Evaluating the performance of natural treatment systems for domestic wastewater treatment towards sustainability in South India.

Ramdas Pinninti[1], Maheswaran Rathinasamy[2], and Subrahmanyam M[1]

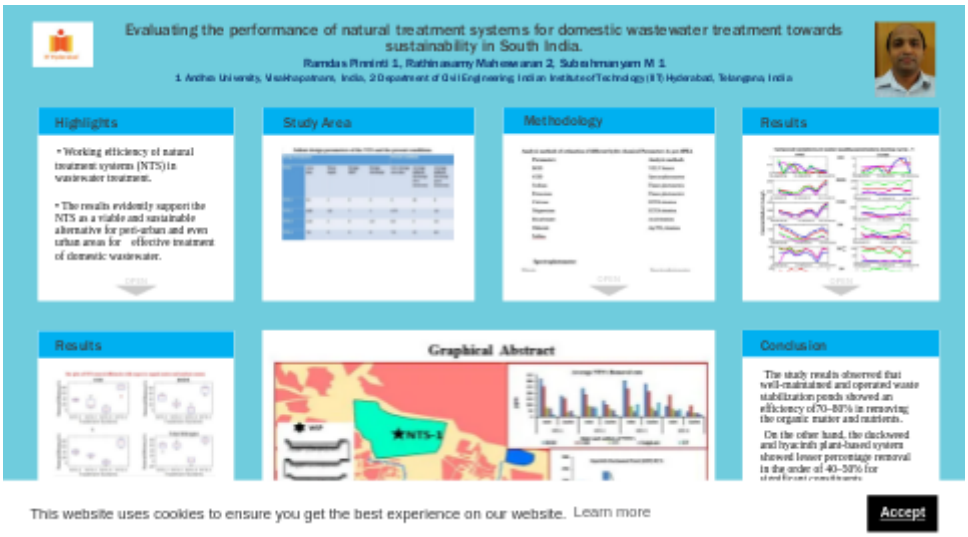
[1]Andhra University, Visakhapatnam, India
[2]Department of Civil Engineering, Indian Institute of Technology (IIT) Hyderabad, Telangana, India

November 23, 2022

Abstract

Wastewater is a valuable resource that requires effective treatment management solutions on a global scale. Wastewater has become a major source of irrigation in peri-urban areas in developing countries. Natural treatment systems (NTS) have recently gained appeal in peri-urban environments due to their lower cost and maintenance requirements. The operating efficiency of natural systems was tested in this study using case studies from Vizianagaram, Andhra Pradesh, India. The efficacy of nutrient (Phosphorous and Nitrogen content) and organic matter removal was investigated in four NTS with varying operation maintenance and loading rates. According to the study, Natural treatment systems have a lot of potential for treating peri-urban wastewater. Waste-stabilization systems outperform systems based on duckweed and hyacinth plants, according to the findings. Regularly maintained and operated systems have an organic and nutrient removal efficiency of over 80%, outperforming others. According to the findings, decentralized, well-maintained Waste Stabilization Ponds (WSP) provide a feasible, self-sustaining, and environmentally beneficial wastewater treatment option for rural irrigation water.

Evaluating the performance of natural treatment systems for domestic wastewater treatment towards sustainability in South India.



Ramdas Pinninti 1, Rathinasamy Maheswaran 2, Subrahmanyam M 1

1 Andhra University, Visakhapatnam, India, 2 Department of Civil Engineering, Indian Institute of Technology (IIT) Hyderabad, Telangana, India

PRESENTED AT:

HIGHLIGHTS

• Working efficiency of natural treatment systems (NTS) in wastewater treatment.

• The results evidently support the NTS as a viable and sustainable alternative for peri-urban and even urban areas for effective treatment of domestic wastewater.

• This study bring awareness to farmers, stakeholders and policymakers about the working mechanism and significance of these systems and thereby their involvement in the maintenance.

STUDY AREA

Salient design parameters of the NTS and the present conditions.

Design Parameters					Present conditions		
NTSs	Area (ha)	Mean depth	Design HRT	Design discharge	Live storage area (ha)	Average influent discharge (Pre-monsoon)	Average influent discharge (post-monsoon)
NTS-1	5.2	2	9	5	5	10	8
NTS-2	0.85	1.8	7	1	0.75	2	1.6
NTS-3	1.22	2	5	1.5	0.3	3	2.3
NTS-4	7.8	5	9	8	7.5	12	8.3

METHODOLOGY

Analysis methods of estimation of different hydro chemical Parameters As per APHA

Parameters	Analysis methods
BOD	VELF Sensor
COD	Spectrophotometer
Sodium	Flame photometric
Potassium	Flame photometric
Calcium	EDTA titration
Magnesium	EDTA titration
Bicarbonate	Acid titration
Chloride	Ag NO_3 titration
Sulfate	

Spectrophotometer

Nitrate	Spectrophotometer
Hardness	EDTA titration

Removal efficiency assessment

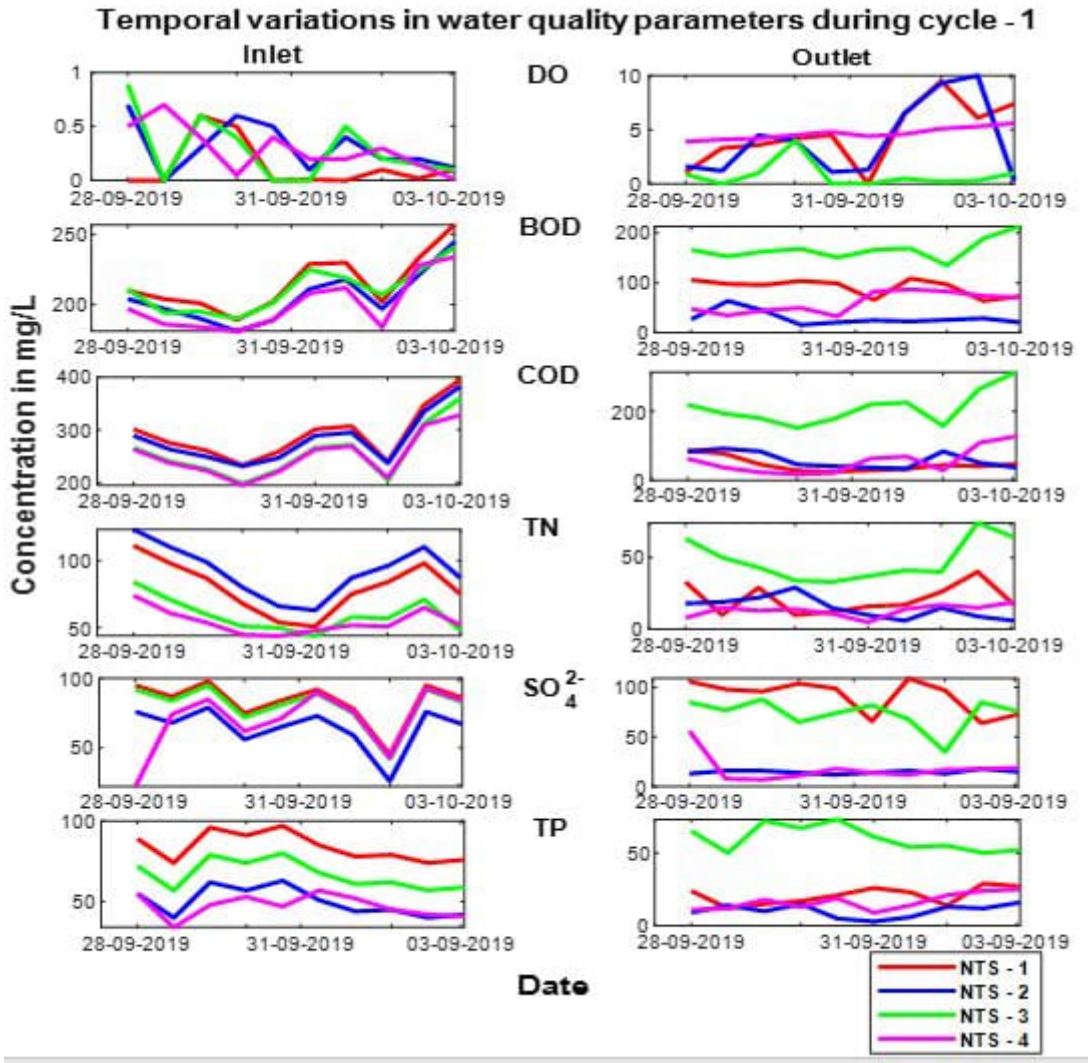
Removal efficiencies were assessed using Equation (Jamwal et al, 2019).

$$RE = \frac{(C_i - C_o)}{C_i} X100$$

Where C_i = influent determinant concentration (mg/L)

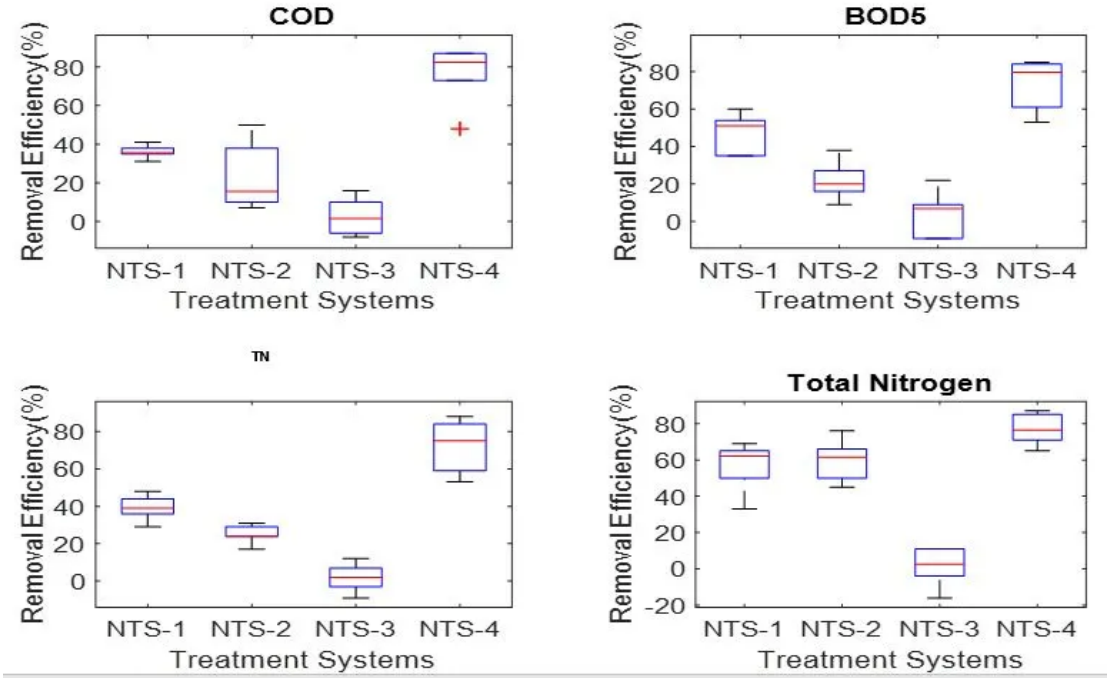
C_o= effluent determinant concentration (mg/L)

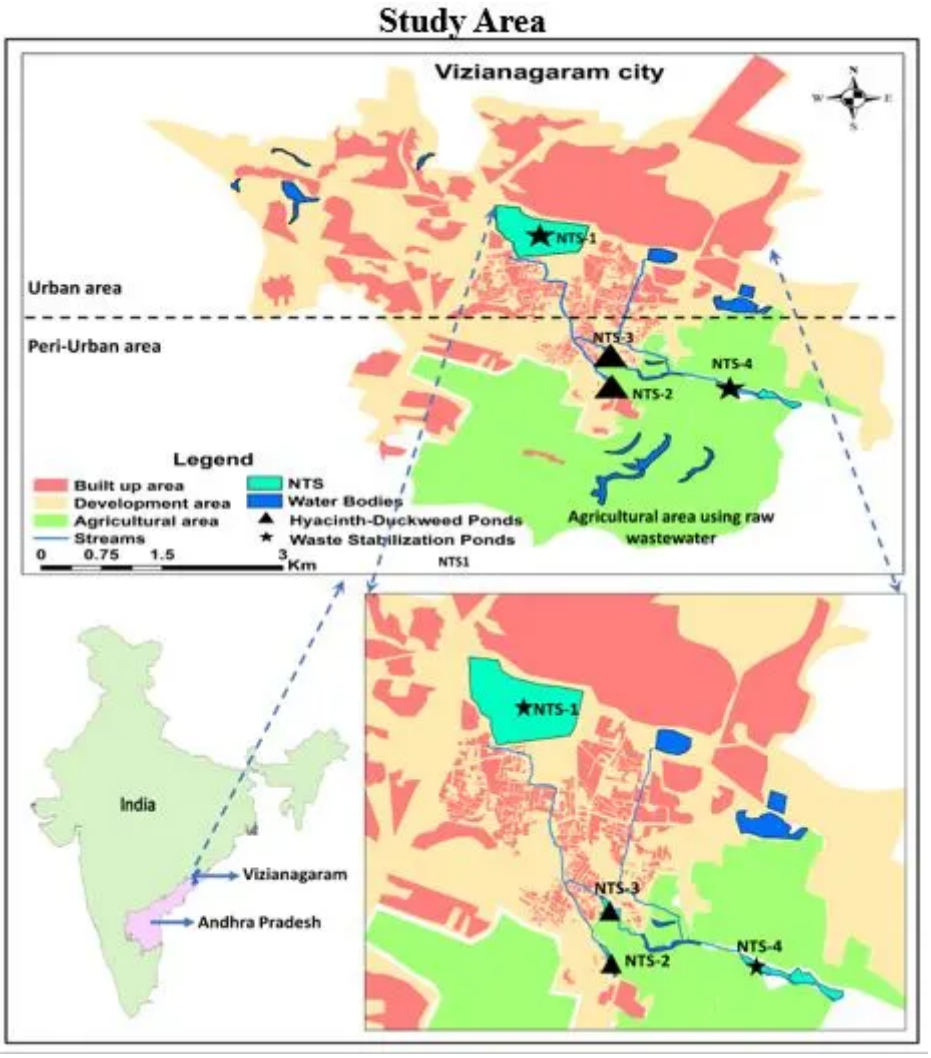
RESULTS


Temporal variations in water quality parameters during cycle - 1
Inlet
Outlet
DO
BOD
COD
TN
TP
Concentration in mg/L
Date
28-09-2019
31-09-2019
03-10-2019
03-09-2019
NTS - 1
NTS - 2
NTS - 3
NTS - 4

RESULTS

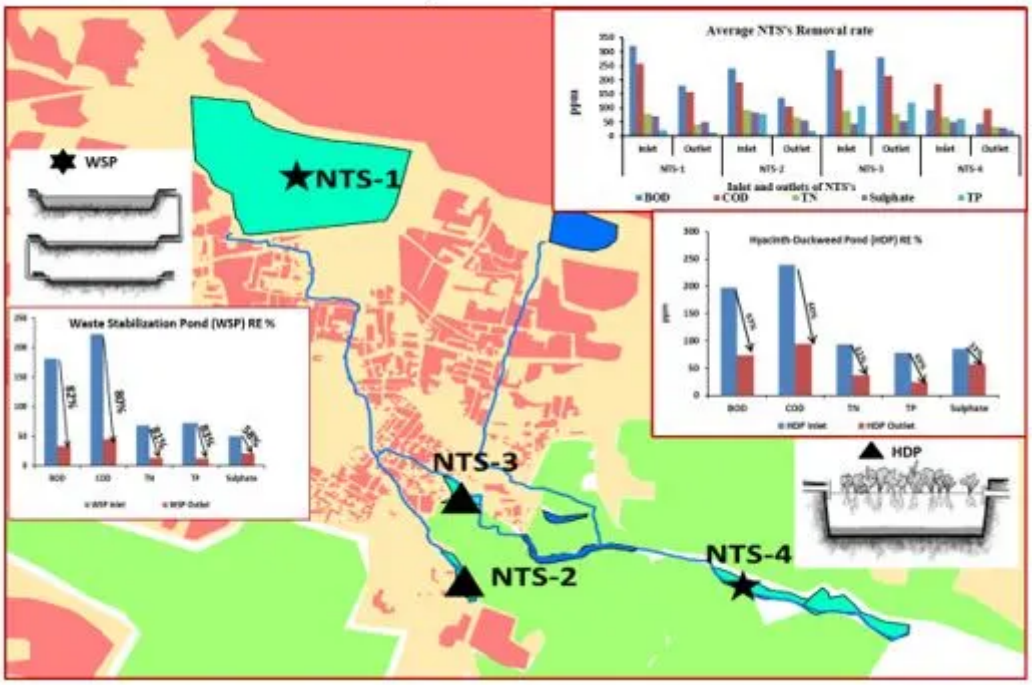
Box plots of NTS removal efficiencies with respect to organic matter and nutrient content.





Google Earth clips and field photos showing the status of the treatment systems NTS 1 -4 during the period 2004–05 (left column) and 2020–21 (right column). (a, b) – NTS-1 Waste Stabilization Ponds [1, 4 – Anaerobic Ponds, 2, 5 – Facultative Ponds and 3, 6 – Aerobic Ponds], (c, d) – NTS-2 Hyacinth and Duckweed Ponds. (e, f) – NTS-3 Hyacinth and Duckweed Ponds, (g, h) – NTS-4 Waste Stabilization Ponds [1 – Anaerobic Pond, 2 – Facultative Pond and 3 – Aerobic Pond]

Graphical Abstract



CONCLUSION

•The study results observed that well-maintained and operated waste stabilization ponds showed an efficiency of70–80% in removing the organic matter and nutrients.

•On the other hand, the duckweed and hyacinth plant-based system showed lesser percentage removal in the order of 40–50% for significant constituents.

•Further, improper maintenance and encroachment, and clogging of the inlets can seriously reduce the working efficiencies of the natural system.

•The results from the present study clearly support the NTS as a viable and sustainable alternative for peri-urban and even urban areas for the effective treatment of domestic wastewater.

•Further, the study shows the importance of stakeholder participation in maintaining these systems for effective operation and working.

•Awareness among the farmers who are utilizing the treated water on the working mechanism of these systems will undoubtedly invoke interest in them and thereby their involvement in the maintenance.

AUTHOR INFORMATION

Evaluating the performance of natural treatment system for domestic wastewater treatment towards sustainability in South India.

Ramdas Pinninti 1, Rathinasamy Maheswaran 2, Subrahmanyam M 1

1 Andhra University, Visakhapatnam, India, 2 Department of Civil Engineering, Indian Institute of Technology (IIT) Hyderabad, Telangana, India

ABSTRACT

Wastewater is a valuable resource that requires effective treatment management solutions on a global scale. Wastewater has become a major source of irrigation in peri-urban areas in developing countries. Natural treatment systems (NTS) have recently gained appeal in peri-urban environments due to their lower cost and maintenance requirements. The operating efficiency of natural systems was tested in this study using case studies from Vizianagaram, Andhra Pradesh, India. The efficacy of nutrient (Phosphorous and Nitrogen content) and organic matter removal was investigated in four NTS with varying operation maintenance and loading rates. According to the study, Natural treatment systems have a lot of potential for treating peri-urban wastewater. Waste-stabilization systems outperform systems based on duckweed and hyacinth plants, according to the findings. Regularly maintained and operated systems have an organic and nutrient removal efficiency of over 80%, outperforming others. According to the findings, decentralized, well-maintained Waste Stabilization Ponds (WSP) provide a feasible, self-sustaining, and environmentally beneficial wastewater treatment option for rural irrigation water.

REFERENCES

Sonkamble, S., Wajihuddin, M., Jampani, M., Sarah, S., Somvanshi, V. K., Ahmed, S., Amerasinghe, P. & Boisson, A. 2018 Natural treatment system models for wastewater management: a study from Hyderabad, India. Water Science and Technology 77(2), 479–492

Sonkamble, S., Wajihuddin, M., Jampani, M., Sarah, S., Somvanshi, V. K., Ahmed, S., Amerasinghe, P. & Boisson, A. 2018 Natural treatment system models for wastewater management: a study from Hyderabad, India. Water Science and Technology 77(2), 479–492.

Amarasinghe, U. A., Palanisami, K., Singh, O. P. & Sakthivadivel, R. 2009 State of irrigation in Tamil Nadu: investments and returns. Strategic Analyses of the National River Linking Project (NRLP) of India Series 5, 53.

Vymazal, J. 2012 Wastewater treatment and control through wetlands. Journal of Encyclopedia of Sustainability Science and Technology 11891–11911.