Issues and challenges of wastewater treatment and their impact on river systems in Blantyre, Malawi

V. Chipofya*, L. Chapola, J. Gondwe and I. Chikopa

Department of Geography and Environmental Studies, The Catholic University of Malawi, P. O. Box 5452, Limbe

*Corresponding author. Email address: vchipofya@gmail.com (V. Chipofya)

Abstract

This paper reviews issues and challenges of wastewater treatment systems and their impact on river systems in Blantyre, Malawi. The paper focuses on one major plant in the city of Blantyre. It evaluates the design of this plant in the context of the ED-WAVE tool. The paper further looks at the existing policy and regulatory framework on water resources management in the country and how these instruments relate to the operation of the wastewater treatment systems. The paper establishes that the design of the wastewater treatment plant under review confirms the practical use of case-based design and case-based reasoning principles in the ED-WAVE tool. After encountering a new situation, already collected decision scenarios are invoked and modified in order to arrive at a particular design alternative. What is necessary is to appropriately modify the case arrived at through the Case Study Manager in the tool in order to come up with a design appropriate to the local situation taking into account technical, socio-economic and environmental aspects. The paper further establishes that the requirement to treat wastewater in the country is underscored by the existing regulatory framework. The paper compares pollutant levels in effluent from this plant to Government of Malawi standards and World Hearth Organisation (WHO) guidelines. The study established that Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) levels in effluent from this major wastewater treatment work in the city are in most cases above the recommended Malawi standards and WHO guidelines. In view of the pollution threat posed by the high levels of BOD_5 from this plant, the paper recommends that the assimilative capacity of the receiving watercourse be ascertained to determine impact of the organic and solids loading in the final effluent upon the aquatic flora and fauna.

Keywords: aquatic flora and fauna, Biochemical Oxygen Demand, Chemical Oxygen Demand, ED-WAVE tool, Total Suspended Solids, wastewater treatment systems

Methodology

Study area

The study focused on Blantyre wastewater treatment plant in the city of Blantyre, Malawi.

The ED-WAVE tool

The ED-WAVE tool was used for the conceptual design of the two wastewater treatment plants. The tool consists of virtual industrial and municipal environments created using an IT based tool using real-life applications.

The ED-WAVE tool is a shareware PC based package for imparting training on wastewater treatment technologies. The system consists of four modules viz. Reference Library (RL), Process Builder (PB), Case Study Manager (CM), and Treatment Adviser (TA) (Fig. 2) .

Data collection and analysis

Data was collected through a desk study which was based on the work by Kuyeli, (2007).

Results and Discussion

Comparative sequencing of treatment units

According to the Case Study Manager in the ED-WAVE tool, a similar case to both the dry season and wet season conditions of Blantyre WWTW is Municipal Case 6 in Greece (2003), with a flow rate of 6,600 m^3/day. The treatment sequence for this plant and the comparative sequencing of the treatment units at the Blantyre plant, dry and wet season, and the actual sequencing of treatment units at this works are illustrated in Table 1.

Table 1.

Comparative sequencing of treatment units for Municipal Case 6 and Blantyre WWTW

Plant/ Step No.	Municipal Case 6, Greece	Suggested sequencing of dry season conditions by Treatment Adviser	Suggested sequencing of wet season conditions by Treatment Adviser	Actual sequencing for Blantyre plant
1	Screening	Grit chamber	Grit chamber	Screening
2	Grit chamber	Neutralisation	Neutralisation	Grit channels
3	Oxidation ditch	Chemical precipitation/ sedimentation	Chemical precipitation sedimentation	Primary sedimentation
4	Sedimentation	Activated sludge process	Activated sludge process	Trickling filters
5	Chlorination	Facultative lagoon	Activated carbon adsorption	Humus tanks
6	-	Activated carbon adsorption	Ion exchange	Aeration ponds

Results and Discussion (Cont'd)

Operational data for Blantyre WWTW

Tables 2(a) and 2(b) below show the influent and effluent characteristics of the wastewater at Blantyre WWTW during the dry season and wet season, respectively, with corresponding Malawi effluent standards (Malawi Bureau of Standards, 2005) and WHO guidelines (1996). Table 2(c) shows the influent and effluent characteristics of Municipal Case 6 in Greece.

Table 2(a)

Blantyre works influent and effluent physicochemical characteristics for the dry season in mg/l

Parameter	BOD	COD	TSS
Influent	440.66±5.6	1642.3±12.5	210.0±4.05
Effluent	38.0±3.1	691.0±5.6	232.1±1.42
Reduction Efficiency (%)	*87*	*58*	*-11*
Malawi Standard	20	60	30
WHO Guidelines	20	60	30

Table 2(b)

Blantyre works influent and effluent physicochemical characteristics for the wet season in mg/l

Parameter	BOD	COD	TSS
Influent	510±14.14	691±5.03	29.01±0.0
Effluent	450±42.43	503 ±0.91	25.91±2.03
Reduction Efficiency (%)	*12*	*27*	*3*
Malawi Standard	20	60	30
WHO Guidelines	20	60	30

Table 2(c)

Influent and effluent characteristics of Municipal Case 6 in Greece in mg/l

Parameter	BOD	COD	TSS
Influent	227	-	355
Effluent	11	40	16
Reduction Efficiency (%)	*95*	-	*96*
Malawi Standard	20	60	30
WHO Standards	20	60	30

The BOD, COD and TSS removal efficiency in the dry season was 87%, 58% and -11%, respectively. BOD, COD and TSS removal efficiency in the wet season was 12%, 27% and 3%, respectively. On the other hand, BOD and TSS removal efficiency at Municipal Case 6 in Greece was 95% and 96%, respectively. The reason for the rise in the effluent TSS levels in the dry season calls for further investigation.

Conclusion

In conclusion, it is observed that there is a close match in technologies at Blantyre WWTW, and Municipal Case 6 in Greece as invoked by the Case Study Manager in the ED-WAVE tool. What is important, however, is to appropriately modify the case arrived at through the Case Study Manager in order to come up with a design appropriate to the local situation in terms of operation and maintenance

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