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Maksud Bekchanov, Pablo Evia, Mohammad Monirul Hasan, Narayan Adhikari,
Daphne Gondhalekar

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Authors' addresses

Dr. Maksud Bekchanov
Center for Development Research (ZEF), University of Bonn,
Genscherallee 3
53113 Bonn, Germany
Tel. 0049 (0)228-73 1841; Fax 0228-731972
E-mail: mbekchan@uni-bonn.de
www.zef.de

Dr. Pablo Evia
Center for Development Research (ZEF), University of Bonn,
Genscherallee 3
53113 Bonn, Germany
E-mail: pabloevia@gmail.com
www.zef.de

Dr. Mohammad Monirul Hasan
Department of Economics, East West University
A/2, Jahurul Islam Avenue
Dhaka – 1212, Bangladesh
E-mail: monir1021@gmail.com
www.ewubd.edu

Dr. Narayan Adhikari
Alternative Energy Promotion Centre
Khumaltaar Heights, Lalitpur, Nepal
Tel. +9771-5539
E-mail: narayan.adhikari@aepc.gov.np
www.aepc.gov.np

Dr. Daphne Gondhalekar
Technical University of Munich
Department of Civil, Geo and Environmental Engineering
Am Coulombwall 3
85748 Garching, Germany
Tel. +49 89 289 13709; Fax +49 89 289 13718
E-mail: d.gondhalekar@tum.de
www.sww.bgu.tum.de

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Abstract

Open dumping of waste and discharging untreated wastewater into environment are key causes of environmental pollution in the developing world, including South Asian countries. Waste and wastewater however can be a source for recovering energy, nutrients and water if properly treated or recycled rather than a cause of pollution and diseases spread. The importance of adopting Resources Recovery and Reuse (RRR) technologies increases under growing demand for food and energy in contrast to depleting fossil fuel mines and groundwater reservoirs. However, institutional framework including the organizations and various stakeholders involved in the waste and wastewater management sectors, government policies and legislation, as well as financial arrangements and incentives to technological change play a pivotal role in adopting and scaling up RRR options. This study therefore focuses on institutional and financial aspects of challenges and opportunities for implementing RRR options in South Asia. It is argued that improving financial capacities, easing to obtain land use permits to expand RRR facilities, maintaining quality of RRR products (compost, biogas), and raising environmental awareness are imperative for the successful performance of the RRR projects in South Asia.

Keywords: Resource Recovery and Reuse (RRR), organic waste, wastewater, alternative resources, environmental security, environmental policy

JEL codes: O13, Q01, Q53, D02, Q58, Q20

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1 Introduction

Increasing demand for energy, water and food due to population and economic growth requires employing alternative options of resources extraction. The depleting stocks in the fossil fuel and rock mines, concerns over GHG emissions related with fossil fuel uses, and reduced availability of water resources due to global warming tendencies increase the importance of sustainable resource use with the employment of renewable resources (Cordel et al., 2011; Höök and Tang, 2013; Lazarova et al., 2013). Therefore, waste and wastewater is being considered an important asset for recovering energy, nutrients and water to meet growing demand, as postulated by the concept of circular economy (Geissdoerfer 2017). Compost from food and livestock waste, biogas from animal dung and sewage sludge, purified wastewater are examples of Resource Recovery and Reuse (RRR) technologies that can augment the supply of the essential resources, sequentially improving energy, water and food access (Bekchanov 2017). These options also improve the sanitation access and environmental health due to reduced dumping of waste and environmental pollution.

As the world's largely populated and underdeveloped regions, South Asian countries such as India, Bangladesh, Nepal and Sri Lanka are more prone to environmental degradation and poverty due to mismanagement in waste and wastewater management systems (Visvanathan and Glawe, 2006). Although annual water supply is abundant to meet food and drinking demands on average, water scarcity is an issue in long-continuing dry seasons and dry zones of the countries. All countries except India fully depends on the imports of fertilizer to support agricultural production (Bekchanov and Evia 2018). In rural areas where majority of the population resides, biomass burning for cooking due to lack of access to energy grid is key cause for indoor air pollution and related pulmonary illnesses. RRR technologies can be effective options for reducing waste related pollution and augmenting energy and fertilizer supply in these countries. In earlier study, we analyzed current state of waste management and resource availability as well the relevance of RRR options to address environmental pollution and resource augmentation in South Asian countries (Bekchanov and Evia 2018). The current study is a logical continuation of that earlier work, and here we focus on institutional framework and financial arrangements to implement RRR options in the study area.

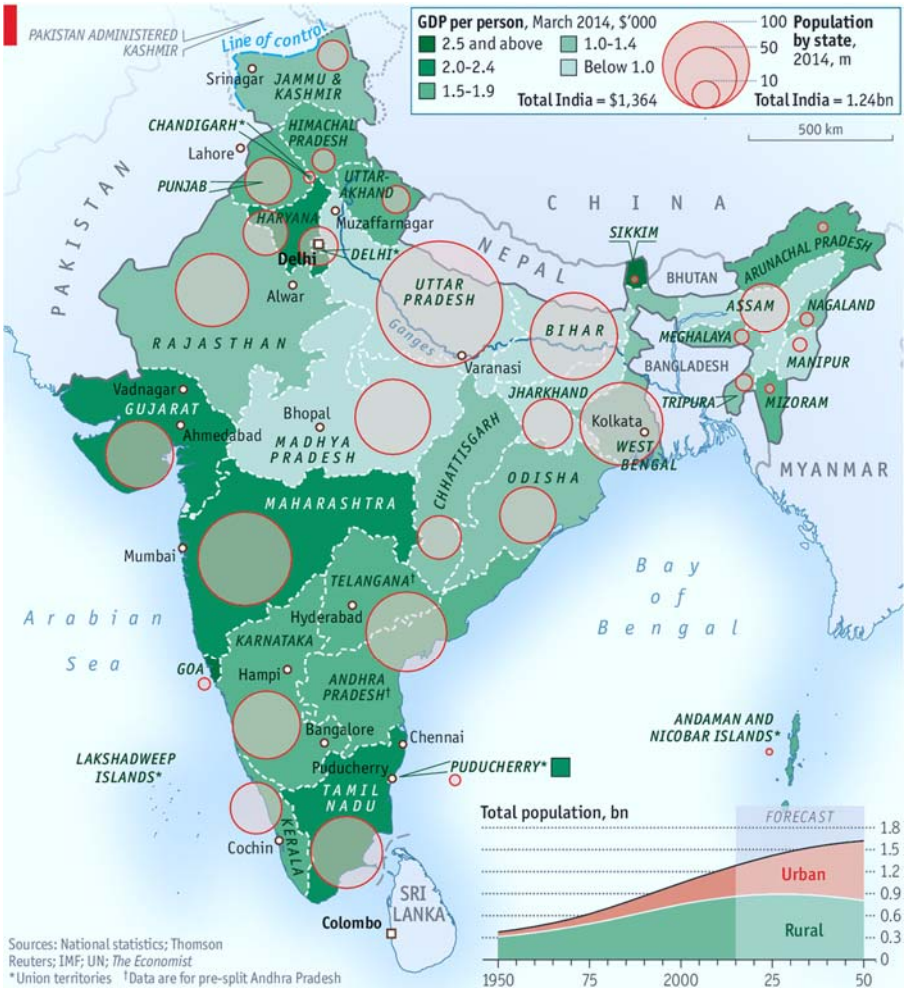
2 Financial capability, income sources and poverty

Affordability of renovating and constructing sanitation infrastructure and RRR facilities largely depends on government and people's incomes measured through Gross Domestic Product (GDP) as well as the distribution of income among social groups and regions. Income levels, poverty rates and credit access in the studied South Asian countries are highlighted in this section.

2.1 India

Average GDP per capita in India was estimated as US$ 1,364 (as of 2014; Fig. 1). However, the states across the country have different levels of economic development. The wealthiest population with income levels of higher than US$ 2,500 are from the smallest states such as Goa and Sikkim. In terms of GDP per capita, Gujarat, Haryana, Maharashtra and Tamil Nadu also perform well having income levels between US$ 2,000 and 2,400. The states located in the Ganga basin such as Uttar Pradesh, Bihar, Jharkhand, and Madhya Pradesh are the poorest in terms of per capita income, earning less than US$ 1,000 per capita.

Figure 1: Economic development levels across India

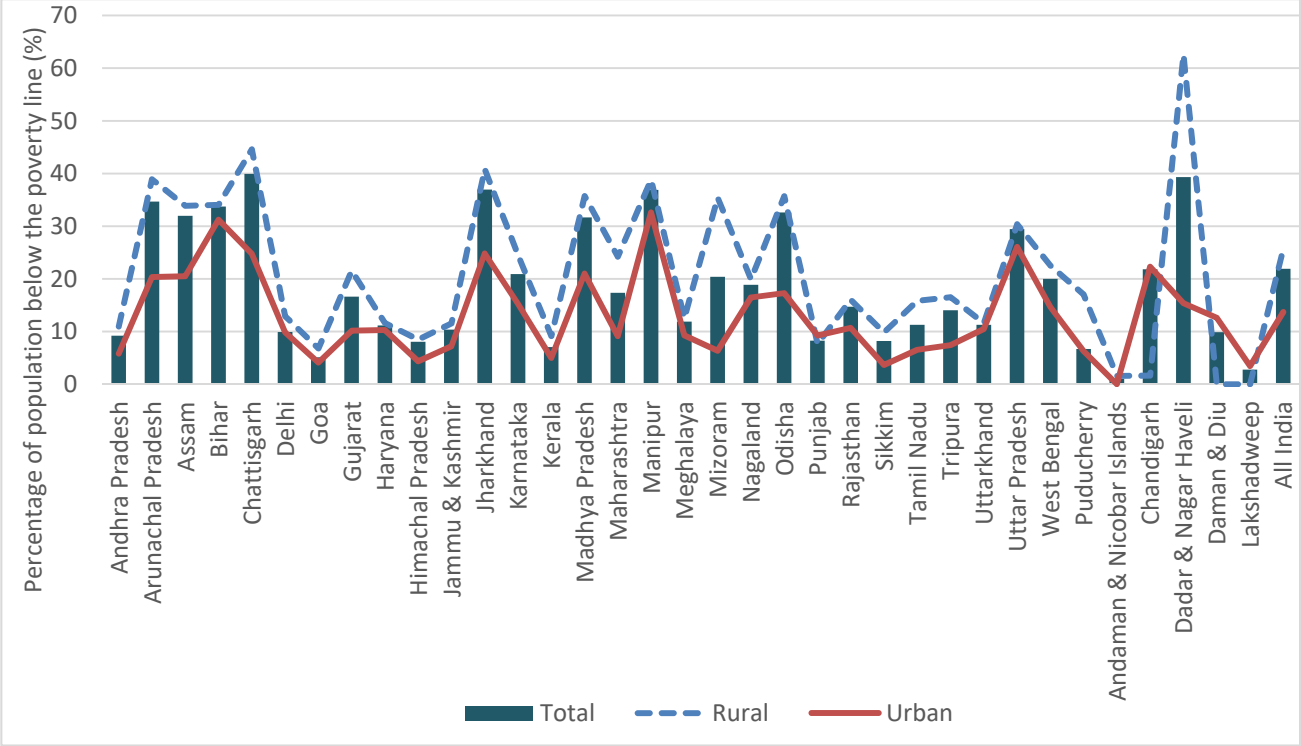


Source: the Economist (2015)

Income levels largely vary not only across the regions within India but also across the social groups. In other words, income inequality and poverty rates are quite high in most of the states across the country. In some states such as Chattisgarh, Jharkhand and Manipur, incomes of almost 40% of the population are below the poverty line (Fig. 2). Poverty rates are greater in rural areas. Even in the

states with the lowest poverty rates such as Andhra Pradesh, Goa, Kerala, Punjab and Sikkim, incomes of almost 10% population are below the poverty line. In India, people living under the conditions of below the poverty line are 21% on average. High poverty rate is one of the main barriers for the adoption improved sanitation and RRR technologies in the country (Fig. 2).

Figure 2: Poverty rates across India (2011-2012)



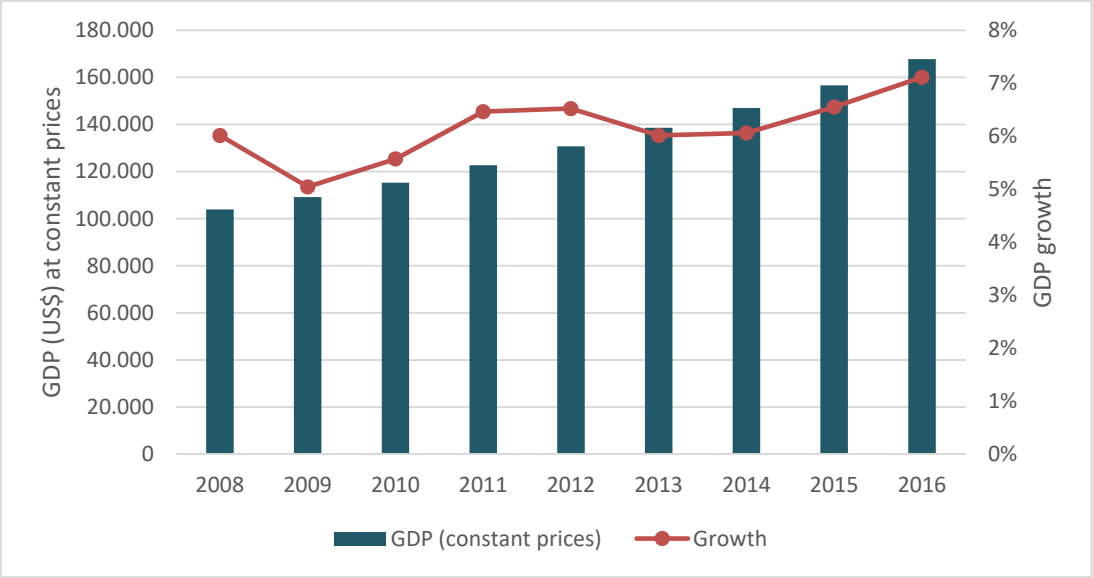
Source: Ministry of Statistics (2013)

Access to bank loans seems favorable for businesses due to sufficiently low inflation and interest rates in India. According to the World Bank (2018), easiness of getting credit (EGC) index for the country is 75 (within 0 to 100 range). Annual inflation rate is about 5% and interest rate is 9.7% (as of 2016; World Bank 2017a).

2.2 Bangladesh

A sustained economic growth in the last 20 years as shown through GDP increases allowed Bangladesh to change its status from a low income country to a lower-middle income country. The average rate of GDP growth was 4% in the 1990s, while it was 5.5% in the 2000s (Figure 3). Thus, Bangladesh was ranked as the 35th in the world according to GDP (PPP-adjusted; as of 2016). The GDP per capita (PPP) was of US$ 3,586.

Figure 3: GDP levels and growth



Source: Based on World Bank (2017a)

Following the continuous economic growth, over 24 million people were pulled out of poverty since 2000 (World Development Indicators). Despite this progress, about 40 million people still live in poor conditions (below the poverty line; as of 2016). According to IMF (2013), inequality, low productivity, and inadequate financing are main challenges to impede the inclusive growth. Vulnerability to climate shocks such flooding is also a key issue exposing the most vulnerable groups (women and children) to poverty and health risks.

Low income levels limit the affordability of food for the poor. Some of the ultra-poor are landless workers who depends almost entirely on the availability of precarious jobs. The agricultural season thus determines if they will be able to earn enough money for their upkeep. In addition, there is a lack of opportunities for off-farm employment in rural areas, leading to migration of millions of people to major urban centers with all the risks that it entails (health, safety, etc.; FAO 2014). Low income levels in turn is a key barrier to implement household level RRR activities such as biogas from household waste.

2.3 Nepal

Nepal is one of the low-income countries of South Asia. The Gross Domestic Product (GDP) of Nepal is US$ 18.3 billion and GDP per capita is about US$ 700 (as of 2011, ADB 2012). More than 55% of population lives in poverty at the level of less than US$1.25 income per day and 75% of population lives below the poverty level of US$2 income per day. Indeed, GDP of the country has been constantly growing but mostly due to rapid development in urban areas (ADB 2012). Small business enterprises dominate in the urban economy. Remittances also play a great role for urban household incomes. Therefore, there is a huge income disparity in urban and rural areas and majority of the impoverished people reside in rural places.

Agriculture is a backbone of the economy and contributes over 40% of GDP (Timilsina 2016). More than 80% of economically active population is engaged in agriculture. Due to seasonal migration of male population to urban areas and abroad for earning income, mostly women should take care of farming in rural areas (Cook et al. 2016). Industry accounts for only 8% of GDP. Main industrial activities are processing agricultural commodities such as jute, tobacco, sugarcane, and grain.

2.4 Sri Lanka

Sri Lanka is a middle-income country with GDP per capita of about USD 4,000 (as of 2015). Given its favorable geographic location (access to the sea), and developed infrastructural facilities, the Western Province contributes more than 40% of national GDP (CBSL 2016). The agriculture was the main sector previously contributing more than 50% of GDP (as 1950s) but its share reduced to less than 10% at present (as of 2015). Nevertheless, majority of population lives in rural areas and 33% of economically active population (7.7 million) is engaged in the farming sector.

The share of population living below the poverty line of US$ 1.25 per day fell from 22.7% to 6.1% in period between 2002 and 2013 in the part of country outside Northern and Eastern provinces. Despite the substantial share of population started living above the poverty line, living standards remained low. The share of population living above the poverty line but below twice the poverty line is high and this people reside in conditions similar to poor neighborhoods (Newhouse et al. 2016).

3 Institutions and regulatory framework

In addition to financial capability, various government institutions, suppliers and customers along the supply chains in the waste and wastewater management sectors play an important role for scaling up RRR projects. In waste and wastewater management, in general, stakeholders can be grouped into waste generators, waste collection services, treatment and recycling plants, business supporting services, organizations involved in marketing and distribution of RRR products, and authorities to set policies and control the system (Duwal 2015). Waste and wastewater generators are households, hotels, catering services, shops, markets, industrial enterprises and farms. Waste collection services is supposed to be established by local governments and can be operated through private organizations or state enterprise. Business supporting institutions are consultancy agencies and NGOs that provide technical assistance, commercial enterprises that deliver main inputs and machinery, and credit institutions that provide loans for constructing composting or biogas plants. Regulatory agencies are governmental institutions that set rules and strategies in the sector as well as enforce the implementation of the laws. Defining the roles and responsibilities of the various stakeholders clearly allows for effective coordination of the tasks for managing waste and reducing pollution. This section describes various institutions which are involved in waste and wastewater management, and play important role in adopting RRR technologies.

3.1 India

The main stakeholders involved in wastewater and organic municipal waste management in India are the Ministry of Urban Development, Ministry of Environment, Forest and Climate Change, Ministry of Social Justice and Empowerment, Central and State Pollution Control Boards, State Governments, Urban local bodies, NGOs and households (Rohilla et al. 2017).

The Ministry of Urban Development is responsible for formulating FSM strategies and designing the implementation plans at state and city levels. The Ministry provides technical support to states, conducts trainings for state officials, provides funding, establishes nation-wide awareness programs, promotes PPPs in wastewater and organic municipal waste management system, and organizes nation-wide monitoring of the progress in sanitation system development.

The Ministry of Environment, Forest and Climate Change is responsible for the enforcement of the rules and regulations related with environmental protection and capacity building to control pollution. The ministry ensures the compliance of the environmental laws and regulation in the process of collecting, transporting, disposing and recycling the fecal and sewage sludge.

The Ministry of Justice and Empowerment helps states in eliminating manual scavenging and manual empting septic tanks. The Ministry monitors the progress in rehabilitating manual scavengers and workers involved in manual emptying. This Ministry also organizes nation-wide campaigns to raise public awareness on the risks related with manual scavenging.

State administrations are responsible to support urban local bodies technically and financially, coordinate the cooperation among urban local bodies, and ensure financial stability of the municipalities in improving sanitation services. The state administrations develop plans and strategies of sanitation system improvement at state level, organize capacity building and training of officials engaged in sanitation sector, support research in sanitation system, and organize public awareness campaigns at state level. Urban local bodies are responsible to support and implement sanitation measures at municipal level. Urban municipalities are also in charge of establishing partnerships with NGOs and private companies for conducting waste and wastewater collection services, operating landfills or incineration plants, and organize composting activities.

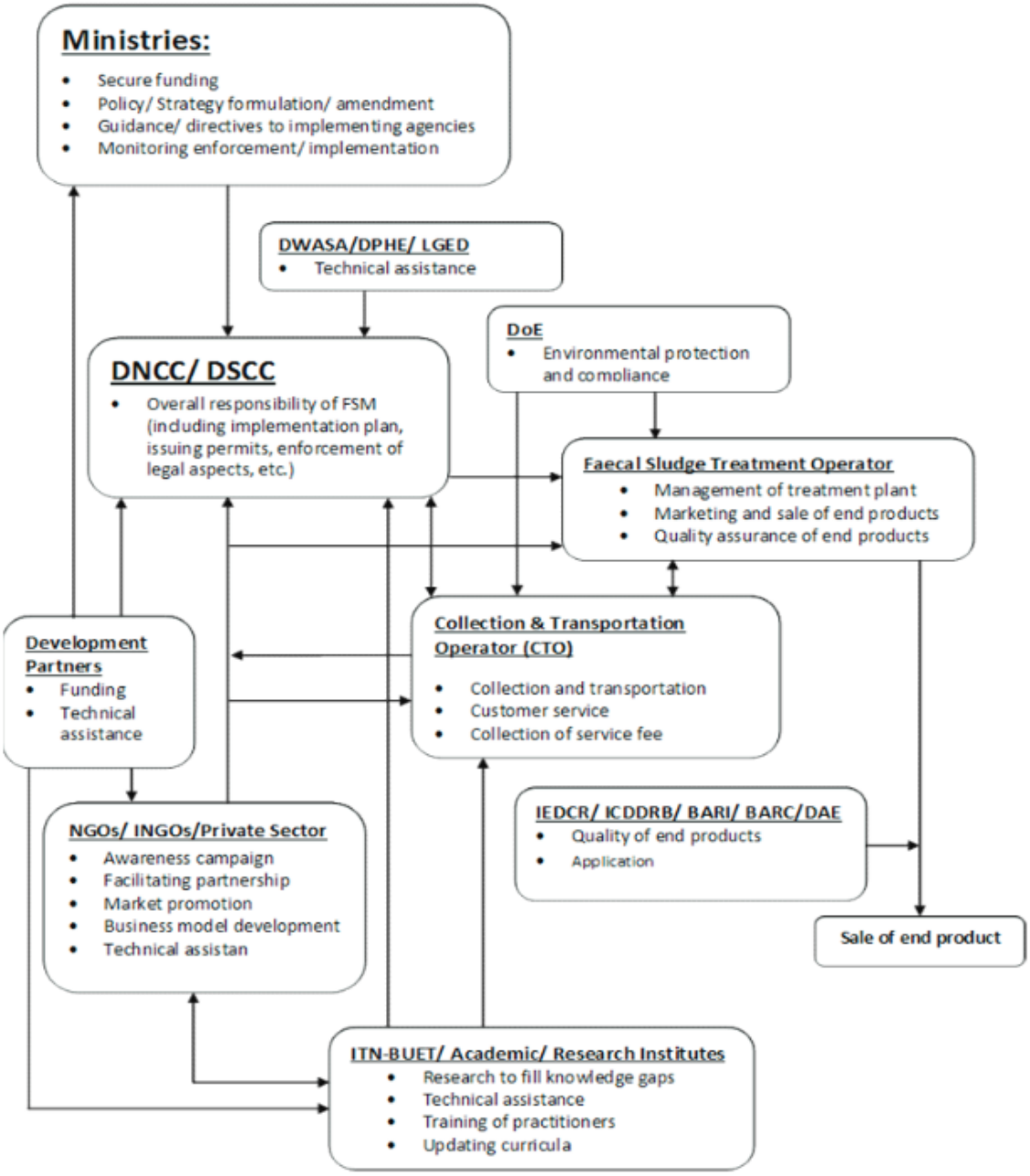
3.2 Bangladesh

Main stakeholders involved in waste and wastewater management system in Bangladesh can be classified in general into waste generators, waste collectors, waste treatment operators, distributors of RRR products, users of RRR products, supporting services, and legal bodies to set the rules and control the activities (Figure 4). Waste generators are households, business companies, markets, shops, farms, administrative organizations, schools, and hospitals. Waste generators may construct sanitation facilities and hire emptiers to remove sludge from septic tanks. Waste collection is mainly responsibility of local municipalities but can be also conducted by private sector if business profits are available. For instance, Dhaka City Corporations hire sweepers to clean roads, open ditches and storm water drains. Or, services of collecting sludge using VacuTug was managed by Dushtha Shasthya Kendra (DSK). Waste treatment organizations incorporate composting plants, incineration plants, companies producing biogas from waste, etc. Distributors of RRR products are fertilizer companies, small shops, individual suppliers, etc. As reported, over 45,000 dealers are engaged in distributing fertilizers in Bangladesh but most of them sell chemical fertilizers (Cook et al. 2016). Users of RRR products are nurseries (for compost), farmers (flower, betel leaf, and potato), hotels and households (for biogas). Supporting services are banks to provide credit to RRR sector and NGOs which provide technical expertise and training. Legal bodies such as different government ministries, environmental protection agencies and local authorities set the rules and enforces the laws.

Governmental bodies that are involved in the sanitation and waste recycling sector in Bangladesh can be classified in three levels: central government, regional /local government, and NGOs. Each of these three levels have different responsibilities in the process of policymaking, framing the regulation, and organizing awareness campaigns or other type of events (Asian Development Bank 2011).

In general, the authorities in the Executive Power (i.e., Ministries and National Agencies) are in charge of framing the policies that regulate the sanitation and waste sectors. In the case of Bangladesh, this institution is the Ministry of Local Government, Rural Development and Cooperatives together with its Local Government Department (Mahmud and Mbuya 2015). The Department of Public Health and Engineering is the main agency in charge of infrastructure in the water and sanitation sector both in rural and urban areas (depends as well on the Ministry of Local Government). Ministry of Housing and Public Works develops Building Code and controls spatial planning. Ministry of Environment and Forests monitors environmental safety of the projects, controls waste discharge permits to enterprises, enforces standard limits for waste, and acts as a focal point for promoting RRR activities (Yousuf 2014, World Bank 2016b). The Department of Agricultural Extension is responsible for the registration of fertilizers including compost (Cook et al. 2016). Soil Resources Development Institute (SRDI) provides soil testing services.

Figure 4: Institutional scheme of Fecal Sludge Management (FSM) in Dhaka



Source: Renouf et al. (2017)

At the local level, it is responsibility of the municipal government (such as the Dhaka City Corporation in Dhaka) to manage the water and sanitation sectors, as well as all type of wastes (including solid waste, wastewater, industrial waste, etc.). Dhaka Water Supply and Sewerage Authority (DWASA) coordinates water and sanitation services in Dhaka, Khulna, and Chittagong cities (World Bank 2016b). Capital Development Authority (RAJUK) inspects the compliance of the building plans and constructions to the accepted standards. Although, RAJUK officers inspect a proper containment and disposal of the sludge in new buildings, it was reported that the developers of new buildings often cheat the inspectors and manage connecting the septic tanks into some drain to empty the contained sludge (World Bank 2016b).

Improved collection of fecal sludge is thus essential for its proper disposal or treatment. However, different stakeholders may react differently for enforcing the elimination of direct disposal of sludge

into drains (World Bank 2016b). For instance, the Dhaka City Corporation can be supportive of this change since it reduces the conveyance burden to their small-bore drainage system and reduce the operation costs. Yet, increased responsibilities related with the change may make them less enthusiastic. Sweepers may get increased income opportunities due to higher demand for empting septic tanks if connecting latrines to drains is eliminated. However, they can loss the potential benefits if mechanical empting is introduced in the medium turn. Households and owners of the constructions can be against to make empting septic tank obligatory since they do not see the public damage costs of dumping sludge into the drain but only their personal costs for emptying services.

Non-governmental organizations (NGOs) play important role to raise environmental awareness and nurture cooperation among RRR sector representatives, state agencies and communities. Waste Concern is one of such research based NGOs which is very active in raising environmental awareness and implementing RRR projects in Bangladesh (Zurbrügg et al. 2005). This organization works closely with state agencies, local communities, private sector and international organizations. Composting is one of the important activities promoted by Waste Concern. A composting project in Mirpur district of Dhaka supported by this NGO became very successful.

3.3 Nepal

In Nepal, water supply and sanitation sector is managed through two Government Ministries and many other non-governmental organizations and private agencies (Karki 2015). Ministry of Water Supply and Sanitation (MOWSS) which was named previously as the Ministry of Urban Development (MOUD) is the key ministry which formulates policies, conducts planning and monitoring in the sector. The implementation of water supply and sanitation projects in areas with more than 1,000 residents is the responsibility of MOWSS and its branches in regions (NPC 2013). Ministry of Federal Affairs and Local Government (MOFALD) regulates water supply and sanitation projects for rural areas with the residents of less than 1,000 people. Ministry of Health and Population is responsible for enhancing health and hygiene through water quality surveillance. Ministry of Population and Environment is responsible for conducting environmental impact assessments and setting wastewater quality standards. Water supply and sanitation services and policies in Nepal are also supported through several international development partners such as Asian Development Bank (ADB), World Bank (WB), UNICEF, Embassy of Finland, World Health Organization (WHO), Japan International Cooperation Agency (JICA), UN-Habitat, and the US Agency for International Development (USAID).

Some NGOs were active recently in supporting DEWATSs. For instance, ENPHO which was established in 1990 promotes the wider implementation of DEWATSs and sanitary toilet programs across Nepal. ENPHO aimed at developing sustainable communities through the integrated research and action programs in public and environmental health. Bremen Overseas Research and Development Association (BORDA) is another organization that is active in implementing sustainable options for alleviating poverty and maintaining environmental sustainability. The Consortium for DEWATS Dissemination (CDD) Society headquartered in India also aims to promote and improve the livelihoods of the less privileged and marginalized groups of people in South Asia through giving them access to decentralized services for basic needs.

Organizations involved in marketing and distribution of RRR products are very important for the success of RRR projects. In composting sector, Agriculture Inputs Corporation (AIC) established in 1965 plays a key role in distribution of compost and other inputs (seeds, pest, fertilizers, etc.) to farmers across Nepal (Mazlumdar 2012). A central soil testing laboratory and its five regional branches became instrumental in testing the quality of compost and inspecting its appropriate uses. Compost and agricultural inputs are also distributed through agricultural cooperatives (farmers' associations) and local shops. In the case of biogas, Biogas Support Program (BSP) maintained a successful implementation of biogas digesters by households through subsidizing and ensuring quality of biogas plant constructions.

According to the Local Self-Governance Act, municipalities are in charge of collecting, transporting, recycling and disposing waste in Nepal (ADB 2013). However, lack of financial resources, technologies and skilled manpower are main hindrances to effectively fulfill their responsibilities. Finding people who want to work in RRR sector is also difficult because of health risks related with malodor and dust. Establishing a specific department within municipality administration, which works on waste management issues, is important for tackling the waste management and environmental pollution issues (Frömelt 2007). The Solid Waste Management Resources Mobilization Center (SWMTSC) can also technically aid local municipalities in planning, managing and recycling waste.

3.4 Sri Lanka

The Central Environmental Agency (CEA) established in 1981 is a main organization in implementing environmental policy and measures in Sri Lanka (Jayalal and Niroshani 2012). National Water Supply and Drainage Board together with provincial councils are responsible for providing potable water and sanitation services across the country. The Board constructs and manages large-scale, pipe-borne water supply and sanitation projects. Small-scale, local water supply and sanitation projects require a community level participation and thus are managed by local authorities such as Municipal, Urban Councils and Prabeshiya Sabha. When local authorities do not have the required expertise in designing and implementing water supply and sanitation projects, the Board gets involved for providing the required support.

Ministry of Local Government and Provincial Councils is responsible for the implementation of policies and coordination of relationships between the central government and provincial councils (JICA 2006). The ministry also provides technical assistance, funds related research, and trains personnel for maintaining good governance. Ministry of Health, Nutrition and Indigenous Medicine oversees policies, monitoring and management of waste from medical facilities (JICA 2006). The Ministry appoints Public Health Inspectors to all municipalities and some rural residential areas. Public Health Inspectors are responsible for monitoring appropriate disposal of waste and wastewater and obedience to the environmental protection regulations.

National Solid Waste Management Support Center was established to provide guidelines and various technical assistance on proper waste management to local authorities. Ministry of Power and Energy is in charge of formulating national energy policies and strategies in Sri Lanka (JICA 2006). The Ministry envisages a gradual expansion of alternative energy sources including biofuel production and conversion of waste into energy. According to its plan at least 10% of total energy consumption should be satisfied through alternative sources in near future.

4 Regulation and policies

For effective management in waste and wastewater sectors, the legislative framework is essential for setting the rules in the system and coordinating the activities of stakeholders involved in sanitation supply chain. Rules of registering new product such as compost and lands use permissions to construct the waste recycling facilities influences on the adoption of RRR technologies. This section presents laws and policies related to waste and waste management in the studied South Asian countries.

4.1 India

Protection of water and environment at state and city levels is adequately addressed in the legislation in India (Rohilla et al. 2017). Maintaining sanitation and public health is assigned as the responsibility of the municipalities, according to the Constitution. The Water (Prevention and Control of Pollution) Act (1974) and Environmental Protection Act (1986) are the main legal documents which provide provisions for prevention and control of water pollution though septage management was not mentioned in these documents.

National Urban Sanitation Policy (2008), Advisory Note on Septage Management (2013), and National Urban Fecal Sludge Management Policy (2017) are the main documents which prioritize sanitation strategies state-wide and emphasize the need for on-site sanitation facilities in areas with no sewerage system. Particularly, the National Policy on Fecal Sludge and Septage Management aims at developing state-level frameworks and plans for tackling septage management, capacity building and trainings on fecal sludge and septage management, supporting the system of data collection for registered on-site sanitation systems, promoting private and public partnerships (PPP) in the sector, maintaining integrated citywide sanitation and safe disposal of wastewater.

Several government programs such as Swarachh Bharat Mission (2014) and Pradham Mantri Awas Yojna (2015) aim at reducing open defecation through providing toilets or fecal sludge containment facilities. The Bureau of Indian Standards prepares standards for building a septic tank. Regulations on sanitation at household level are related with the construction of the sanitation systems and disposal of the waste. The National Building Code of India (1983) (Part IX Plumbing Services, Drainage and Sanitation) and Code of Practice for the Design of Septic Tanks are main documents to manage wastewater at household level. However, the programs on sanitation do not adequately address safe disposal of the collected sludge or proper treatment of wastewater.

No license or permits are required for emptying services and vehicles license is not required when tractors are used for collecting the septage. The Employment of Manual Scavengers and Construction of Dry Latrines Act (1993) prohibits manual emptying of septic tanks though it is still widely practiced in poor areas. Because of the absence of proper disposal sites, emptied fecal sludge is often discharged into freshwater bodies neglecting possible damage to health and environment. Thus, operators engaged in emptying often face harassment by police or environmental protection authorities for illegal dumping of septage though properly designed dumping sites do not exist (Rohilla et al. 2017).

In terms of solid waste, the Solid Waste Management Rules (2016), which is an improved version of the earlier document adopted in 2000, provides adequate regulatory support for MSW management in India. Composting organic municipal waste was seen as an essential way of returning organic carbon and nutrients embedded in the waste back to the soil and enhance sustainable farming and livelihoods, according to the Inter-ministerial Task Force on Integrated Plant Nutrient Management Using City Compost (Dilkara et al. 2016). The Task Force also emphasized a proper quality and affordability of the produced compost to be marketable and usable for farming. To address quality issues and enforce the quality standards for organic fertilizer in addition to tackling logistical problems in the chain, the National Project on Organic Farming has been established and provides subsidies to capital investments in commercial production of organic fertilizers. The main objectives of the project are to promote organic farming to increase agricultural productivity, reduce dependence on chemical

fertilizer uses, and prevent environmental pollution and degradation. The Indian Council for Agricultural Research (ICAR) developed technical programs and resources for promoting organic fertilizer production from organic municipal waste and its further uses to enhance soil health.

In terms of biogas production, government has been supporting policies on a wider implementation of biogas technologies since the 1970s (Mittal et al. 2018). The global oil crisis at that time showed the importance of readiness to shocks in energy markets to prevent dramatic fall in energy access by poor households in remote rural areas. The National Biogas Development Plan (NBDP) was launched in 1981 to alleviate energy crisis in rural areas and capital subsidies were provided to households owning 2-3 cows. In 1995, biogas development strategies were expanded to urban areas for reducing pollution from waste and recovering energy from municipal solid waste. The NBPD was renamed with National Biogas and Manure Management Programme (NBMMP) and off-grid power generation from biogas projects was promoted. Subsidies as well as short courses for raising awareness were provided within the program. The Ministry of New and Renewable Energy (MNRE) is a main organization which implements the NBMMP across India. MNRE has also always been supportive to waste to energy programs through providing financial support or organizing trainings. Programs and policies of promoting generation of power from municipal and industrial waste have been also adopted. Although government is in general supportive towards a wider implementation of biogas facilities, there are no legally supported standards of converting biogas into compressed natural gas for vehicles or off-grid power into electricity grid (Mittal et al. 2018).

Procedures related with registering new fertilizer and related costs plays important role for the feasibility of composting plants. As shown in Table 1, efficiency of regulatory framework for registering new fertilizer seems acceptable. Especially, cost of registering business is not a big deal. However, procedures related with testing new fertilizer and giving permission to produce and sell may take more than two years. Department of Agriculture is responsible for approving the sales of organic fertilizers. Quality control and standards for new fertilizer are unfortunately underdeveloped. Low quality of compost is one of the main reasons for lack of markets for the product in addition to financial difficulties to fund capital investments.

Tab 1: Easiness of registering new fertilizer (2016)

Indicator	Value
Fertilizer registration index (0-7)	5.0
Quality control of fertilizer index (0-7)	3.5
Time to register a new fertilizer product (days)	804
Cost to register a new fertilizer product (% income per capita)	17.1

Source: Based on Doing Business in Agriculture (World Bank 2017b)

4.2 Bangladesh

Sanitation and wastewater sector is regulated through several legislative documents and policies (Mahmud and Mbuya 2015). “National Policy for Safe Water Supply and Sanitation (1998)” is a main document which aims at ensuring access to safe water and sanitation of all the inhabitants. “National Water Policy (1999)” set the functions of the institutions of the central, regional and local level. “National Policy for Arsenic Mitigation and Implementation Plan (2004)” aims to mitigate the effect of contamination by arsenic. “National Sanitation Strategy (2005)” set the goal of access to sanitation for all the population for 2010, and address six areas of concern: open defecation, hardcore poor remaining underserved, use of unhygienic latrines, lack of hygiene practices, urban sanitation, and solid waste and household wastewater disposal (not fully addressed). “Pro-Poor Strategy for Water and Sanitation Sector (2005)” which was revised in 2010 as “National Strategy for Hard to Reach Areas

and People of Bangladesh (2012)" specifies regulations related to set basic minimum service standards for poor people. "National Cost Sharing Strategy for Water Supply and Sanitation in Bangladesh (2011)" proposes the standardization of water supply and sanitation services and recommends measures to ensure affordable, equitable, and sustainable water and sanitation services for all. "National Hygiene Promotion Strategy for Water Supply and Sanitation in Bangladesh (2012)" provides a framework for the implementation, coordination, and monitoring of various activities for launching hygiene promotion at national, regional, and local levels.

"Bangladesh Environmental Conservation Act (1995)" sets standards for disposal of various types of waste. "National 3R (Reduce, Reuse and Recycle) Strategy (2010)" directed municipalities to pursue organic waste recycling projects through composting, refuse-derived fuel, and biogas through private-public partnerships. This strategy also made segregating waste mandatory. "National Renewable Energy Policy (2008)" supports the production of biogas and other types of energy from waste and create incentives to upscaling green energy projects. Acquisition/ Requisition of Immovable Property Ordinance (ARIPO, 1982) regulates land use permits to construct buildings, plants and infrastructural facilities. "National Agricultural Policy (1999)" provides a support for wider use of organic fertilizer among farmers to improve soil health and thus enhance food security. "Fertilizer Act" adopted in 2006 is a main document to regulate fertilizer sector. Rules specific to organic fertilizer were introduced and standards of compost quality were set in 2008 through some modifications to this act. For instance, according to the modifications, organic fertilizer to be used should not contain plastics and other hazardous material, should not be imported from abroad, and its nutrients content and the source materials used should be shown in registration application. Guidelines for monitoring and controlling the quality of compost made of sludge and organic waste were provided in "Bangladesh Standards and Guidelines for Sludge Management" adopted by the Department of Environment in 2015. The Government of Bangladesh also published an "Institutional and Regulatory Framework (IRF) for Fecal Sludge Management (FSM)" that clarifies the roles and responsibilities of different agencies and coordination rules for activities to tackle sanitation and sludge management issues.

Registering new fertilizer including compost is time consuming and expensive procedure (Cook et al. 2016; Table 2). Before getting a license, new fertilizer or compost should be tested through three field trials which may take longer than two years. Additionally, although administrative costs for registering a new fertilizer can be only 50 to 60% of average income (Table 2), a licensing requires a purchase of laboratory facility to measure compost quality which costs over US$120,000. High costs and time requirement for registering new fertilizers are thus the biggest obstacles for establishing compost plants in Bangladesh (Cook et al. 2016).

Tab 2: Easiness of registering new fertilizer

Country	
Fertilizer registration index (0-7)	4.4
Quality control of fertilizer index (0-7)	4.5
Time to register a new fertilizer product (days)	945
Cost to register a new fertilizer product (% income per capita)	58.8

Source: World Bank (2007b)

Governance quality also greatly impact the performance of RRR companies. High corruption rates and lack of transparency are two of the main barriers to RRR business developments (World Bank 2018). Rent seeking behavior and lack of controlling corruption increase the transaction costs of conducting business. Due to inadequate business conditions, the country was ranked among the countries with the lowest index for business climate (World Bank 2017b).

4.3 Nepal

Nepal supports environmental planning and pro-poor development programs to protect natural resources and achieve sustainable development (ICIMOD et al. 2007). Main documents related to environmental protection such as The National Conservation Strategy (1988), Nepal Environmental Policy and Action Plan (NEPAP; 1993), Solid Waste Management Policy (1996), Nepal Biodiversity Conservation Strategy (2002), and the Sustainable Development Agenda for Nepal (2003) aim at minimizing the environmentally hazardous effects of production processes. Main regulations and policies in water supply, sanitation and waste management sectors are (Karki 2015):

- Directives on Operation of Water Supply Services (2012)
- National Hygiene and Sanitation Master Plan (2011)
- Solid Waste Management National Policy (1996)
- Solid Waste Management Act (2011)
- National Urban Water Supply and Sanitation Sector Policy (2009)
- Water Supply Tariff Fixation Commission Act (2006)
- Water Supply Management Board Act (2006)
- National Drinking Water Quality Standards (2005)
- National Policy and Strategy on Rural Drinking Water Supply and Sanitation (2004)
- Water Supply and Sanitation Sector Strategy for Kathmandu Valley (2000)
- Drinking Water Supply Regulation (1998)
- Environment Protection Act (1997)
- Water Resources Act (1992).

Particularly, main objectives of the Municipal Solid Waste Management Policy (1996) are creating environment for effective management of waste, minimizing the external effects of solid waste, enhancing RRR options, and promoting private sector involvement in waste management. The Municipal Solid Waste (MSW) Management Act (2011) revises the previous laws related to MSW aimed at reducing the waste in source point through a segregation of waste and a wider implementation of recycling, recovering and reusing. The Act also considers supporting close partnership between public and private sectors. Additionally, this document set penalties for dumping various types of waste into locations not designed for dumping. The Environmental Protection Act envisages Environmental Impact Assessment System for Development Projects. This Act prohibits creation of pollution sources that threaten environmental and human health.

Many laws and regulations are related to environmental protection but regulation on the construction of wastewater treatment plants lacks though national policies addressed municipal solid waste management (Frömelt 2007). Despite the existence of waste management policies, their implementation is not satisfactory currently (ADB 2013). Despite some shortcomings, regulations are being favorable towards waste recycling, recovery and reuse approaches. Community Mobilization Units promote composting and recycling waste (Frömelt 2007). National Agricultural Development Policy was supportive towards organic farming but did not consider subsidies to organic fertilizers.

Regarding the fertilizer management, National Fertilizer Policy (2002) supported infrastructure arrangements for fertilizer consumption and promoted integrated plant nutrients management in Nepal (Cook et al. 2016). This document was revised in 2008 following the increasing prices for fertilizer in global markets. The revised policy set the rules for organizational structure of importing, distributing and subsidizing chemical fertilizers. According to the revisions, AIC was accepted as the sole agency to import fertilizer to the country, fertilizer prices were fixed at the levels of 20 to 25% more than the

price levels in neighboring India, and fertilizer subsidies were considered only three main crops – rice, wheat and maize. In 2011, new guidelines related with the standard quality of compost to be subsidized ("Organic and Biological Fertilizer Regulation Procedure, 2068 (2011) and Organic Fertilizer Grant Guideline, 2068 (2011)") were adopted to enhance increased use of good quality compost in farming (Mazlumdar 2012).

Temporary or permanent license can be issued to produce organic fertilizer (Cook et al. 2016). A temporary license is granted up to one and half years and upon payment of NPR 6.000 (US$ 55). Additionally, the quality of compost should be proven through testing nutrient and organic matter content by authorized private companies. Meeting the packaging and branding guidelines should be approved by the Ministry of Agricultural Development. For getting a permanent license to produce organic fertilizer, first of all, the harmlessness of the fertilizer should be proved through field tests over two separate seasons. The tests cost NPR 400,000 (about US$ 3,700) and should be conducted by National Agricultural Research Center (NARC). Since the system of issuing permanent license is at its infancy level, the cases of companies who get the license were not detected (Cook et al. 2016).

4.4 Sri Lanka

National Environmental Act adopted in 1980 and amended in 1988 and 2000 is a key legislative document regarding not only wastewater management but also wider environmental protection and pollution control issues (Jayalal and Niroshani 2012). Particularly, the Act determines the tolerance limits for discharging effluents from industry sectors and municipal areas into inland surface water bodies and coastal zones. Main policy measures in the wastewater management sphere aim at improving water use efficiency, protecting water quality and maintaining optimal use of water through integrated management of all types of water. Moreover, the national policy and reforms consider ensuring environmental accountability and social responsibility of people and companies involved in waste generation, collection, transportation, treatment, disposal and coordination, minimizing adverse environmental effects of waste disposal, and ensuring human and environmental health.

For instance, National Environment Policy (2003) aims at promoting a balanced economic development with the consideration of environmental sustainability needs, integrated approach taking into account the interests of multiple stakeholders, and enforcement of environmental accountability. Objective of the supportive National Air Quality Management Policy (2000) is maintaining proper air quality to prevent and reduce air-borne disease incidents and death rates due to air pollution. Similarly, National Watershed Management Policy (2004) underlined sustainable and efficient use of water resources and rehabilitation of watersheds through inclusive decision making. According to the National Policy on Solid Waste Management, environmental accountability and social responsibility of all stakeholders involved in waste management sector should be ensured, recovery of resources should be maximized, and adverse health and environmental effects of waste disposal should be minimized.

Sri Lanka as a member of the Basel Convention developed National Strategy for Waste Management which is used for drafting guidelines for managing waste and wastewater and their disposal. The Central Environmental Authority is supposed to play a key role for the overall coordination of the strategy. Meantime, local authorities are expected to be active in the implementation of the strategy. Ministry of Finance developed implementation and investment plans and is in charge of raising funds.

Like in many developing countries, a proper waste and wastewater disposal was not prioritized and the enforcement of laws was relatively weak in Sri Lanka (UNEP 2001). No legislation and guidelines exist on reuse of wastewater for irrigation purposes (Jayalal and Niroshani 2012). An option of treating wastewater for further sale for farmers have not been practiced since there is no adequate development of legislation and mechanisms on controlling the quality of wastewater reuse in irrigation. However, all large scale enterprises need an Environmental Protection License (EPL) from CEA to operate. For obtaining the license, the companies and medium to large scale entities should

provide a plan how they are managing their waste. Similar permissions are required also for constructing new houses. This strict regulation create incentives to construct small- and medium-scale biogas plants and compost production facilities for recycling organic waste.

Corruption in the governance creates barriers for establishing or expanding waste recycling business. Compost plant managers may face the lack of lands for the expansion of the compost plants or dumping the unrecyclable waste and bureaucratic difficulties in obtaining permission for land uses (Samarasinghe et al., 2015). The gap between the laws and their real implementation also imped wider implementation of recycling. Neighboring houses to the compost plants also complain for malodor and leachate from the plants and frequently organize public protests shut down the plants (Samarasinghe et al., 2015). For instance, despite successful performance of the composting because of good compost quality and high market demand by farming in Walimada, Badulla and Kegala regions, the plants were closed because of public opposition due to malodor and disturbing insects (CEA, private communication, 08.08.2016).

5 Financing arrangements and instruments

Financing arrangements to construct sanitation and RRR infrastructure are also essential for upscaling RRR business models. Especially, introducing incentivizing mechanisms to private companies to participate in RRR activities is important. In addition to existence of demand and financial affordability, interests and influences of various stakeholders, effective coordination of the efforts and interactions of various governmental agencies and market participants, and regulatory policies related with environmental protection and easiness of registering production activities play an important role for the change. This section briefly describes financing mechanisms and institutional and regulatory frameworks to promote RRR activities.

5.1 India

Along the sanitation value chain, several options of value creation exist (Rohilla et al. 2017). First, demand for improved sanitation facilities creates considerable potential for revenue generation to the producers and constructors of the sanitation facilities (pit latrines, septic tanks, water flush toilets, etc.). Second, services of emptying and transportation of fecal sludge in areas not connected to the sewerage system but with adequate enforcement of environmental protection laws have considerable benefit generation potential through waste collection fees and discharging sludge into crop fields. Third, fecal sludge treatment facilities and landfill sites for disposing sludge can augment benefit through payments to waste disposal and government subsidies. Fourth, facilities to recover nutrients from sludge such as composting plants may recycle waste and sell the produced compost to fertilizer supply companies or farmers. Fifth, energy commodities such as biogas, biochar, RDF or power can be produced through recycling waste and sold to households or industrial enterprises. Indeed, any combination of these options also can be considered as a business model by private enterprises, NGOs and state companies to generate revenues.

Given the high capital costs and low prices in RRR sector, governmental financial support through adequate subsidies and tax holidays is important for a successful performance. In India, for supporting municipalities to improve their waste management system, the 13th Finance Commission has endorsed the portion of gross *tax* revenue allocable to Urban Local Bodies (ULBs; Chatri et al. 2012). State governments and funding agencies also considered budgets to support ULBs for the same purpose. Additionally, since 2005, Jawahar Lal Nehru National Urban Renewal Mission (JNNURM) is distributing government grants through the Urban Infrastructure Governance (UIG) and Urban Infrastructure Development Scheme for Small & Medium Towns (UIDSSMT).

Long-term agreements on purchase of RRR commodities at guaranteed price may play important role for durance and long-term sustainability of RRR business models (Mittal et al. 2018). For preventing illegal disposal of waste into sites not designed for dumping and thus safeguarding the environment, fines or alternative punishment measures can be also considered for such misconduct while enforcing environmental protection rules. Public Private Partnerships (PPPs) are also essential for efficient functioning of RRR facilities. PPPs have been increasing in sanitation sector and RRR sphere but there are still many difficulties for wider cooperation because of inadequate institutions, inefficient governance and weak market linkages (Chatri et al. 2012).

5.2 Bangladesh

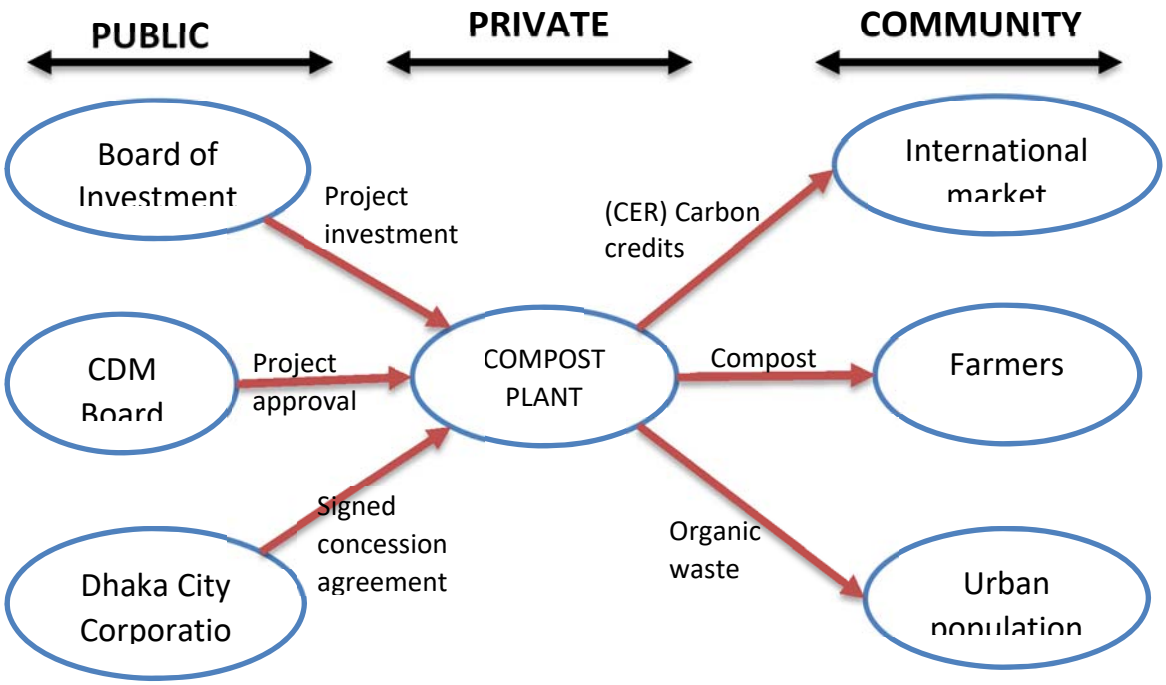
Despite multiple advantages of composting, sustainable operation of composting over time requires adequate funding. Several approaches are available to establish composting plants. As reported by Enayetullah (2015), (1) the system can be municipally owned and operated, (2) municipality may own the system yet it can be operated by private sector through a concession, or (3) private sector owns and operates the system. Because of huge investment requirements for large-scale composting plants,

the private sector could hardly afford the entire funding requirements. Thus, approach related with governmental ownership of the system yet its leasing to private firm for operation seems more suitable.

In the case of the composting project in Dhaka by Waste Concern mentioned above, the composting plant was functioning due to adequate funds from fees for waste collection from households as well as revenues from selling compost to fertilizer distribution company (Zurbrügg et al. 2005). Yet, land was provided free of charge by local municipality since the composting plant can reduce the costs of the municipality to construct and maintain landfills where waste is supposed to be dumped. International donors financed initial investments for establishing the plant, providing machinery and construct the buildings. Scale effects also mattered in this project since additional profits from composting was possible only after increasing compost production from 1.7 tons to 3 tons per day.

In composting facility in Bulta established by Waste Concern, in addition to waste collection fees and revenues from selling compost, an agreement was reached to get financial resources for reducing carbon gases (Sinha and Hasnat 2010). Given the reduced carbon and methane gas emissions from composting organic waste, the project can attract addition revenues through the participation in Certified Emission Reduction (CER) program. Revenue from selling compost was 0.54 million Euro at the price level of 60 Euro per ton of compost and income from selling CERs was 0.19 million Euro (27% of total income). A cooperation among private sector (a composting plant), NGO (Waste Concern), international organization (CDM Board), governmental agencies (Dhaka City Corporation), and local communities (households and farmers) provided the success of the project (Fig. 5).

Figure 5: Example of private-public partnership in Resources Recovery and Reuse



Source: Based on Sinha and Hasnat (2010)

Another financing model for cooperative FSM and RRR operations have been tested in Faridpur by Practical Action Bangladesh (De La Brosse et al. 2017). According to this scheme, revenues are mainly generated from waste collection fees (US$ 22 per empting) and compost sold to horticultural farms and urban dwellers. Local municipality leases waste collection machines to a waste collection company. Payments for the leasing were exempted for the initial six months of starting the business. For eliminating the incentives to openly dump the waste, fecal sludge treatment plant pays to waste collection company for the delivered sludge. Since the revenues from selling compost made of dried

sludge can be low due difficulties in certification and social stigma attached to human waste, subsidies are provided by the local government to the composting process using the revenues from the leasing contract. The business model is expected to be profitable from the third year of the operation. For raising public awareness and promoting demand for the compost, the program also considered various promotion campaigns including street drama, cycling rallies and quiz contests aimed to stop illegal connection of sanitation facilities to drains and avoid environmental and public health hazards (La Rosse et al. 2017).

In addition to land requisition and financial support for initial investments, a consideration of reliable market characteristics and channels to distribute compost was recommended as essential for the success of the composting projects (Zurbrügg et al. 2005). Particularly, for successful performance of composting plants, producers should keep in mind varying demands of different segments of customers (agriculture, horticulture, land reclamation, etc.), place of application, perception and knowledge of existing and potential customers about compost, seasonal demand variation, the quality of compost, the availability of alternative soil nutrients, and effective distributional channels. Since relying on a single customer may increase the risks of economic loss, making a long-term sales contracts to supply compost and establishing trade relationships with multiple distribution networks and compost users are also important.

In biogas sector, IDCOL is active in supporting biogas projects. This organization uses the funds from German Technical Cooperation (GIZ), The Netherlands Development Organization (SNV), and the World Bank to provide subsidies and technical support to construct biogas plants (Halder et al. 2016). The program provided grants amounted to BDT 520 million to its partnering organizations to construct biogas plants in 2016. A subsidy amounted to US$64 per household is provided to construct a biogas plant and customers should pay 15% of total costs at the beginning of the investment period. The remaining costs including 6% interest rate should be paid monthly within two years. Cost-benefit analyses indicated that payback period for these household-scale biogas plants (with the capacity of 2 to 3.2 m^3) varies between 1.2 to 1.9 years depending on the size of the plants (Halder et al. 2016).

Government subsidies to chemical fertilizers, Liquid Petroleum Gas (LGP) and electricity reduce the demand for alternative energy and nutrients sources such as compost and biogas. Elimination of the subsidies to electricity and chemical fertilizer is thus essential for a wider implementation of RRR facilities. Government incentivizing mechanisms should aim at improved waste collection, recycling and recovery of valuable resources. For instance, reduced collection fees to a separated waste and heavy fines to illegal waste dumping may contribute to environment safety.

5.3 Nepal

In poor economies, financing the installation and operation of RRR business is a challenging task. Part of the income can come from fees for the collected waste. Indeed, rather than fixed monthly charges for waste collection volumetric fees are more recommendable to incentivize the households to recycle waste partially at source point and thus reduce the amount of waste to be collected. Since budget costs of local administration can be considerably decreased due to the reduced volume and costs of waste to be dumped into sanitary landfills, local governmental bodies should also contribute to construct and run RRR facilities. Given the environmental benefits such as reduced carbon and methane gas emissions or decreased deforestation after a wider implementation of RRR facilities, managers and public servants engaged in RRR sector may consider to apply for Clean Development Mechanism (CDM) and claim carbon credits. International development agencies and NGOs also can support RRR sector development through providing seed funding and organizing technical trainings and exchange programs. Subsidies to RRR products also play important role for motivating demand for these products (Mazlumdar 2012). For instance, according to governmental incentives for organic farming in 2011/2012, farmers using organic compost could get a subsidy of NPR 10 per kg (or US$ 0.09 per kg) of compost and commercial producers of compost also could receive subsidies of up to 50% of the costs of equipment used for composting (Cook et al. 2016).

More opportunities should be given to private sector to make RRR business attractive to them. Easiness of obtaining land use rights for constructing RRR facility, tax holidays at the beginning of the RRR business project, and subsidies to the produced RRR products can be options to involve private sector representatives in waste management and environmental safeguarding. By participating in the processes of waste containment, collection, transportation, treatment and final disposal, private sector can be effective to reduce the costs and improve the efficiency along waste and wastewater supply chains. Information campaigns to raise public awareness on environmental and economic benefits of RRR activities, and ensuring the quality of the quality of the RRR product through guarantees are crucial factors for successful scaling up of the RRR technologies (AEPC 2012).

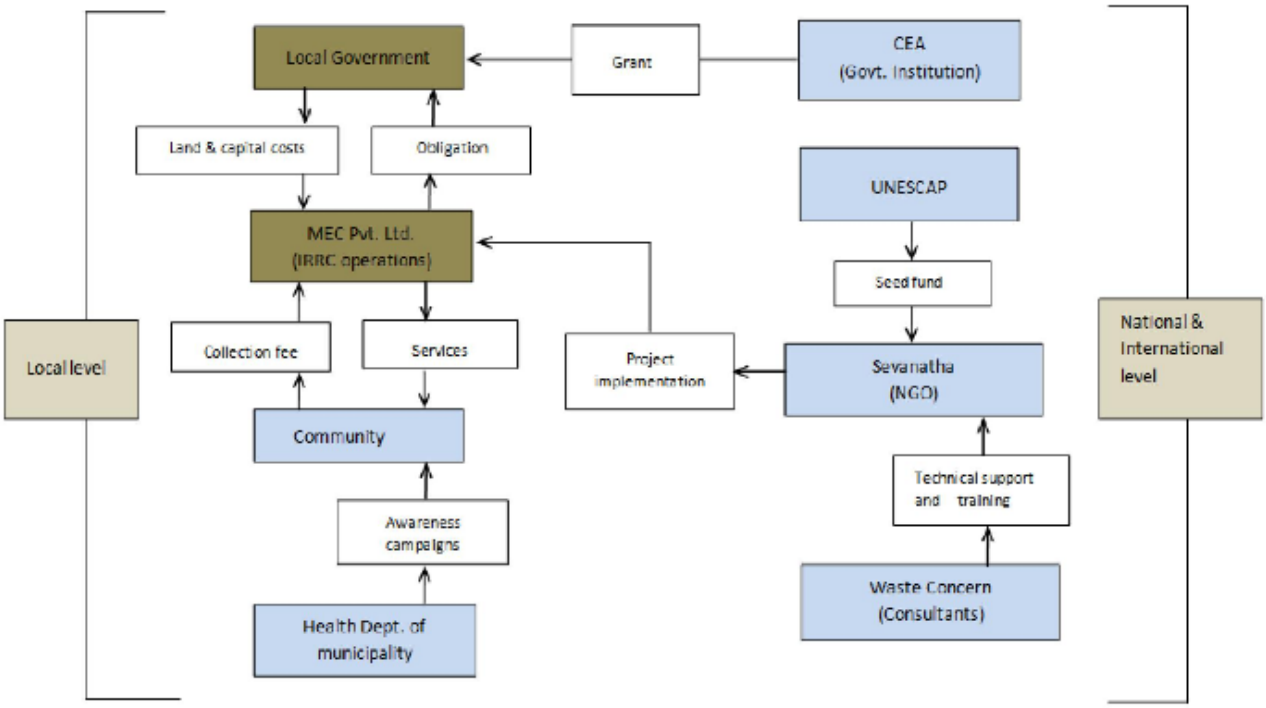
5.4 Sri Lanka

In Sri Lanka, government investments and subsidies play an important role to adopt waste recycling facilities. Following the Pilisaru Program adopted by the national government in 2008, over 110 compost plants were planned to be established to recycle about one fifth of the collected waste (JICA 2006). Investments for this project provided by the government budget for the first three years of implementation amounted to over Rs 5.7 Billion (over € 30 Million, Samarasinghe et al., 2015). Majority of the composting plants planned to construct are under operation at present (JICA 2006).

Since financing is a challenging issue for a wider implementation of RRR options in Sri Lanka, a collaboration between government agencies, local authorities, NGOs, international donors and producers is important for the success of RRR projects. Here a brief example of financing was provided using the case of composting facility in Matale municipality of Sri Lanka. With population of over 40,000, the municipality generates about 21 tons of organic waste each day (Storey et al. 2013). UNESCAP worked closely with Sevaratna (a local NGO) and provided seed funding for establishing compost plant to recycle 2 tons of organic waste in 2007. Given the successful performance of the project, additional funds were made available by Central Environmental Authority (CEA) through Pilisaru Project in 2011 to construct additional facility with a capacity of 2 tons. One more plant with a capacity of recycling 5 tons of waste per day was established with the support of UNESCAP in 2013. Closeness of the composting facilities to the neighborhoods they serve reduced the transportation costs. The project also provided 20 jobs for poor people from urban areas.

Sevartna NGO became instrumental to establish partnership between local government and composting company. Matale Municipality Council helped in obtaining land for the plant operated by the MEC Pvt Ltd and in turn the company was responsible for recycling waste and improving urban environment (Fig. 6). The Public Health Department was active in raising public awareness on hygiene and public health issues and thus helped also in the promotion of waste segregation in source points. Community Development officers of the Department visited every household in the municipality at least once per month and communicated about the benefits of waste separation for improving environmental health and reducing dengue risks. Technical support to establish and run the composting facility was provided by the experts of Waste Concern (Bangladesh).

Figure 6: Partnership arrangements for RRR



Source: Storey et al. (2013)

Demand for compost derived from organic waste is important for successful performance of composting facilities (Bekchanov and Mirzabaev 2018). Quality of the compost, marketing the product, prices of the substitute goods such as chemical fertilizer are main factors influencing the demand for compost. Since the visibility of the effects of compost application on crop growth takes much longer time than seeing the results from chemical fertilizer application large-scale commercial farmers may prefer the application of chemical fertilizers rather than compost (CEA, private communication, 08.08.2016). The bulky mass of compost also increase its transportation, implementation and thus labor costs making it less attractive compared to chemical fertilizers (Samarasinghe et al., 2015). As the results of the surveys across Sri Lanka indicated majority of the farmers also consider that the price for compost is higher than its real worth in farming (CEA, private communication, 08.08.2016). Meantime, chemical fertilizers were supplied at artificially reduced prices through government subsidies over decades which substantially reduced the marketability of the composts (Wickramasinghe et al., 2010). When chemical fertilizers were heavily subsidized (up to 90%) it was not beneficial at all considering compost as a soil ameliorative. The elimination of the government support for chemical fertilizer uses or giving equal support to both chemical and organic fertilizers may improve the demand for compost.

6 Conclusions

Poor sanitation and improper disposal of wastewater and organic waste are main reasons behind heavy environmental pollution and increased health risks across South Asia. Introduction of RRR technologies are a promising option to prevent open dumping and thus stop environmental degradation and prevent health hazards but it may require substantial changes along the entire sanitation and waste value chains. Given the high rates of open defecation even in municipal areas of India, not only adequate establishment of proper sanitation systems such as improved toilets with pit latrines or septage tank but also educative programs to raise the awareness of people about the harmful health and pollution consequences of such behavior are of paramount importance.

In addition to the costs of such technologies their environmental effects and technical feasibility through the consideration of local conditions such as shallowness of groundwater table should be taken into account. Timely and affordable services for the collection of the septage and safe disposal or treatment of this waste are required to prevent overfilled and dysfunctional septage tanks and maintain safe and clean living environment. Availability of septage treatment plants in close location and affordability of empting waste into these sites are important for preventing illegal dumping of septage into sewerage network or adjacent water bodies. Municipal waste management should be improved in all countries while aiming at minimizing the environmental pollution effects of open dumping in all countries studied. Separation of solid waste at the source would largely reduce the costs of transportation, screening and system maintenance. Recycling organic waste into nutrients or energy could provide additional value added. The amount of waste to be converted into nutrients or energy should be determined based on the availability, demand and prices of the alternative commodities such as chemical fertilizers, electricity and LPG. Considering interconnectedness of all processes along the sanitation and waste management value chains, a proper planning and integrated management in the system is essential for a proper functioning and successful performance of sanitation services and RRR enterprises.

Availability of lands and easiness of taking permission to use this land for constructing RRR facilities are important factors for modernization in the sanitation and waste management sectors. Improved institutional framework and governance by formulating proper policies for reducing illegal open dumping and fining such behavior as well as restricting waste disposal into landfills may create incentives for wider implementation of the RRR technologies. Centralization or decentralization of wastewater treatments depend on local conditions and financial affordability. Because of low income levels in South Asia cheaper sanitation facilities and septage and wastewater treatment options are recommendable. Participation of the private sector in constructing sanitation systems or recycling facilities, collecting and treating the waste should be supported. Given the unaccounted environmental and health benefits (positive externalities) but high capital intensity of improved sanitation and RRR business, adequate subsidies from public funds should be allocated for supporting RRR activities. To improve the marketability of the recovered materials such as compost or CNG, the quality of such products should be ensured through establishing a trustful certification system. Monitoring the proper functioning of the private companies in the sanitation value chain should be conducted to prevent the pollution due to unsafe disposal or treatment of wastewater and sludge. Enforcement of laws on environmental security and substantial fines for misconduct are important for achieving environmental sustainability goals through improved sanitation and waste treatment. Educational programs and awareness raising campaigns are important for improving knowledge of people and government officials on environmental well-being and increasing social acceptability of improved sanitation facilities and RRR products.

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Authors: Maksud Bekchanov, Pablo Evia, Mohammad Monirul Hasan, Narayan Adhikari, Daphne Gondhalekar

Contacts: mbekchan@uni-bonn.de, pabloevia@gmail.com, monir1021@gmail.com, narayan.adhikari@aepc.gov.np, d.gondhalekar@tum.de

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