BIOLOGICAL WASTEWATER TREATMENT BY PHYTOREMEDIATION IN A CONSTRUCTED WETLAND SYSTEM

A Comparative Study using Vetiver (*Chrysopogon Zizanioides*) and Narkot (*Phragmites karka*)

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Outline

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Introduction

- Wastewater: Combination of Organic and Inorganic pollutants
- Wetlands: Storehouse of organic nutrients
- Constructed wetlands: Mimic of natural system
- Phytoremediation: Biologically nutrient absorption by plants and microorganisms
- Vetiver(*Chrosopogon zizanioides*) and Narkot; Common reed(*Phragmites karka*) widely used for wastewater treatment in many countries

Vetiver

Narkot

Statement of Problem

- Human sanitary wastes, Sewerage, Industrial effluents are main cause of water pollution
- Bagmati river quality: COD(110-197.62), TSS (92-3000), NO3(0.6-1.25) mg/l since 2003-2013 (ENPHO, 2003;Ghimire. N., 2013)
- Bagmati and its tributaries around Kathmandu being degraded
- Kathmandu Valley had five municipal wastewater treatment plants (WWTP) at Guheshwori, Kodku,Dhobighat,Sallaghari and Hanumanghat but the only operated was activated sludge system at Guheshwori (Aratha, 2003)
- Conventional methods for wastewater treatment are costly and technically advance
- Natural, easy and low cost method needed which is best done by phytoremediation in Constructed wetland system

Objective

- **Broad Objective**
- To determine the waste water treatment efficiency of Vetiver (*Chrysopogon zizanioides*) and Narkot (*Phragmites karka)* in Constructed Wetland System

- **Specific objectives**
- To Study the morphological changes in the Vetiver and Narkot during their growth on planting individually or mixed way
- To determine the Physiochemical Parameters of wastewater before and after treatment at an interval of two weeks to determine the change in chemical concentration
- To identify the variability of water parameters in relation to morphological change and different way of plantation of Vetiver and Narkot
- To compare the efficiency of Vetiver (*Chrysopogon zizanioides*) and Narkot (*Phragmites karka)* in waste water treatment

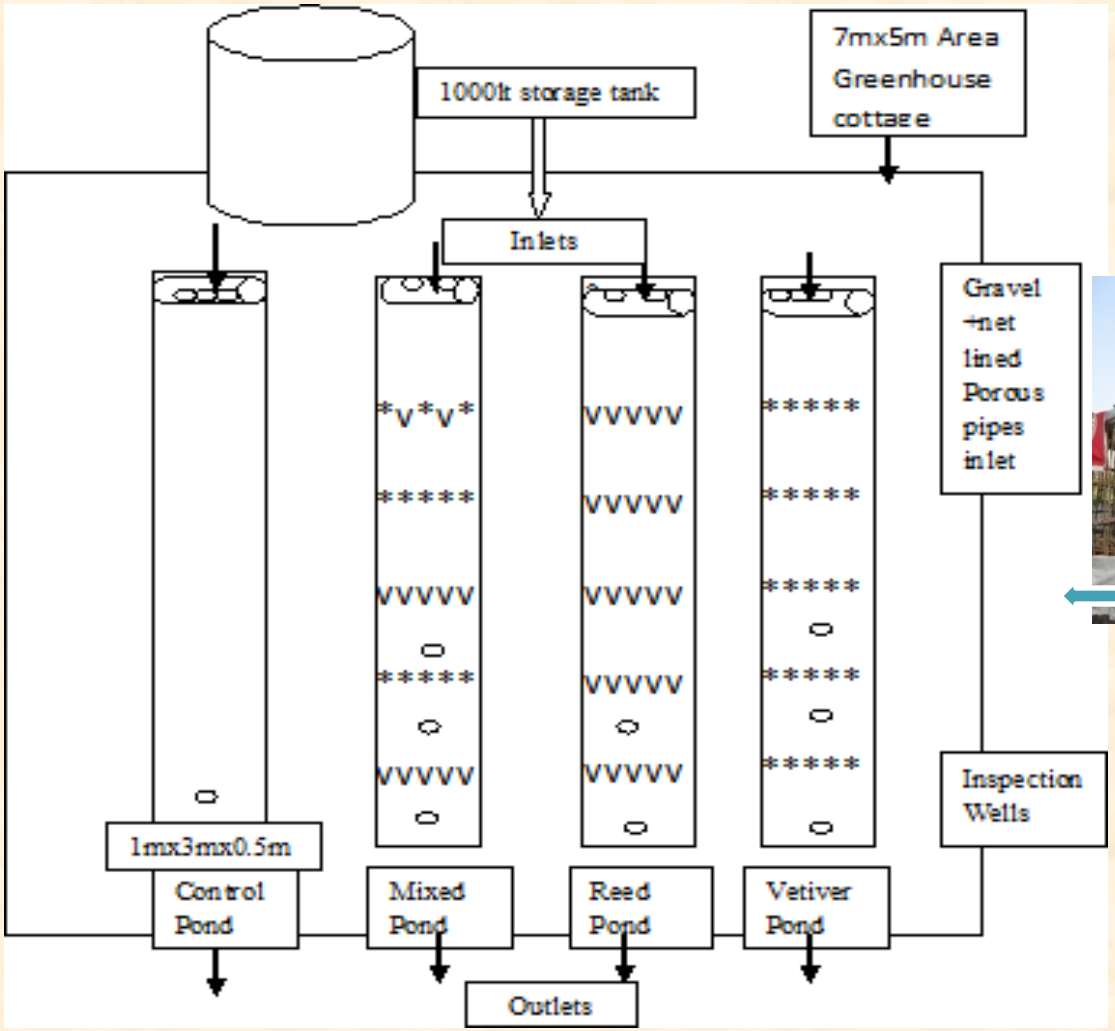
Significance of Study

- Phytoremediation- natural process, no additional technical assistance once planted properly with appropriate planning
- water quality of natural streams improved
- Impact on surrounding positive
- Beneficial for agriculture, social, environment and economic sectors
- Comparision bring better solution
- Would be helpful for further research
- Treatment and recycling of wastewater
- Meet water demand without deteriorating the natural systems

Limitation of Study

- conducted in very small scale (150 lt/ pond/ day) (Cull *et al.*, 2000, 600ml/pot)
- The research duration only six month (March to August- favorable environmental condition)
- The Lab Tests were done after three months of plantation
- Exact variation in treatment efficiency with growth could not be studied in detail
- mixing of rainwater and the ground water flow during Monsoon

Study Area


1000lt storage tank
7mx5m Area
Greenhouse
cottage
Inlets
Gravel
+net
lined
Porous
pipes
inlet
Inspection
Wells
1mx3mx0.5m
Control
Pond
Mixed
Pond
Reed
Pond
Vetiver
Pond
Outlets

Data Collection Technique

S.No	Objective	Method	Tools and methodologies
1	Studying morphological changes in the vetiver and Narkot during their growth	Site Observation	Measuring plants height and hedge at weekly interval
2	Determining Physiochemical parameters before and after treatment	APHA, AWWA and WEF (2005) MPN method	Determining BOD, COD, NO3 , TP, CO2, Cl and coliform at two weeks interval
3	Identify variability of water parameters in relation to morphological change	Comparing treated water parameters values at different level of growth	MS-Excel 2007, SPSS 20, CONOCO 4.5 and R 1.12.1 for T-Test, Scatter Diagram and ANOVA

Major Findings

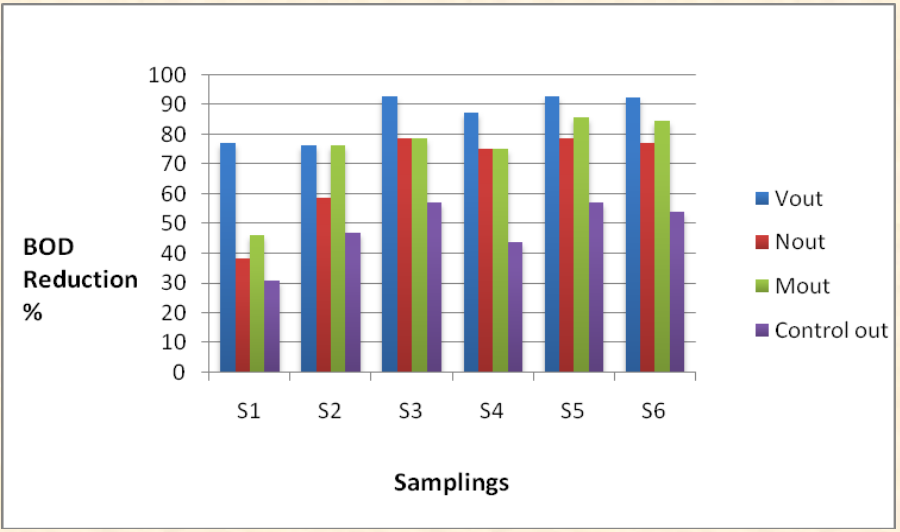
- Maxm Growth rate V=67cm, Narkot=48cm
- On the sixth month the overall concentration of BOD5, COD, NO_3- N, TP, Free CO_2, Chloride content and EC in the effluent after treatment were reduced by

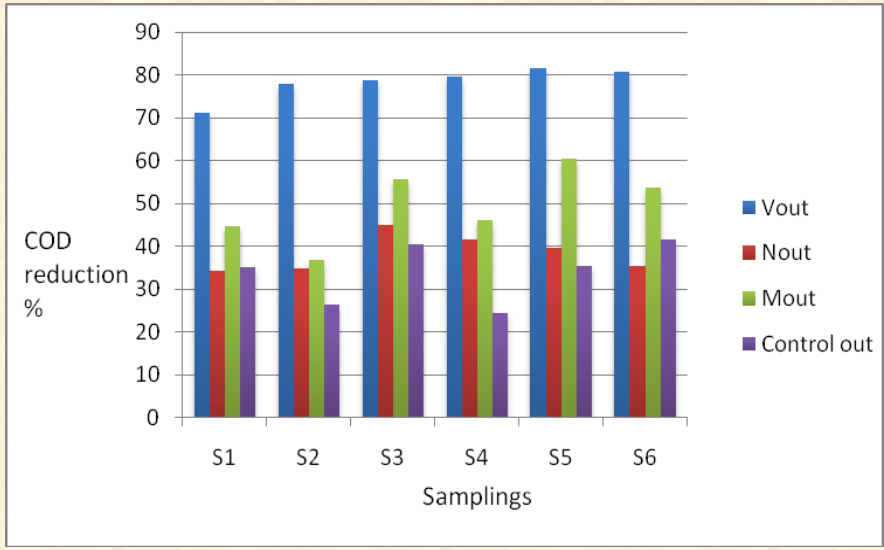
% RED	BOD 5	COD	NO3-N	TP	CO2	Cl-
Vetiver	92.30	80.76	90.90	78.12	87.5	81.13
Narkot	76.92	35.38	81.18	55	56.25	52.83
Mixed	84.61	53.84	84.09	60	62.5	60.37
Control	53.84	28.12	30	32.5	28.12	26.41

- Treatment efficiency vetiver>Mixed>Narkot>Control
- Soil Nutrients Org. matter, TN%, TP(ppm), Organic compound high from vetiver pond than Narkot, Nutrients after six month increased in all treatment ponds

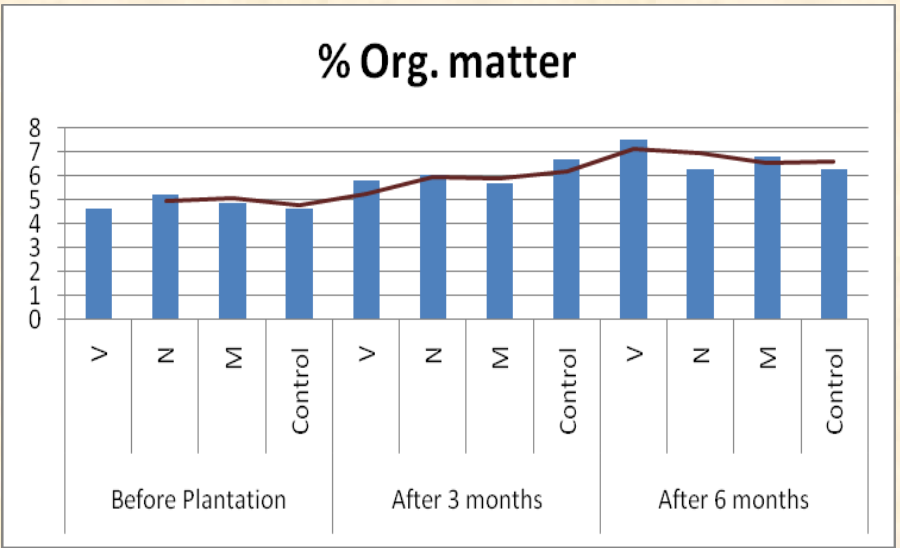
Findings Contd…

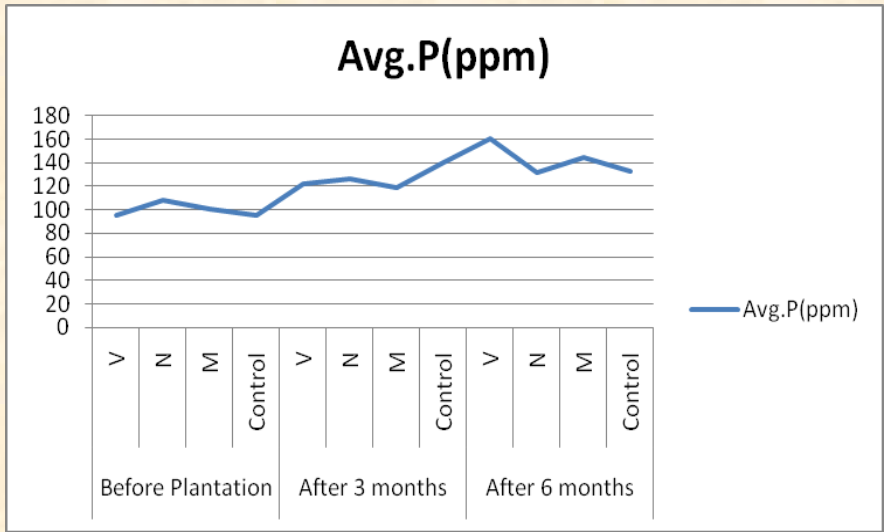
Water Quality BOD COD reduction





Soil Nutrients





Results From Paired T-Test for COD reduction

Compared Between	T	DF	P-Value	95% confidence interval		Sample mean difference
Vetiver Vs Phragmites	22.706	5	3.08e-06	35.35626	44.38374	39.87
Vetiver Vs Mixed	9.5919	5	0.0002087	21.04633	36.45700	28.75167
Phragmites Vs Mixed	-3.663	5	0.01455	-18.920748	-3.315918	-11.11833

One way ANOVA test of variance of COD reduction effeciency of Vetiver and Narkot with Growth Rate

Vetiver*(Chrosopogon zizanioides)*	Df	Sum Sq	Mean Sq	F value	Pr(>F)
(COD Red%)	1	16.1	16.06	0.112	0.754
Residual	4	571.9	142.99		

Narkot (*Phragmites karka*)	Df	Sum Sq	Mean Sq	F value	Pr(>F)
(COD Red%)	1	636.4	636.4	1.614	0.273
Residual	4	1577.0	394.2		

Change in %Organic matter, % Organic carbon, Average P and Total Nitrogen concentration in soil

	Before Plantation				After 3 months				After 6 months			
	V	N	M	Control	V	N	M	Control	V	N	M	Control
% Org. Carbon	4.64	5.23	4.86	4.64	5.82	6.04	5.67	6.67	7.55	6.26	6.81	6.30
%OM	8.00	9.02	8.38	8.00	10.03	10.41	9.78	11.49	13.02	10.80	11.75	10.86
Avg.P(ppm)	95.0	108.1	99.9	95.0	121.3	126.2	118.0	140.2	160.0	131.2	143.5	132.0
TN%	0.34	0.38	0.35	0.34	0.42	0.43	0.41	0.47	0.53	0.45	0.48	0.45

Summary

- Growth rate greater in the Vetiver than Narkot
- Narkot showed dying and new growth continuously Wastewater treatment, As new plants played role in absorbing nutrients, its efficiency was unaffected by growth rate
- Mixed Pond performed better than Narkot in wastewater treatment
- Vetiver survived 100%, Wastewater treatment efficiency remained excellent everytime along its growth, Growth rate didn't vary its efficiency
- Reduced range of the pollutants concentration within the standard Guideline value by Vetiver treatment

Conclusion

- with no arguments can be developed as an easy, natural and cost effective option for the treatment of wastewater
- Wastewater treated by Vetiver can be reused for irrigation, aquaculture, recreation and industrial purposes and has no harm to the aquatic lives and river ecosystem.
- Decentralized wastewater treatment necessary
- Phytoremediation in Constructed wetland- best and easy option for wastewater treatment at less invest of money, time and technology

Recommendation

- More practical, reliable and cheaper method of treating effluent before being passed into the river should be sought
- Decentralized wastewater treatment for promoting reuse and recycle of wastewater
- Appropriate techniques for rainwater harvesting should be developed, particularly for major urban areas
- Awareness activities about conserving water quality and quantity should be conducted in all parts of the country
- Strict laws and efflent standards should be enforced for the major contributors of wastewater like Industries, Hospitals, Hotels, Housings, Departement malls etc.
- Guideline should be updated and maintained

Acknowledgement to All