An Integrated Water and Sanitation System: A Bangkok Case Study

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Introduction

In Thailand, wastewater and solid waste production has rapidly increased due to industrial development and dramatic economic growth. This results in environmental pollution, which impacts population health. Wastewater and sewage treatment (WST) service and municipal solid waste (MSW) service are needed to mitigate this health impact. Drinking water supply (DWS) service is also of utmost importance because it concerns with what is essential to our lives. Currently, DWS, WST, and MSW services in Thailand generate byproduct (i.e., sludge and leachate) which was left untreated if each service is operated separately. This research explores the potential of integrating DWS, WST, and MSW services across multiple regions in Bangkok, Thailand—assuming its efficacy within water and sanitation system. More specifically, the goal of this research is to compare the separated system with the integrated one through a case study. The approach uses the model proposed by Louis and Magpili (2007) to explore the environmental flow, but extend it for use in multiple districts (Louis & Magpili, 2007). This would make the model more realistic and fit well in this Bangkok case study The model treats DWS, WST, and MSW services as three distinct services in a single management district. The deficits of DWS, WST, MSW services are calculated for different service regions in both the case of the separated system and of the integrated one. The aim of this research is to understand advantages and disadvantages of an integrated water and sanitation system by evaluating many linkages of the three services.

Material and Methods

The model proposed by Louis and Magpili (2007) is a conceptual model of an integrated water and sanitation system (Louis & Magpili, 2007). In order to calculate the deficits of water and sanitation services (WatSan), a general description of this integrated water and sanitation system is developed.

This integrated water and sanitation system (IWSS) is composed of three water and sanitation services (DWS, WST, and MSW services). These services are managed by municipal WatSan service managers. The general description of the IWSS is described below:

Let *i* be WatSan services for *i* = 1 = DWS, 2 = WST, and 3 = MSW.

Let *Git* be the gap between demand and supply of WatSan services at time t. *Git* is calculated as:

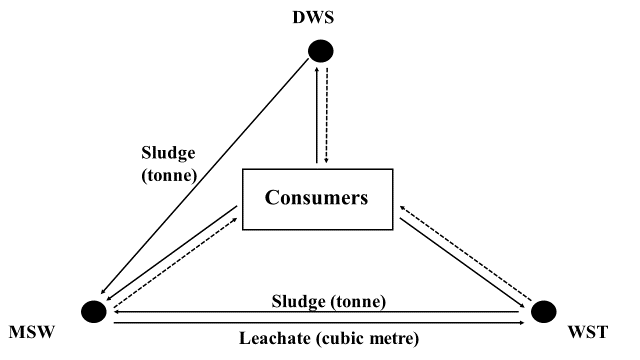
*Git*= *Dit* - *Sit*

= *Dit(in)*+ *Dit(int)* - *Sit*,

where

* *Git* represents the gap in service, *i*, at time *t*,
* *Dit* represents the demand for service, i, at time t,
* *Sit* represents the supply for service, i, at time t.
* *Dit(in)* represents the demand for service, i, at time t,
* *Dit(in)* represents the demand for service, i, at time t, obtained from interrelationships among other services within a single management region.

For the propose of visualization, I draw a diagram representing an IWSS by using vertices and edges below. Vertices represent services, and edges represent flow among services. More specifically, solid edges represent demand flows, and dash edges represent supply flows.

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**Figure 1.1** IWSS within a single management region.

Data associated with the DWS, WST, and MSW services were obtained from the national Metropolitan Waterworks Authority, the Department of Drainage and Sewerage, and the Department of Environmental Quality, respectively. The data in the Nong Khaem region is selected for this study.

Results and Conclusions



**Table 1.1** The deficits of nonintegrated water and sanitation services.



**Table 1.2** The deficits of the integrated water and sanitation services. X = sludge from the WST service, and Y = leachate from the MSW service. The variables X and Y are used because values are unknown. Note: Volumes of sludge and leachate can vary due to factors such as Biochemical Oxygen Demand (BOD), rainfall intensity, and soil moisture.

As shown in the Table 1.1 and Table 1.2, the demand and supply of DWS service are adequate. That is, the Metropolitan Waterworks Authority treat the raw water according to the demand of the population in each region. For the WST service in the nonintegrated case, there is not enough supply of the service in the Nong Khaem region, as indicated by the excess of 17,460 cubic meters of wastewater and sewage. The MSW service has the deficits of 3,930 tonne per day of municipal solid waste. Regarding the WST and MSW services, their deficits increase in the integrated case. This is because the demand of the WST and MSW services increase as a result of the interrelationships between services shown in the Table 1.2.

In conclusion, the integrated water and sanitation system might be more efficient than the nonintegrated system, because the former yields more deficits. Using the model above, the integrated system results in more deficits that are closer to the actual values.

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