

Sustainable Domestic Wastewater Management Mechanism: Exploring Current Practices in Ratnapura Municipal Council Area

I. Rajapaksha^a, N. L. C. P. Liyanage^a and H.M.M.Herath^b

^aDepartment of Architecture, University of Moratuwa, Moratuwa, Sri Lanka; chathu.privee@gmail.com

^bDepartment of Town and Country Planning, University of Moratuwa

Abstract

Sustainable management of water and sanitation are at the core of 2030 agenda of Sustainable Development goals which is an ambitious plan of action to transform our world for people, planet and prosperity. United Nations report on world urbanization prospects reveals the world's urban population is expected to increase by more than two thirds by 2050 with nearly 90% of the increase to take place in the urban areas of Asia and Africa. Hence the increasing population will impose an immense demand on natural resource utilization in future, thus it is important to investigate not only the availability of water but also the effective disposal of wastewater.

National statistics on water consumption in Sri Lanka informs more than 70% of water is consumed by the domestic sector and predicts an increase of 5% for a period of 5 years from the year 2012 to 2017. However the current national focus on development of selected cities in the Western province as a Megapolis will initiate an urban sprawl towards the cities in neighbouring provinces. Although the Megapolis development prioritized on upgrading the existing urban infrastructure of the Western province, there will be a limited attention on exaggerating urban issues in emerging large townships due to agglomeration. Thus it is vital to investigate the prevailing status of urban services and amenities of the potential cities in transformation. Hence the study focuses on investigating the current practices in wastewater management of the Municipal Council region of Rathnapura.

This study incorporates multiple data collection methods such as gathering of secondary data, field observations and focused group discussions and interviews with stakeholders. The results inform at present there is a mechanism for collection and disposal of sewage in the Municipal Council region of Rathnapura. However, the study identifies considerable limitation on facilities available for treatment of sludge and its disposal. At present a quantity of 4285 m³ of annual sewage is collected and this capacity will be doubled ((9870m³) by the year 2025. Thus the above findings highlight the importance of an effective wastewater management system to promote health and well-being.

Introduction

United Nations report on world urbanization prospects reveals the world's urban population is expected to increase by more than two thirds by 2050 with nearly 90% of the increase to take place in the urban areas of Asia and Africa. Hence increasing population in cities in developing Asia will impose an immense demand on natural resource utilization in future.

Sustainable management of water and sanitation are at the core of 2030 agenda of Sustainable Development goals. Thus it is important to investigate not only the availability of water but also the effective disposal of wastewater.

National statistics on water consumption in Sri Lanka reveals that more than 70% of water is consumed by the domestic sector and predicted an increase of 5% for a period of 5 years from the year 2012 to 2017. Moreover achievement of an ambitious national target on safe water supply is in progress. Although 85% of the population had access to safe water by the year 2010, it has been forecasted by the year 2025 total population of Sri Lanka is provided with safe water. Since there is a direct integration between the consumption of water and generation of wastewater, the increasing quantities of water consumption demands for an efficient management of wastewater. However a limited attention is evident in the management of wastewater in most of the cities in Sri Lanka, since

majority of the surface inland waters in urban areas are contaminated due to disposal of domestic sewage. Thus it is apparent that the degradation and depletion of quality of water is exaggerating with the increasing population, which will instigate national health jeopardy.

Since wastewater management shows a limited attention locally, it is significant to explore international good practices on effective wastewater management mechanisms. Thus the study will focus on widely used decentralized wastewater management mechanism.

Decentralized Wastewater Management Mechanism (DWMM):

An overview of decentralized waste water management mechanism (DWMM) developed as an alternative technology to overcome the shortcomings of conventional wastewater management systems is explored in this section. DWMM is an appropriate practical alternative technology for cities in transformation owing to high population densities. It contains prevention and reduction of wastewater production, treatment and recovery of wastewater components, and safe disposal of any wastewater component unable to recycle or reuse. Thus the system represents a cost-effective and long-term option for achieving the goals of water quality and public health interventions.

Although the decentralized systems are advantages for urban areas this allows a greater flexibility in operation of sustainable infrastructure systems of peri-urban areas, small towns and urban centers in large cities. Moreover investment required for installation and maintenance of the infrastructure is less due to smaller collection area and shorter distance of travel required for treatment of sewage. Decentralization is consists of cluster wastewater systems. The whole urban area is serviced through a network of amalgamated small to large number of units ranging from 5 to 100. Collected volumes of wastewater are relatively small compared to a centralized system. Cluster system incorporates an appropriate method of treatment focusing on land-based ecosystem reentry. This method of effluent disposal is based on local conditions and treatment needs.

Further cluster system have low maintenance requirements, and also accommodates large load fluctuations with small lots having less cost on waste water collection and located close proximity to state owned vacant land.

Decentralization reflects an approach to strengthen the role of local government and also an effective means to address environmental and health issues. Moreover, utilization of local resources and opportunities for greater stakeholder involvement in the decision-making process and planning are positive attributes. The capital investment for this system is comparatively low compared to the centralized system, since it is cost effective in construction and operation. Also encourages a demand-responsive, participatory approach and improve the connection between communities and local government authorities. Moreover, limitations in technical knowledge on planning and designing and facilities to support long-term management are predominant challenges.

However there is a growing trend among developing countries to initiate DWMM exploring its challenges and barriers. This study investigates the current wastewater management practices available in transformation cities in Sri Lanka to propose a potential approach to originate a DWMM in local context. The selected city for this study is the Municipal Council region of Rathnapura.

Method of Study

Justification for selection of the case study

Current national focus on development of selected cities in the Western province as a Megapolis will initiate an urban sprawl towards the cities in neighbouring provinces. Thus a trend in urban agglomeration towards Western province will transform some of the existing cities of the neighbouring provinces towards large townships. Although the Megapolis development prioritized on upgrading the existing urban infrastructure of the Western province, there will be a limited attention on exaggerating urban issues in emerging large townships due to agglomeration. Thus it is vital to investigate the prevailing status of urban services and amenities of the potential cities in transformation. Municipal Council region of Rathnapura represents one of the potential cities in transformation due to urban development initiatives of national Megapolis action plan.

Description of the case study location:

Rathnapura is the main city of Sabaragamuwa province. There is an approximately 101 Km distance to Colombo, the commercial capital of Sri Lanka. Rathnapura MC Area is consists of 15 Municipal wards which covers a total land extent of 22.18 km. Fig. 1 shows the location map of the study focus.

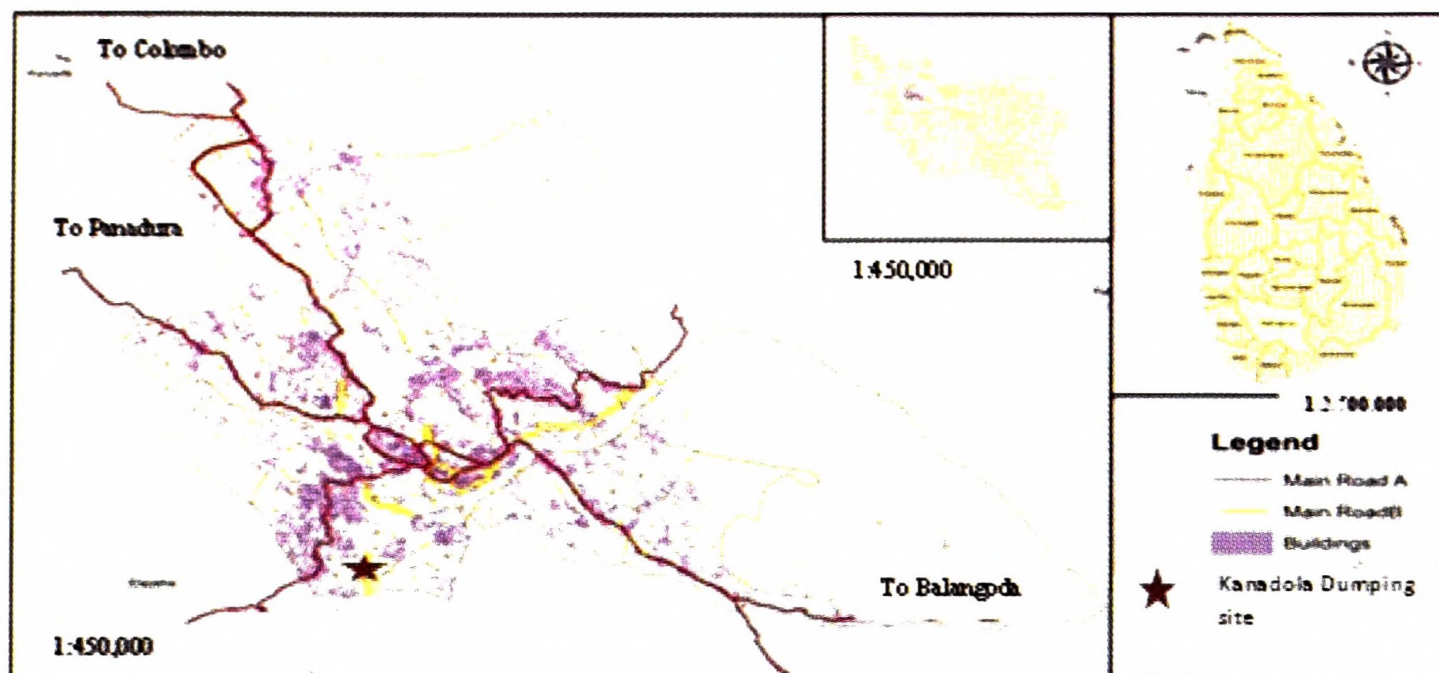


Fig. 1, Location Map of the Study Area

The total static population is 58,085 (Est. 2013) and the city accommodates a daily commuting population of 150,000. The average population density is 2,400 (persons/km) and accounts for a population growth rate of 1.07%. There are 11,833 households of average family size of 04 and of which 10,382 houses are located in the city.

Rathnapura is situated at a higher elevation in the range of 15 to 305 meters from the mean sea level. The annual rainfall varies between 4000 to 5000 mm with an average temperature of 24 to 35 C

Data Acquisition methodology

Data acquisition methodology of this study incorporates multiple methods such as gathering of secondary data, field observations and focused group discussions and interviews with stakeholders such as Local Authority officers, Public Health Inspector, allied professionals and residents. Main data base was collected from the Municipal Council annual records to realize the current demand and future need. People who were affected were the main focus group for further details. The stakeholders' views were gathered using a structured interview guideline.

Results and Discussion

Wastewater Management System: Exploring the current practice

At present, there is no proper system for domestic wastewater (sewage) management in the Rathnapura Municipal Council (RMC). The collected sewage is discharged to a natural sloping area of Kanadola directly causing environmental and health risks for people who live downstream of Kanadola. Information gathered in focused group discussions revealed during the rainy season, the

untreated sewage discharged at Kanadola site flows to the river Kalu Ganga through paddy lands. Thus it is evident that RMC is currently practicing an insanitary and environmentally inappropriate practice and thus proves nonexistence of an acceptable sewage management system.

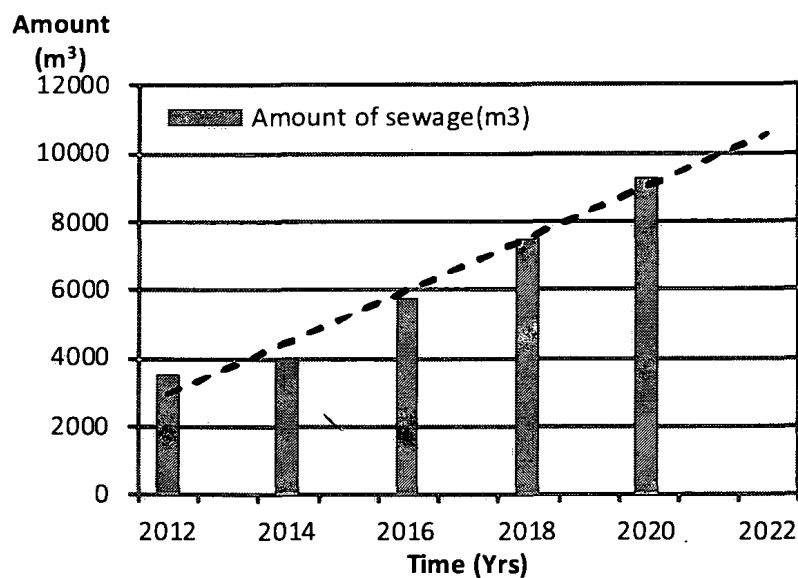
Current practice of wastewater management in Rathnapura is a centralized system managed by RMC. RMC is the authority responsible for public health conditions through secure sanitation. At present the health department of the RMC handles wastewater management which includes collection and disposal. These operations are supervised by the chief Public Health Inspector. However inadequate facilities have restricted treatment of the sludge before disposal. There is a need for the application of a sustainable solution for acceptable sewage management in the area of RMC.

Although steps have been taken to construct a center for disposal of solid and sewage waste in 2014, lack of proper maintenance protocol has affected its operation. It is evident in a month approximately 250 to 300m of sewage wastes of RMC is transported and dumped on this ground. Moreover, the open land adjoining this site is used as a dump yard for sewage waste transported from nearby towns such as Kuruwita. Poor management and lack of effective administrative structure has affected 2500 people living in the vicinity of the unhealthy dumping sites.

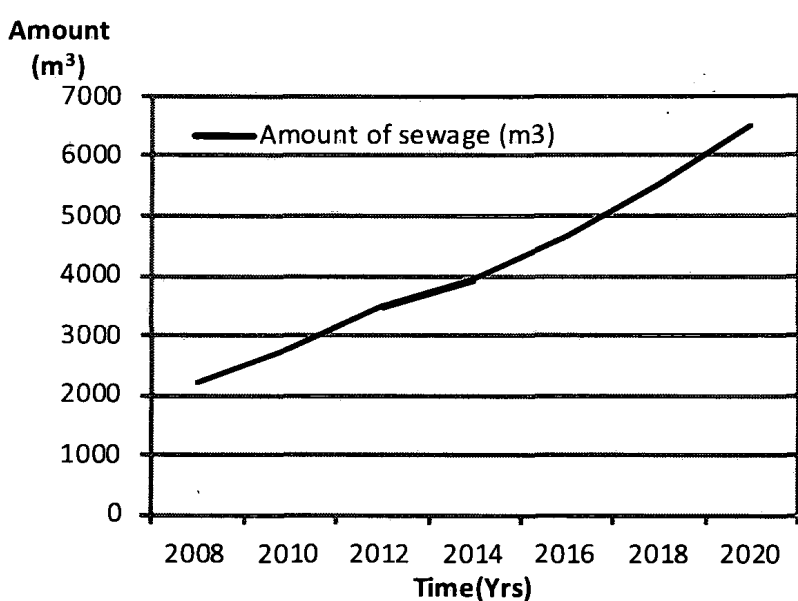
Forecasting quantity of sewage 2012- 2025

Fig 2A and B show the forecast for annual sewage collection and the increasing rate respectively. As shown in Fig. 2A, at present a quantity of 4285 mof annual sewage is collected and this capacity will be

doubled ((9870m) by the year 2025. Forecast



analysis of the data revealed an Fig. 2A. Sewage



collection forecast

Fig. 2B. Annual Sewage collection increasing rate

increasing trend in the quantity from the year 2012 to 2025.

Non existence of service providers in this area is one of the major causes for the increasing trend. Thus RMC is the only service provider for sewage collection in MC area and adjoining cities.

Moreover a substantial increase in the total sludge collection is recorded during the Rainy seasons and the festival season (Perahera) of Saman Dewalaya. As shown in Fig. 2B the predicted result proves an increase in the sewage collection annually with a rate of 8.7%. The existing collection will be increased by nearly 750m in the year of 2020. The average annual sewage collection will be over 10000 m by the year 2025.

Annual expenditure

The cost of the current system is assessed on varying cost factors such as operation, maintenance, transportation and management costs as shown in the Figure 3A, B and C respectively. Operation cost decreased from 2012 to 2014 with the highest recorded in the year 2013.

Fig. 3B shows that the highest maintenance cost was reported in 2012 at Rs.30,000. As shown in Fig. 3B, a slight reduction is evident in 2013 and an increase in 2014. Management cost was calculated using the wages of the staff and shown in Fig. 3C.

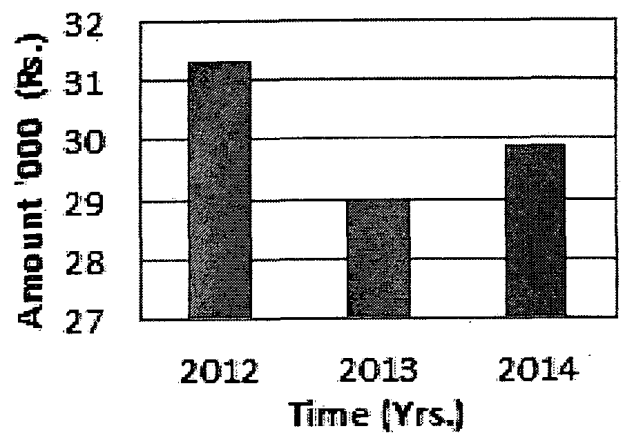


Fig. 3A. Operation Cost

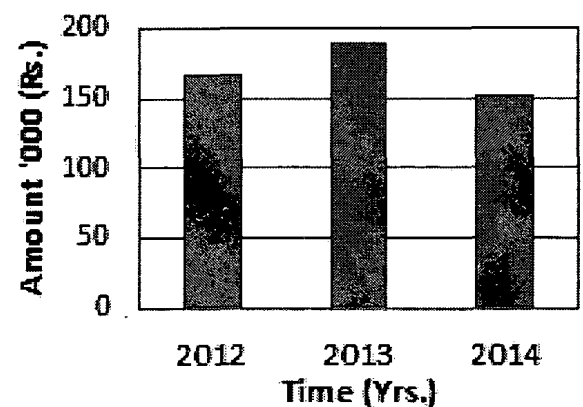


Fig. 3B. Maintenance Cost

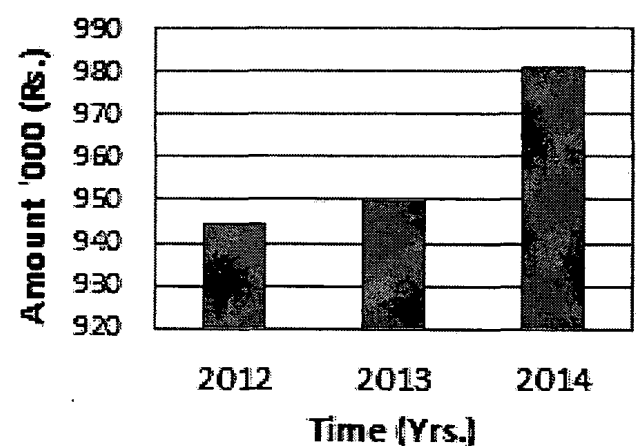


Fig. 3C. Management Cost

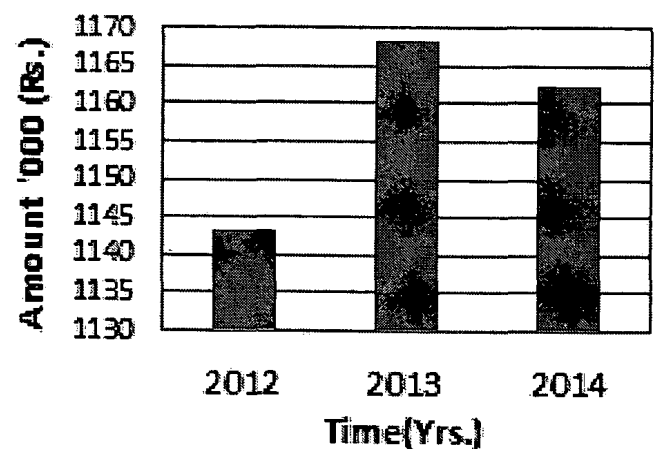


Fig. 3D. Total Cost

Date revealed an increase of 5% per month of maintenance cost in 2012. However as shown in Fig D, the total cost of the current system remains constant among 03 years period with an annual total cost of 1.5 million rupees approximately.

Annual revenue

Sewage management is considered as a mandatory service of Rathnapura MC and is one of the major income sources of this local authority.

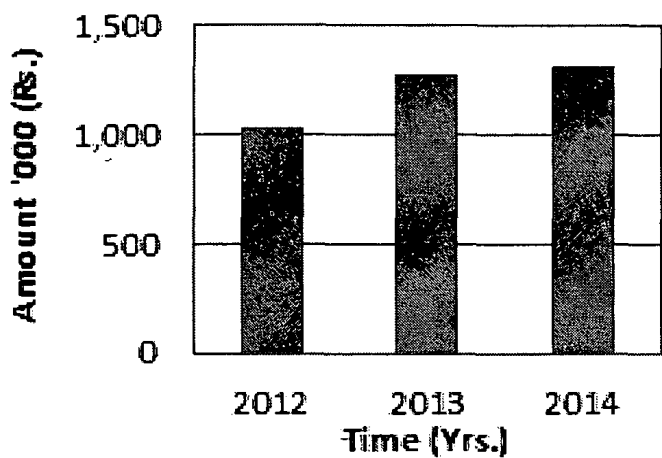


Fig. 4: Revenue Collection

With the increasing need for this service, data reveals an annual increase in income from 2012 to 2014 as shown in Fig. 4. However it is evident that currently revenue collection is approximately 1 million rupees per year but total expenditure per year is more than 1.5 million, highlighting that current practice on wastewater management is not economically viable. Within this perspective it is significant that RMC needs to explore a sustainable wastewater management system

Methodology for formulating a Sustainable DWMM

Findings of the study reveal the availability of a mechanism for collection and disposal of sewage in the Rathnapura MC. However it is apparent that there are substantial limitations on facilities needed for treatment of sludge and its disposal, pointing to the need for an effective wastewater management system. This section will explore a methodology to formulate a specific DWMM for RMC region.

The approach to formulate an effective wastewater management system for the selected context is dependent on major parameters focusing on physical, social, technical, environmental and financial attributes. Careful evaluation of all parameters is important in the decision making process of establishing an appropriate mechanism for wastewater management system.

Each of these parameters is composed of variety of criteria as detailed in Figure 5. Thus it is important to identify most appropriate and locally acceptable criteria. Parameters and the criteria use for selection of an appropriate wastewater system was analyzed and ranked using Multi-criteria Decision Analysis with Analytical Hierarchy Process (AHP). This was performed to evaluate the applicability of DWMM. The overall results of criteria evaluation will show the most appropriate DWMM for the selected context. Although this paper focuses on exploring the current issues in wastewater management the proposed mechanism for DWMM for RMC will be presented elsewhere.

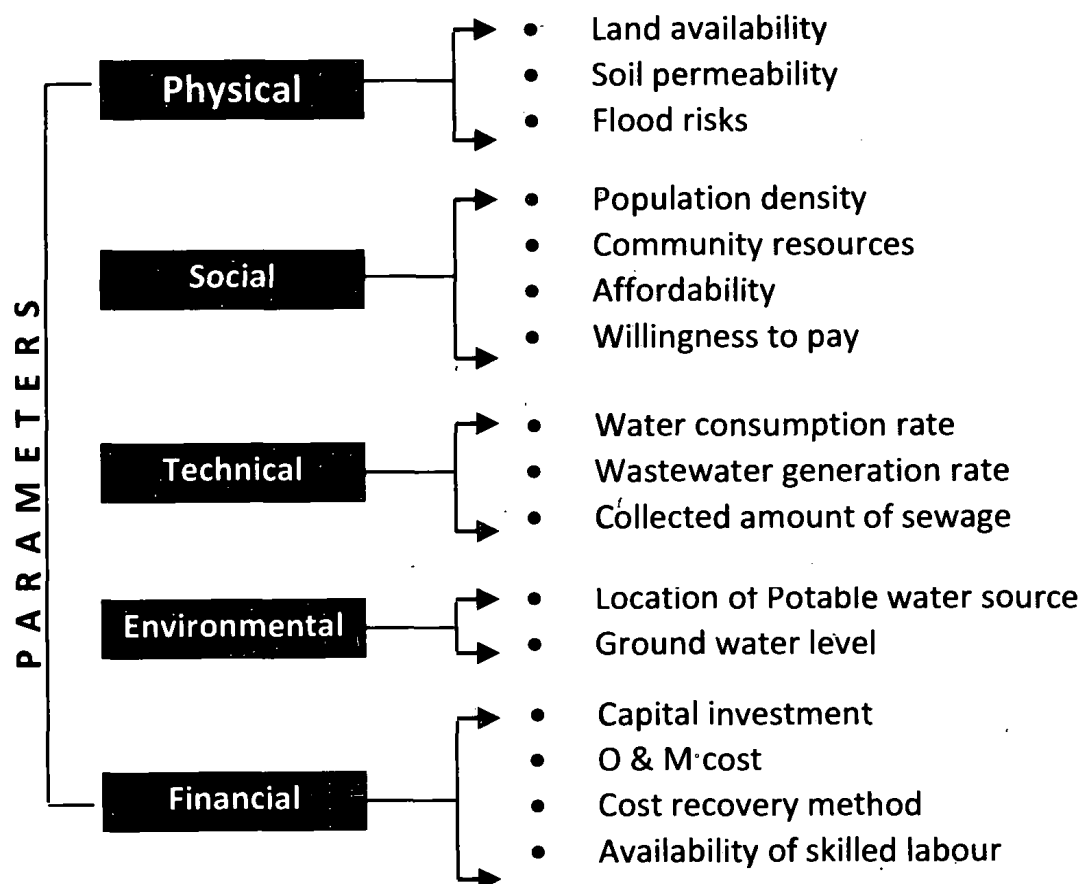


Fig. 5: Parameters and criteria to be considered in selecting a most appropriate system

Conclusion

As the world's urban population is expected to increase rapidly, the increasing population will impose an immense demand on natural resource utilization in future, thus it is important to investigate not only the availability of water but also the effective disposal of wastewater.

A limited attention is evident on waste water management in most of the cities in Sri Lanka. Majority of the surface inland waters in urban areas are contaminated due to disposal of domestic sewage. Thus it is vital to investigate the prevailing status of urban services and amenities of the potential cities in transformation. However there is a growing trend among developing countries to initiate DWMM exploring its challenges and barriers. Thus, this study investigated the current waste water management practices available and proposed a potential approach to originate a DWMM in the local context focusing Municipal Council region of Rathnapura.

This study incorporates multiple data collection methods such as gathering of secondary data, field observations and focused group discussions and interviews with stakeholder's data. The predicted results from 2012 to 2025 show the sewage collection increased each year at a rate of 8.7%. Keeping with this trend the average annual sewage collection will exceed 10000 m by the year 2025.

However it is apparent that there are substantial limitations on the facilities required for treatment of sludge and its disposal. Moreover the current practice is not economically viable.

Thus the above findings highlight the importance of an effective waste water management system to promote health and well-being of the population in Rathnapura. Thus, this study proposes a methodology to originate a DWMM considering a holistic approach amalgamating all parameters and selection of appropriate criteria which will best fit to the local context. This approach will establish a sustainable DWMM for RMC region which will eventually promote health and well-being of people.

References

1. P. S. Gamini, Challenges in the Water Sector and Wastewater Sector, Sri Lanka, National Water Supply & Drainage Board, 2013.
2. Millennium Development Goals Country Report, United Nations, Sri Lanka, 2014
3. C. Laugesen and O. Fryd, Sustainable Wastewater Management in Developing

- Countries, Elements of Sustainable Wastewater Management, ASCE Library, New York, 2009, pp. 33-88
4. R. L. Siegrist, J. E. McCray, K. S. Lowe, T. Y. Cath and J. Munakata-Marr, Onsite and Decentralised Wastewater Systems, *Water*, 2013, 1-8.
5. J. Parkinson, Decentralized wastewater management in per-urban areas in low-income countries. *Environment & Urbanization*, 2003, 75-91.
6. G. F. Tjandraatmadja, S. Burn, M. McLaughlin and T. Biswas, Rethinking Urban Water Systems – Revisiting Concepts in Urban Wastewater Collection and Treatment to Ensure Infrastructure Sustainability, *Water Science & Technology*, 2005, 5 (2), 145-154
7. P. Lombardo, Cluster Wastewater Systems Planning Handbook. National Decentralized Water Resources Capacity Development Project, Newton, MA: Lombardo Associates, Inc, 2004
8. M. Kayitesi, Improving Sanitation Systems: Technical and Socio-Economic Perspectives - The Case Study Of Kigali City, Rwanda, 2008, University of Dar es Salaam.
9. S. Naik, Decentralized Wastewater Management Solutions for Improved Public Health Protection and Reclamation: Optimization and Application, 2014. Retrieved from eScholarship: <http://escholarship.org/uc/item/4fq5w3df#page-23>
10. W. Wickramarathna, Audit of the Effect of irregular Waste management on community, public property and the environment - Ratnapura MC. Audit Report, 2012, Ratnapura Municipal Council, Ratnapura.
11. R. J. P. Franceys, A Guide to the Development of on-Site Sanitation, 1992, WHO Library Cataloguing in Publication Data, England:
12. S. Hophmayer-Tokich, Wastewater Management Strategy: centralized v. decentralized. info:eu-repo/semantics/report, CSTM, 2006 Retrieved from <http://doc.utwente.nl/95384>