 ,5 days	COD -54.9% NH4–N -54.8% TN - 90% .	TyphaLotifolia was better in campare to PharagmiteAustarils ,AcorusCalamus plants.
19	C.A Prochaska et al.	PharagmitesAustrails	VSSF	Gravel	3 days	COD -96% PO4 – P - 52% TN - 60%	Not required to increase in depth from 0.6cm to 1m.
20	Suntudsirianuntapib-oon	TyphaLotifolia And Canna Sieamensis	VSSF	Sand and Gravel	6, 3, and 1.5 days	Removal rate of SS- 90%-93%,TN- 85%-88%,Phosphate-85% -90% in 6days . SS- 87%-91%, TN- 68%-72%,Phosphate 77%-81% in 3days. SS- 84%-87%, TN- 56%-63% ,Phosphate -52%-63% in 1.5days	Sixth day of HRT shows higher removal efficiency.
21	Keffala C, Gharabi A.	PhragmitesAustrails and TyphaLotifolia	VSSF and HSSF	Gravel and sand	-	The removal rate for nitrogen, nitrogen ammonia ,nitrate nitrogen of 27%,19%,4% for planted, 5%,6%,13% for unplanted	VF system support nitrification and HF to denitrification in nitrogen removal
22	M.L.Solano et al	PharagmiteAustrails and TyphaLotifolia	HFW and VFW	Sand and Gravel	1.5 and 3 days	In the first year removal rate of phragmitesaustrails and typhalotifolia. BOD -71%-86% and 76% -81% COD- 64% -78% and 69%-76% TSS 88%-87% and 90% In second year BOD- 70 %-80% and 64%-70% COD- 51%-77% and 65%-87% TSS ,94%-81% and, 75%-83%	Pollutant removal efficiency is good in PhragmitesAustrails than Typhalotifolia.
23	Jos T.A. Verhoeven , F.M. Meuleman	PhragmitesAustralis, Typha	Surface-flow wetland Infiltration wetland	Soil	5 day	Removed 99% of bacterial pollution, 80–90% of COD and BOD and 30–40% of N and P	A well-designed wetland system is capable of furtherimproving the effluent quality regarding nutrients
						In the 3.96 days BOD- 64.5%, COD- 68% SS- 79.7%, TP- 21%	4.56 days and 5.4 days of HRT had given better cleanup efficiency

24	Erkankalipci	pharagmiteAustrails	HSSF	Coarse Aggregate	3.96, 4.56 and 5.4 days	TN- 20.7 In the 4.56days BOD- 65.1%, COD-70.8%, SS-81.8% TP - 22.7%, TN- 21.9% In the 5.4 days BOD- 71.2%, COD- 75.1%, SS - 87.3% TP- 24.8%, TN- 23.5%	
25	V Luederitz et al	Reed	VSSF	Sand and gravel	-	Removal rate of COD -99.5% TN -93.8%	More than 90% of organic load and of total N and P removed by HF and VF.

7. Advantages and Disadvantages of Phytoremediation

7.1 Advantages of phytoremediation

- Phytoremediation is economical as compare to other treatment methods.
- It is a natural process not harmful to the environment.
- It is effective on low strength contaminants.
- It is very easy method to operate.
- It is more effective method for removal of hazardous pollutants.
- It is effective for removing dissolved nutrients.

7.2 Disadvantagesof phytoremediation

- It is required large area for installation.
- Highly toxic materials can effect on aquatic plant.
- When the high concentrated pollutants present in wastewater than Pretreatment processes is necessary.
- Repeated cleaning processes is necessary
- The type of plants are also affects the phytoremediation process.
- Depth of plant root is affects the potential of plant for uptake
- Climatic conditions is also affected the Performance of phytoremediation technology

8. Conclusion

In this paper we focused on phytoremediation method for treating waste water. From the above study the use of plants for removing of contaminants from waste water is cost effective and having a very less operation and maintenance work. The phytoremediation mechanism has high removal rate of pollutants along with different HRT. In this paper we also focused on the aquatic plants and their pollutant removal efficiency.This study shows that plants gives good result in cold climatic condition. The removal of the contaminants is dependent on the type planted beds. Canna plant is a good option for plantation in the development of wetlands because it is easy to grow in any local climatic condition and more decontamination efficiency. In this papers observed that the HRT is directly proportional to the effectiveness of phytoremediation system .The treatment also improved the physical characteristics of the kitchen wastewater such as colour and turbidity. The treated water use for gardening and other related purposes. We hope this paper would help researchers in finding the better removal efficiency from kitchen wastewater in phytoremediation with different HRT.

References

[1] Namratha,Harshini , Hamsalekha et al. , (2016) "A Review on Removal of Phosphate and Nitrate from Kitchen Wastewater by Constructed Wetlands",International Journal of Modern Trends in Engineering and Research (IJMTER) Volume 03, Issue 03.
[2] AdityaVikramChopra, UmangK Shah et al., (2016) "Waste Water Treatment by Phyto-Remediation Technique", ISSN 0974-5904, Volume 09, P.P.393-399 .
[3] Sara G. Abdelhakeem, Samir A. Aboulroos (2016) "Performance of a Vertical Subsurface flow Constructed Wetland under Different Operational Conditions", Journal of Advanced Research , 803–814.
[4] Oladejo, O. Seun ,Owoade, Nelson Adeshina et al.(2015) " Kitchen Wastewater Treatment with Constructed Wetland Using Water Hyacinth" International Journal of Scientific & Engineering Research, Volume 6, Issue 1, 834 ISSN 2229-5518.
[5] Samson O. Ojoawo, GaddaleUdayakumaret al.,(2015) "Phytoremediation of Phosphorus and Nitrogen with Canna x Generalis Reeds in Domestic Wastewater through NMAMIT Constructed Wetland", ICWRCOE, e-mail: soojoawo@lautech.edu.ng.
[6] Kavya S Kallimani, Arjun S Virupakshi, (2015) "Comparison Study on Treatment of Campus Wastewater by Constructed Wetlands Using Canna Indica&PhragmitesAustrails Plants", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 09 .
[7] XiaoyunFu ,Xingyuan He , (2015) " Nitrogen and Phosphate Removal from Contaminated Water by Five Aquatic Plants"International Conference on Mechatronics, Electronic, Industrial and Control Engineering (MEIC).
[8] kavya S. kallimani and Arjun S. Virupakshi , (2015) "A Review on Removal Efficiency of Pollutants in Subsurface flow Systems" , ISSN;0976-1353 volume 14 Issue 2 .
[9] Anwaruddin Ahmed Wurochekkea et al., (2014) "Constructed Wetland of LepironiaArticulatafor Household Greywater Treatment", ICESD .
[10] Onanong Phewnil1, KasemChunka et al., (2014) "Choosing Aquatic Plant Species for High Wastewater

Treatment Efficiency through Small Wetland" Vol. 8, No. 4, ISSN 1913-1844 E-ISSN 1913-1852.
[11] HosseinRezaie, Mohsen Salehzadeh, (2014) "Performance Removal Nitrate and Phosphate from Treated Municipal Wastewater Using PhragmitesAustralis and TyphaLatifolia Aquatic Plants", J. Civil Eng. Urban., vol 4 (3):pp 315-321.
[12] Mega Anggraeni, Hadiyanto et al., (2014) " Effluent Treatment of Pharmaceutical Industry by Using Subsurface flow Wetland System", waste tech,vo 2(1), pp 8-12 .
[13] S.K. Singh, VishakhaKaushik et al. (2014) "Waste Management in Restaurants: A Review", IJEERT Volume. 2, Issue 2, May 2014, PP 14-24.
[14] Arivoli,Mohanraj, (2013) " Efficacy of TyphaAngustifolia Based Vertical Flow Constructed Wetland System In Pollutant Reduction of Domestic Wastewater" ,International Journal of Environmental Sciences Volume 3, No 5.
[15] Xiaoyun Fu ,Xingyuan He , (2012) " Nitrogen Removal From Contaminated Water by Two Aquatic Plants" ,ISSN: 1662-8985, Vols. 610-613, pp 1829-1832.
[16] Ramprasad .c (2012) "Experimental Study on Wastewater Treatment Using Lab scale Reed Bed System Using PhragmitisAustralis" ,ISSN 0976-4402,volume 3,no 1.
[17] Suhendrayatna, Marwan, Rika Andriani (2012) "Removal of Municipal Wastewater BOD, COD, and TSS by Phyto-Reduction: A Laboratory–Scale Comparison of Aquatic Plants at Different Species TyphaLatifolia and SaccharumSpontaneum"ISO 9001:2008 Certified International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 6.
[18] Yadav S.B,jadhav A. S,et.al., (2011) "Performance Evaluation of Surface flow Constructed Wetland System by Using EichhorniaCrassipes for Treatment for Wastewater Treatment in an Institutional Complex" volume 1, issue4;435-441.
[19] G. Baskar, V.T. Deeptha, Abdul A Rahman,(2009) "Treatment of Wastewater from Kitchen in anInstitution Hostel Mess using Constructed Wetland", International Journal of Recent Trends in Engineering, Vol. 1, No. 6.
[20] Guang Sun, Yongshen Ma, Ran Zhao, (2009) "Study on Purification in Constructed Wetlands with Different Plants", World Rural Observations, vol 1(2), pp 35-3.
[21] C.A Prochaska, A.I. Zouboulis, (2009) "Treatment Performance Variation at Different Depths Within Vertical Subsurface-flow Experimental Wetlands fed with Simulated Domestic Sewage", Journal of Desalination vol 237, pp.367–377.
[22] Sukha Ram Vishnoi and P.N Srivastava, (2008) "Phytoremediation – Green for Environmental Clean" , Department of Botany , J. N Vyas University , Jodhpur - 342005.
[23] SuntudSirianuntapiboon, SontidejJitvimolnimit,(2007) "Effect of Plantation Pattern on the Efficiency of Subsurface flow Constructed Wetland (sfcw) for Sewage Treatment", African Journal of Agricultural Research Vol. 2 (9), pp. 447-454.
[24] Keffala C., and Ghrabi A,(2005) "Nitrogen and Bacterial Removal in Constructed Wetlands Treating Domestic Wastewater", Journal of Desalin., vol 185, pp 383-38.
[25] Jos T.A. Verhoeven , Arthur F.M. Meuleman "Wetlands for wastewater treatment: Opportunities and limitations"
[26] M L Solano, P Soriano,M P Ciria (2004) "Constructed wetlands as a Sustainable Solution for Wastewater Treatment in Small Villages", Biosystems Engineering, vol 87(1), pp 109–118.
[27] ErkanKalipali(2001) "Investigation of Decontamination Effect of PhragmitesAustralisfor Konya Domestic Wastewater Treatment", Journal of Medicinal Plants Research Vol. 5(29), pp. 6571-6577.
[28] V Luederitz, E Eckert, M Lange-Weber et al.,(2001) "Nutrient Removal Efficiency and Resource Economics of Vertical flow and Horizontal flow Constructed Wetlands", Ecol. Eng.vol 18, pp 157– 171.