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A new approach to nationwide sanitation planning for developing countries: Case study of Indonesia

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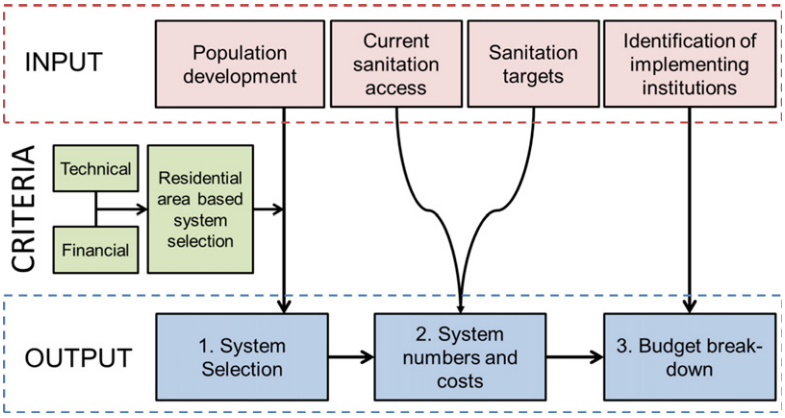
HIGHLIGHTS

- A nationwide wastewater and solid waste planning framework was developed.
- The framework distinguishes urban, rural, poor and non-poor beneficiaries.
- Output links national policies to required facilities and budgets per institution.
- Planned system types are visualized in GIS to facilitate regional prioritization.
- The framework was applied in Indonesia for 2015–2019 sanitation planning.

GRAPHICAL ABSTRACT



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ABSTRACT

Many developing countries struggle to provide wastewater and solid waste services. The backlog in access has been partly attributed to the absence of a functional sanitation planning framework. Various planning tools are available; however a comprehensive framework that directly links a government policy to nationwide planning is missing. Therefore, we propose a framework to facilitate the nationwide planning process for the implementation of wastewater and solid waste services. The framework requires inputs from government planners and experts in the formulation of starting points and targets. Based on a limited number of indicators (population density, urban functions) three outputs are generated. The first output is a visualization of the spatial distribution of wastewater and solid waste systems to support regional priority setting in planning and create awareness. Secondly, the total number of people served, budget requirements and distribution of systems is determined. Thirdly, the required budget is allocated to the responsible institution to assure effective implementation. The

Abbreviations: 3R, Reuse, Recycling and Recovery; ADB, Asian Development Bank; AGS, Aerobic Granular Sludge; BOD, Biological Oxygen Demand; BPS, *Buro Pusat Statistik* (Central Statistical Bureau of Indonesia); CAS, Conventional Activated Sludge; CBS, Community Based System; CLTS, Community Lead Total Sanitation; COD, Chemical Oxygen Demand; DSM, Department of Statistics in Malaysia; GIS, Geographic Information Systems; IPLT, *Instalasi Pengolahan Limbah Tinja*, Sludge processing facility; JSM, Java Spatial Model; MBR, Membrane Bioreactor; MDG, Millennium Development Goals; MFA, Material Flow Analysis; MoPW, Ministry of Public Works (of Indonesia); MSW, Municipal Solid Waste; N, Nitrogen; NBSC, National Bureau of Statistics in China; O&M, Operation and Maintenance; ODI, Overseas Development Institute; OPEX, Operational Expenditures; OSI, Online Supplementary Information; P, Phosphorus; SDG, Sustainable Development Goals; TTPS, *Tim Teknis Pembangunan Sanitasi*, technical team for sanitation development; UN, United Nations; USDP, Urban Sanitation Development Program; WHO, World Health Organization; WSP, Water and Sanitation Program of the World Bank; WWT(P), Wastewater Treatment (Plant).

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determined budgets are specified by their beneficiaries, distinguishing urban, rural, poor and non-poor households. The framework was applied for Indonesia and outputs were adopted in the National Development Plan. The required budget to reach the Indonesian government's 2019 target was determined to be 25 billion US$ over 5 years. The contribution from the national budget required a more than fivefold increase compared to the current budget allocation in Indonesia, corresponding to an increase from 0.5 to 2.7 billion US$ per year. The budget for campaigning, advocacy and institutional strengthening to enable implementation was determined to be 10% of the total budget. The proposed framework is not only suitable for Indonesia, but could also be applied to any developing country that aims to increase access to wastewater and solid waste facilities.

1. Introduction

Between 2005 and 2010, developing Asia experienced remarkably higher annual growth rates (7.3% in Gross Domestic Product per capita) than other developing regions like Sub Saharan Africa and Latin America and the Caribbean (both 2.3%) (ADB — Asian Development Bank, 2012). However, this rapid economic growth had a limited impact on improving access to wastewater facilities, which remains low at 55% (ADB, 2012) and has been increasing with only 3% annually since 1990. Similarly, solid waste services coverage in Asian cities is low at about 20% (Hutton et al., 2008), with an increase from 23.4% in 2010 to 24.9% in 2013 only in Indonesia (Ministry of Health, 2010, 2013). The Millennium Development Goals (MDG) aimed to halve the proportion of people without access to wastewater facilities by 2015 compared to 1990. A progress report shows that a number of (South East) Asian countries, such as Indonesia, Cambodia and India, did not meet these targets (WHO and UNICEF, 2015). A challenge for governments to reach the MDG and the 100% access aim of the Sustainable Development Goals (SDG) target in 2030 (United Nations, 2015) is the absence of a functional sanitation framework dealing with planning and budgeting (Baum et al., 2013; WHO and UNICEF, 2014).

Sanitation planning frameworks aim to respond to real needs and make informed decisions about investments for sanitation improvements (Törnqvist et al., 2008; Parkinson et al., 2014). Existing sanitation planning frameworks typically focus on specific population groups, distinguishing urban, rural or poor or non-poor communities (Törnqvist et al., 2008; Mehta and Movik, 2010; Sijbesma, 2011), while a comprehensive planning framework that incorporates all these citizens is required. Planning frameworks further differ in level of complexity, ranging from simple methodologies relying on guiding principles and check lists, like the Sanitation 21-framework (Parkinson et al., 2014) to more complex ones, including material flow analysis (MFA) (Meinzinger et al., 2009) or Quantitative Microbial Risk Assessment (Surinkul and Koottatep, 2009). One example for the latter is the SANEX™ decision support system (Loetscher and Keller, 2002), which consists of several steps, including a selection and screening of feasible technologies on a range of criteria considering settlement characteristics, soil characteristics, quality of water supply, community profiles and pollution control measures. SANEX™ has been tested in small scale communities in several developing countries, including Indonesia (Loetscher and Keller, 2002). However, the more complex frameworks like SANEX™ are often budget and time demanding and hardly applicable for a nationwide long term sanitation planning, because required data input, such as soil conditions or quality of water supply are not available on a nationwide level (Törnqvist et al., 2008). The simpler ones may not provide the required level of insight to respond to real needs.

In addition to wastewater, solid waste also contributes to pollution. Therefore, a comprehensive approach addressing both sanitation sub-sectors is desired (Ersoy et al., 2008; WSP — Water and Sanitation Program of the World Bank, 2011; ADB, 2013a). In several sanitation practices, like community lead total sanitation (CLTS) (Mehta and Movik, 2010) (basic) household waste management is considered besides wastewater. However, the CLTS approach focusses on rural areas only. Analytical tools, like MFA, can also both wastewater and include solid waste flows and may support sanitation planning (Meinzinger et al., 2009). However, MFAs cannot be readily up-scaled for nationwide planning due to their complexity.

An available framework designed for nationwide sanitation planning and budgeting is the Service Delivery Assessment (SDA) of WSP (WSP, 2014). The SDA consists of (1) a review of past sanitation access, (2) a costing model, and (3) a diagnosis of service delivery bottlenecks. It lacks, however, a wastewater system selection based on residential features and neglects the impact of untreated sewage on public health and the environment.

To organize and integrate wastewater and solid waste systems in land use planning activities, and to support regional priority setting and to create awareness of the required implementation, visualization in Geographic Information Systems (GIS) can be used (Quaye-Ballard and An, 2010; Coutinho-Rodrigues et al., 2011; Gondhalekar et al., 2013). However, sanitation frameworks that present their output in GIS are, to the best of our knowledge, not readily available.

Table 1 summarizes the differences between described existing frameworks and our proposed framework. It shows that none of the reviewed frameworks considers all the described elements to develop one sanitation plan from a (national) governmental sanitation (wastewater and solid waste) policy.

In this paper, a new wastewater and solid waste planning framework is presented that directly links government policies to a nationwide planning roadmap. The framework requires input from government planners and experts in the formulation of starting points and targets. It then only requires a number of key indicators to arrive at: (1) spatial planning visualized in GIS, (2) number of facilities and budgets per population group and (3) allocation of budgets to implementing institutions. The framework has been successfully applied in Indonesia and the outputs were adopted in the National Medium Development Term Plan.

The national average of access to wastewater facilities in Indonesia was 56% in 2010, with highest access in the urban areas (73%) (Ministry of Health, 2010). Barely 1% of the population is connected to a sewer system (Kearton et al., 2013). Most of the installed wastewater infrastructure comprises septic tanks. However, 95% of the septic tanks leach liquid directly into the ground or discharge to surface water (WSP, 2013a). The current septage sludge management system is performing poorly in terms of technical and financial operation (WSP, 2013b). Only 25% of the Indonesian population are served by a solid waste management system (Ministry of Health, 2013). The lack of adequate wastewater systems, combined with inadequate solid waste management, is causing contamination of surface and groundwater (ADB, 2013a). Increased government attention towards sanitation resulted in an increased investment from 0.6 to 1.5 billion US$ per year between 2010 and 2014 (USDP — Urban Sanitation Development Program, 2014). In 2013 the Ministry of Planning started preparing the National Medium Term Development Plan (2015–2019) for which the framework presented here was applied. In that plan, the "universal targets" were introduced which define that the entire population must have access to wastewater facilities; 70% of the population should be served by a solid waste management system; and a 20% reduction in landfilling of household waste should be achieved (Bappenas, 2014a).