A strengths, weaknesses, opportunities, and threats analysis on integrating safe water supply and sustainable sanitation systems

Sayed Mohammad Nazim Uddin, Zifu Li, Heinz-Peter Mang, Elisabeth-Maria Huba and Jean Lapegue

ABSTRACT

This paper applies a 'comprehensive' strengths, weaknesses, opportunities, and threats (SWOT) analysis to compare the 'before and after' scenarios of integrating a safe water supply (SWS) into a sustainable sanitation system (SSS) in the peri-urban Ger areas of Ulaanbaatar. Qualitative field investigations, including interviews and focus group discussions, are conducted with stakeholders and key informants to collect data on the scenarios before the SSS and to develop a conceptual framework after the SSS implementation. The before-implementation scenario has one strength, that is, the interest of communities and NGOs toward the SWS–SSS integration, which facilitates the acceptance and up-scaling of sustainable technologies. The after-implementation scenario shows additional strengths, such as community acceptance and satisfaction with SSS. The identified weaknesses are attributed to the lack of community-based organizations, community participation, and inter-sector coordination. The marketing of SSS, the involvement of banks and micro-credit systems, and the reuse of treated greywater have been identified as opportunities. The before-implementation scenario identifies the use of pit latrines and the lack of political will as the primary threats, whereas the after-implementation scenario identifies technology innovations for the extreme cold as a primary threat. The application of the SWS–SSS integration in other cases must be investigated further.

Key words | integration, safe water supply, sustainable sanitation system, SWOT, urban development, WASH

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INTRODUCTION

The research, development, and implementation of sustainable sanitation systems (SSS) involve several concepts, such as complete sanitation, ecological sanitation, environmental sanitation, and resource-reuse-oriented sanitation (Langergraber & Muellegger 2005; Schertenleib 2005; Nelson & Murray 2008; Zurbrugg & Tilley 2009). SSS is a holistic approach that combines an efficient safe water supply (SWS) with improved sanitation techniques to recover nutrient and energy resources, reuse treated greywater, improve health conditions, and protect the environment. Improved sanitation plays a key role in ensuring public health and access to safe drinking water (Fry *et al.* 2008). SuSanA (2013) defined sustainable sanitation 'as a system which protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable, a sanitation system has to be economically viable, socially acceptable, technically and institutionally appropriate, it should also protect the environment and the natural resources' (www.susana.org). Safe drinking water has microbial, chemical, and physical characteristics that satisfy the WHO guidelines or national standards on drinking water quality (WHO

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2014). Although the target of drinking water supply met the Millennium Development Goals (MDGs) in 2010 (WHO 2012), the quality should be maintained and monitored to improve the health and environment conditions in the world (e.g., Uddin *et al.* 2013a). Esrey *et al.* (1991) investigated the improvements in water supply and sanitation, particularly on human excreta disposal, water quality, and personal and domestic hygiene, which can reduce the occurrence of waterborne diseases. Therefore, the integration of SWS into sanitation and hygienic practices in both low- and high-income countries may reduce waterborne diseases such as diarrhea, which is currently the second leading cause of child mortality in the world (two billion cases with 1.5 million child deaths each year).

Most low-income countries will be unable to satisfy the MDG sanitation target of halving the number of people without access to adequate sanitation by 2015 (Zurbrugg & Tilley 2009; WHO 2011). Sanitation coverage is expected to reach 67% in 2015, with 580 million people still lacking access to adequate sanitation (WHO 2012). Guzha *et al.* (2005) recommended that the ecological/sustainable sanitation concept and the reuse of human excreta, both feces and urine, should be implemented in catchment areas as alternative excreta management options, which could prevent the watershed from diffusing pollution to some extent. Although conventional systems can restore resources, these technologies are very expensive and anti-poor (Patersan *et al.* 2007). Therefore, less expensive processes, such as biogas production and composting of human and organic wastes, are recommended to recover a considerable amount of nutrients for agricultural use.

The current study is performed in the Mongolian People's Republic, which has approximately 3.2 million residents (CIA 2013). The continuous influx of rural migrants into the capital city of Ulaanbaatar, which has a population of more than one million, has resulted in numerous environmental, health, and socioeconomic problems (Altansukh 2008; ADB 2010; Batjargal *et al.* 2010; Itoh *et al.* 2011; Nriagu *et al.* 2012). Mongolia is 'on track' and 'off track' in satisfying the drinking water and sanitation targets of MDG, respectively (UNICEF & WHO 2012). The safety and quality of drinking water in the peri-urban areas of Ulaanbaatar is not monitored at the household level (Uddin *et al.* 2013a). Moreover, the health and environmental situation in the Ger areas needs to be improved.

The current study performs a strength, weakness, opportunities, and threats (SWOT) analysis to compare the 'before and after' scenarios of SWS–SSS integration in the peri-urban Ger areas (informal settlements) of Ulaanbaatar. Such integration can be replicated in other low- and middle-income regions to improve their health and environment conditions as well as to recover their resources.

METHODOLOGY

This study has been conducted as part of an ongoing PhD research project in Ulaanbaatar that is jointly performed by the University of Science and Technology Beijing (USTB) and Action Contre la Faim (ACF) International, which has likewise funded the study. The peri-urban Ger area of Ulaanbaatar (Figure 1) was investigated in 2012. This informal settlement houses 60% of the city's population, which continues to increase every year (Sigel *et al.* 2012).

This study applies SWOT as a research tool, which presents several applications in business (Hill & Westbrook 1997), environmental management (Nikolaou & Evangelinos 2010), solid waste management (Srivastava *et al.* 2005), and energy planning and sustainable energy development studies (Terrados *et al.* 2007; Markovska *et al.* 2009). However, SWOT has never been applied in water, sanitation, and hygiene (WASH) studies.

The WASH-related scenarios in Ulaanbaatar are investigated through qualitative field investigations, such as transect walk, focus group discussions (FGDs), and semi-structured interviews with community members and stakeholders. A conceptual framework has been developed for the SSS–SWS integration scenario based on the findings from the existing literature, discussions, and expert interviews.

Five transect walks are performed with the help of key informants and local staff members from ACF Mongolia to observe, listen, learn, and familiarize the Ger area, as well as to identify the problems, conditions, and structure of the settlements. The existing practices and technologies in these areas (i.e., types of toilets, greywater discharge systems, and hygiene scenarios) are addressed and noted during the transect walk for the SWOT analysis.

Fifteen semi-structured key informant interviews are performed with community members, sector stakeholders,

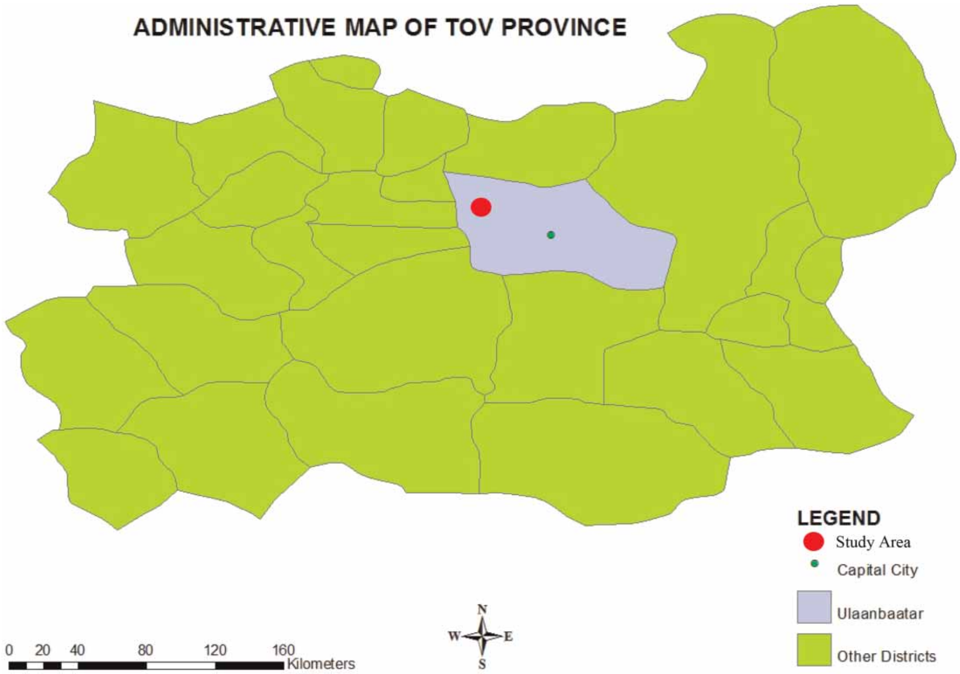

Figure 1 | Map of the study area.

government officials, university teachers, and community-based organizations (CBOs). WASH-related questions are asked during the interviews. The interviews are likewise audio/video recorded by the authors to facilitate the SWOT analysis. The recorded interviews are repeatedly checked to validate the gathered and analyzed interview data.

Ten stakeholders are interviewed, and six members of CBOs have participated in an FGD during the ACF WASH conference in Ulaanbaatar. Another FGD is performed during the International Conference on Water Research in Singapore in January 2013 to obtain supplementary views/opinions. Questions on WASH and SWS–SSS integration are asked during these sessions. Mongolian translators are likewise present during these sessions.

SWOT ANALYSIS RESULTS

Table 1 shows the SWOT analysis results of the data from the semi-structured interviews and FGDs. SWOT is applied to categorize the results into different components and develop comparative scenarios of the SWS–SSS integration.

DISCUSSION

Strengths

Several organizations, such as ACF, UNICEF, World Bank, Xac Bank, and World Vision, work directly and indirectly with the WASH sector of Mongolia (see World Bank 2010). These organizations work at different levels, such as communities and schools, in the rural, peri-urban, and urban areas of Ulaanbaatar. Although insufficient in the Ger area context, the WASH interventions of these organizations can encourage future collaborations and plans for SWS–SSS integration. The presence of NGOs, including their local partners, as well as their strong interests toward WASH may result in the future acceptance and up-scaling of SWS and SSS technological interventions that can improve the overall health and environmental conditions in Mongolia. The strengths before the integration, such as the community interest toward SWS and SSS technological interventions, must be considered in the future designing and planning of various programs for encouraging active community participation. More than 500 water kiosks have been established in Mongolia where Ger residents

Table 1 | Comparative scenarios of SWOT before and after SSS–SWS integration

Before integration	After integration
Strengths	
• Organizational interests	• Strong institutional support mechanism, network, and effective communication system
• Existence of many local and national NGOs	• Catalyze organizational interests and build their capacity
• WASH programs/interventions of different organizations at the community and school levels across the country	• Effective inter-sector coordination among the stakeholders
• Community interest toward SSS	• Implementation of effective policies and regulations
	• Fair financial mechanism
	• Increased community interest and capacity
	• High awareness on WASH
	• Increased number of CBOs and enhanced community participation
	• Increased number of skilled people in the Mongolian WASH sector
	• Proper flow of WASH-related information
	• Improvement of health and environmental conditions
	• Technological innovation
Weaknesses	
• Weak institutional network	• Interest toward external funding
• Lack of organizational capacity in WASH	• Low income
• Lack of inter-sector coordination among the stakeholders	• Lack of infrastructural development
• Lack of skilled people in the Mongolian WASH sector	
• Lack of WASH-related information	
• Limited awareness on WASH at the community level	
• Few CBOs	
• Limited community participation	
• Few community initiatives	
• Low income	
• Limited community capacity	
• Interest toward external funding	
• Lack of financial contribution from the government	
• Lack of services for emptying human feces	
• Lack of policies in the greater WASH sector	
• Poor maintenance of existing technologies	
• Low technological innovation	
• Absence of a greywater drainage system	
Opportunities	
• Training and education	• Establishment of resource centers
• Establishment of resource centers	• Community mobilization and formation of youth groups
• Creation of employment opportunities	• Development of micro-businesses that are related to water kiosks, human feces composting, and greywater treatment and reuse for the generation of employment opportunities
	• Development of effective sanitation marketing

(*Continued*)

Table 1 | Continued

Before integration	After integration
	• Involvement of micro-credit organizations in the WASH sector • Development of a human feces emptying service for employment opportunities • Application of integrated approaches in the WASH sector • Increased possibility of reducing waterborne diseases • Nutrient recovery and bio-energy production • Composting of human feces in home gardening as well as in greening of cities and horticultural lands
Threats	
• Unhygienic pit latrines • Unfavorable climate (extreme cold) • Rural migration and urbanization • Limited government support in terms of policy making, financial contribution, and political willingness • Nomadic mentality, habits, attitudes, and lifestyles of residents • Proliferation of waterborne diseases	• Unfavorable climate (extreme cold) • Rural migration and urbanization • Unhygienic pit latrines

collect their water for drinking and other purposes (World Bank 2010). However, the FGD data show that the quality of water from these kiosks, particularly the water storage, collection, transportation, and purification, is neither guaranteed nor monitored. Most Ger residents use second-hand and hazardous materials, such as plastic containers, to collect and transport water from the kiosks and to store them in their households. The traditional sanitation facilities, such as pit latrines and soak pits, may increase the vulnerability of the Ger area residents to WASH-borne diseases (Uddin *et al.* 2013a).

The conceptual scenario after SSS–SWS integration shows several strengths (Figure 2). For instance, the strong institutional network and effective coordination system for WASH intervention can enhance the capacity of organizations and communities for improving their awareness and participation in WASH-related initiatives by establishing a proper flow of WASH-related information. Moreover, the availability of training and education initiatives may increase the number of skilled workers in the Mongolian WASH sector. The establishment of a WASH information center can strengthen WASH-related research and development activities. Uddin *et al.* (2012) reported that CBOs could motivate and educate people toward accepting and up-scaling sustainable sanitation technologies. They likewise identified the 'Tolgit' CBO as a key player in the sanitation of the Ger areas in Ulaanbaatar. The establishment of additional CBOs can help plan, design, and implement overall WASH-related activities in communities through the 'bottom up' approach.

Weaknesses

Several weaknesses, such as the weak institutional network, the absence of coordination, and the lack of WASH-related policies, have been identified in Mongolia. The weak legal and institutional frameworks have been considered as obstacles in the implementation and up-scaling of sanitation technologies, especially for ecological sanitation, in several countries (Stintzing 2007). No WASH-related policies have been implemented in Mongolia despite the immense potential of the country to incorporate or develop SWS- or SSS-related policies. Low income has likewise been identified as a weakness in the traditional sanitation system. The sanitary condition has been rated as 'poor' for more than a century, which concerns all community members including the poor (Welch 1893). Therefore, the weakness

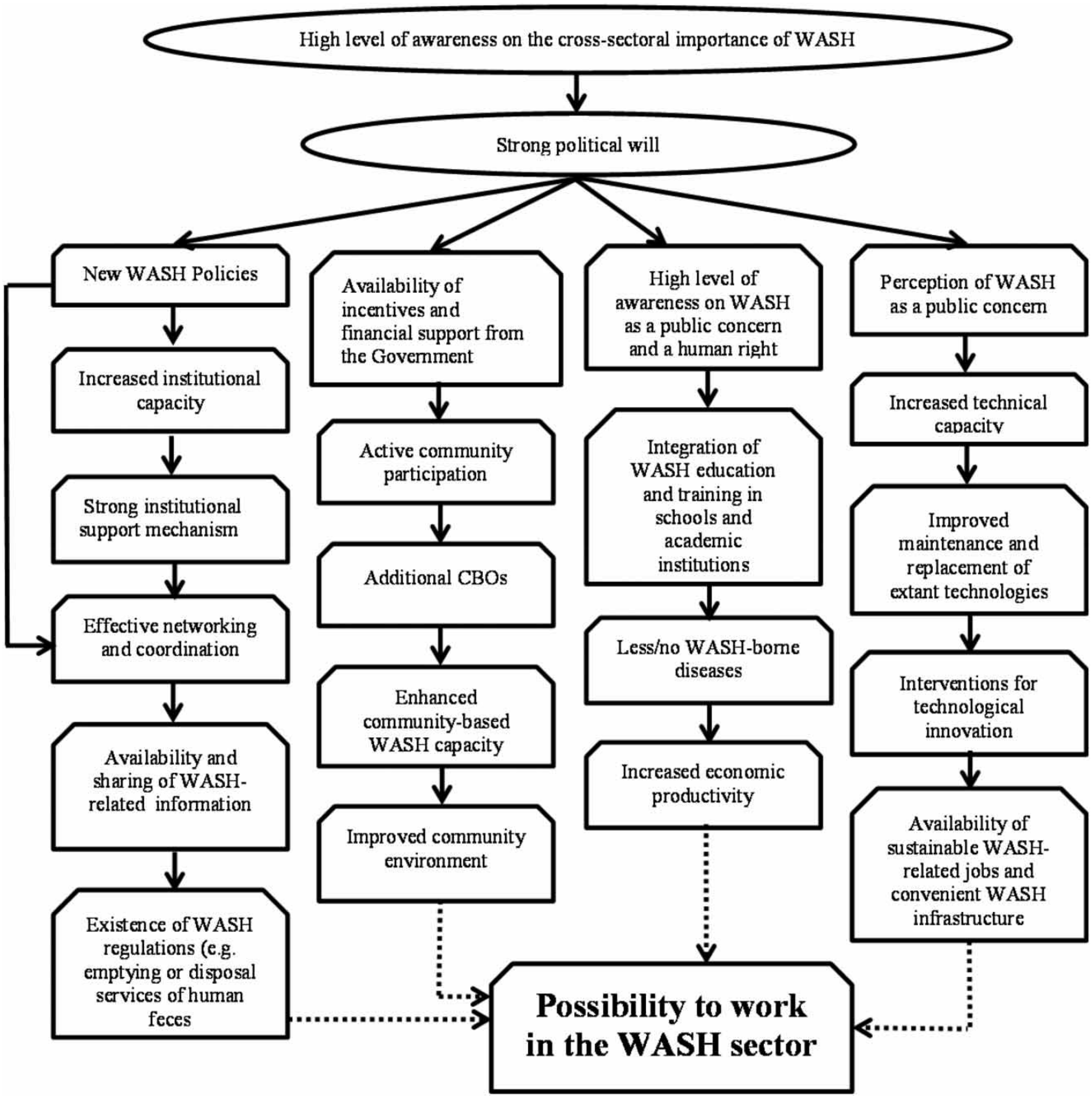

Figure 2 | Combined WASH-borne strength after SSS–SWS integration.

of the entire system negatively affects the entire society including the study area. The lack of awareness on the cross-sectoral importance of WASH and on political will has been identified as a major cause of the weaknesses in the existing system (Figure 3).

Mongolia lacks a department or a ministry that can organize or formulate WASH-related activities and policies. The Ministry of Nature, Environment, and Green Development is responsible for increasing the water resources in Mongolia. Some WASH-related construction projects in the country are being handled by the Ministry of Construction and Urban Development. However, government departments and stakeholders in Mongolia do not coordinate with one another for the proper planning of policies and activities, which has been a long-standing issue in other low-income countries (Koudstaal *et al*. 1992; Solo *et al*. 1993; Allen *et al*. 2006). The WASH sector of Mongolia likewise lacks qualified and skilled workers, which has been identified as a major weakness (McGarry 1980). The weaknesses in the after SSS–SWS integration scenario include

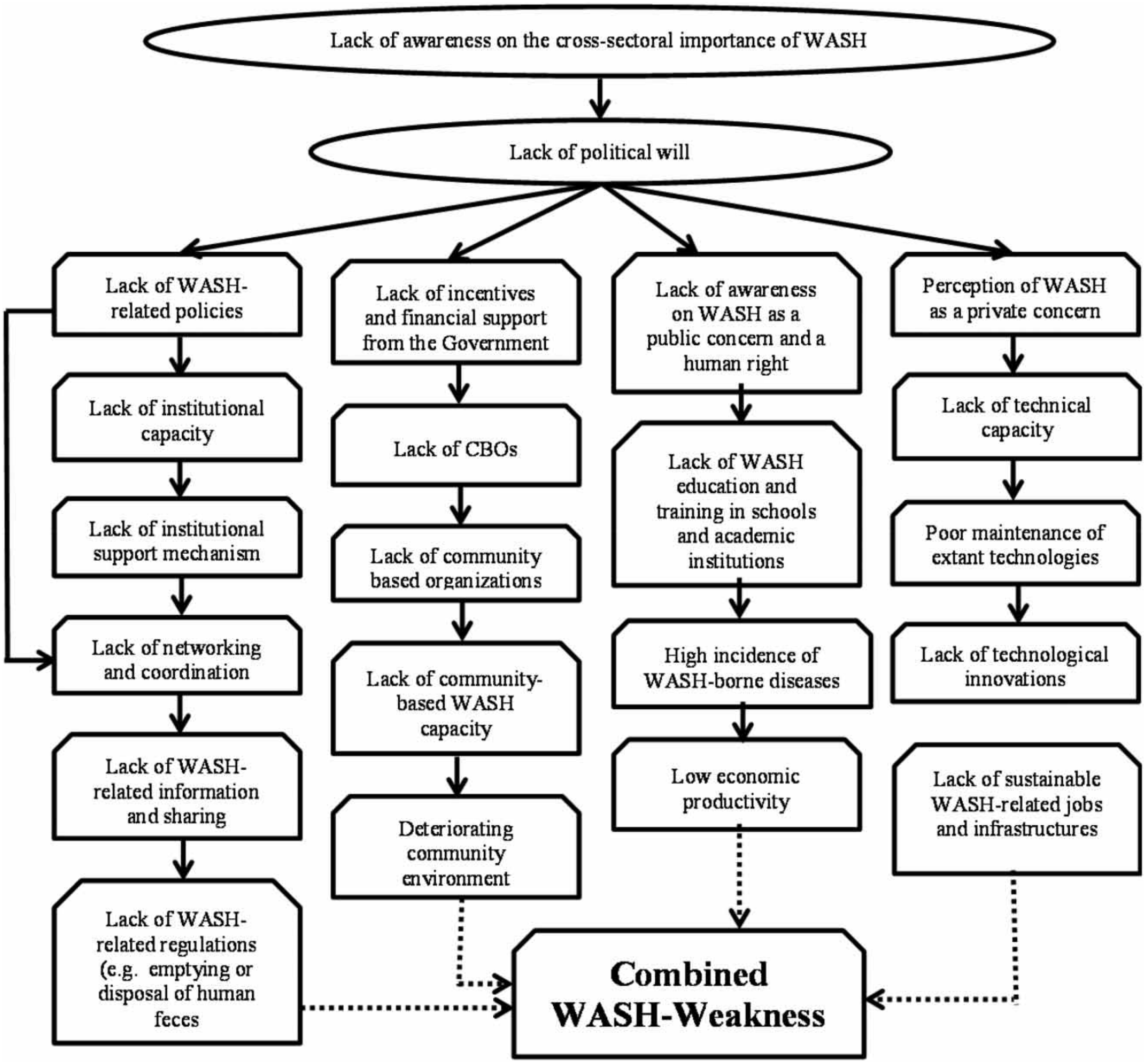

Figure 3 | Root and underlying causes of WASH-borne weaknesses.

interest toward external funding, low income, and lack of infrastructures. Community funds must be collected considering the expensiveness of monitoring and maintaining SSS. The lack of subsidies and external funds may hinder the proper and effective maintenance of the system, which may be overcome by the proper planning and active involvement of government agencies and other stakeholders in WASH-related initiatives.

Opportunities

No opportunities are found under the current and traditional sanitation systems. However, several opportunities may be created, such as WASH-related jobs, interventions, education, awareness, and material development, before the SSS–SWS integration.

The opportunities in the after SSS–SWS integration scenario include the establishment of the WASH Resource Center, which will be used as a source of information for various WASH actors inside and outside of Mongolia. A range of employment opportunities and business options can be created from the implementation, operation, and maintenance of SSS components, such as the development of multi-service water kiosks and the production of bioenergy and compost from human feces. The composting of human feces may recover valuable nutrients for plants and humans, which will create business and marketing opportunities. Household greywater treatment and reuse can be considered as another business option for solving the water shortage problem in the Ger areas of Ulaanbaatar. Effective sanitation marketing may be implemented in the WASH sector of Mongolia, such as the development of an emptying service system for urine-diverting toilets, the composting and application of human feces from these toilets, the application of sanitized urine in agricultural lands, the recovery of nutrients through other processes, and the production of bio-energy. The compost that is produced from human feces and treated greywater can be used in home gardening, which is a common interest among the residents of Ger areas. The compost can likewise be applied for greening cities and other horticultural lands. Figure 4 shows the proposed mechanism of the SWS–SSS integration in which a high concentration (e.g., chemical oxygen demand) of greywater can be treated and reused to prevent health and environmental hazards and solve the water scarcity problem in the area to some extent. Human feces can be treated through composting within the closed-loop sanitation system to prove the feasibility of the system, prevent the proliferation of WASH-borne diseases, and recover resources (Uddin *et al.* 2013a, 2013b). Water kiosks, particularly multi-service water kiosks, can be integrated within the SSS to prevent potential contaminations that are caused by unplanned greywater discharge and by unimproved sanitation technologies.

Threats

The existing pit latrines in the Ger areas of Ulaanbaatar have been identified as threats to the SSS–SWS integration. The lack of a drainage system in the Ger areas prompts the residents to use pit latrines or soak pits to drain greywater, which causes flooding in the roads as well as in and out of households. The threats before SSS–SWS integration include the extreme cold climate, the existence of non-environmental-friendly technologies (i.e., pit latrines), and the lack of political willingness (Table 2), whereas the threats after SSS–SWS integration include the extreme cold climate, the urbanization and migration, and the existing pit latrines. The improvement and proper integration of SWS into SSS may solve the threat of the extreme cold weather.

Several studies have identified many challenges, particularly in low-income countries, in improving the global water supply and sanitation condition (Bhagwan *et al.* 2008; Tornqvist *et al.* 2008; Whittington *et al.* 2009; Roma & Jeffrey 2010; Kathy 2011). Several drawbacks and threats are caused by the traditional sanitation concepts and the implementation of technologies that are hazardous to the environment and to the health of people (Esrey *et al.* 2001; Werner *et al.* 2004). The water supply and sanitation conditions in Mongolia have been identified as among the most pressing problems in the Ger areas (Sigel *et al.* 2012) where residents rely on simple, unimproved pit latrines to solve their sanitation problems. Approximately 80,000 pit latrines are constructed in the Ger areas of Ulaanbaatar for this purpose (GTZ 2008; Girard 2009). The unhygienic sanitation technology and unsafe water supply in these areas may increase the prevalence of waterborne diseases (Sigel *et al.* 2012; Uddin *et al.* 2013a), which can only be decreased by the proper management of human feces and guaranteeing a safe drinking water supply (Esrey *et al.* 1991). These objectives can be fulfilled by the SWS–SSS integration, which can reduce the vulnerability of Ger residents to WASH-borne diseases.

CONCLUSION

The scenario before SSS–SWS integration demonstrates few strengths, such as the interest of communities and NGOs toward SWS and SSS, which facilitates the acceptance and up-scaling of related technologies. The conceptual scenario after SSS–SWS integration, which has been constructed based on the previous literature and stakeholder interview data, demonstrates additional strengths, such as community acceptance, satisfaction with SSS, and development of SWS for a vulnerable population. The identified weaknesses are attributed to the lack of CBOs, community participation, policies in the WASH sector, and inter-sector coordination. The marketing of SSS, the involvement of banks and micro-credit systems, the reuse of treated greywater as a source of plant nutrient, and the strengthened inter-sector coordination have all been identified as opportunities from the integration. The threats before the SSS–SWS integration include the

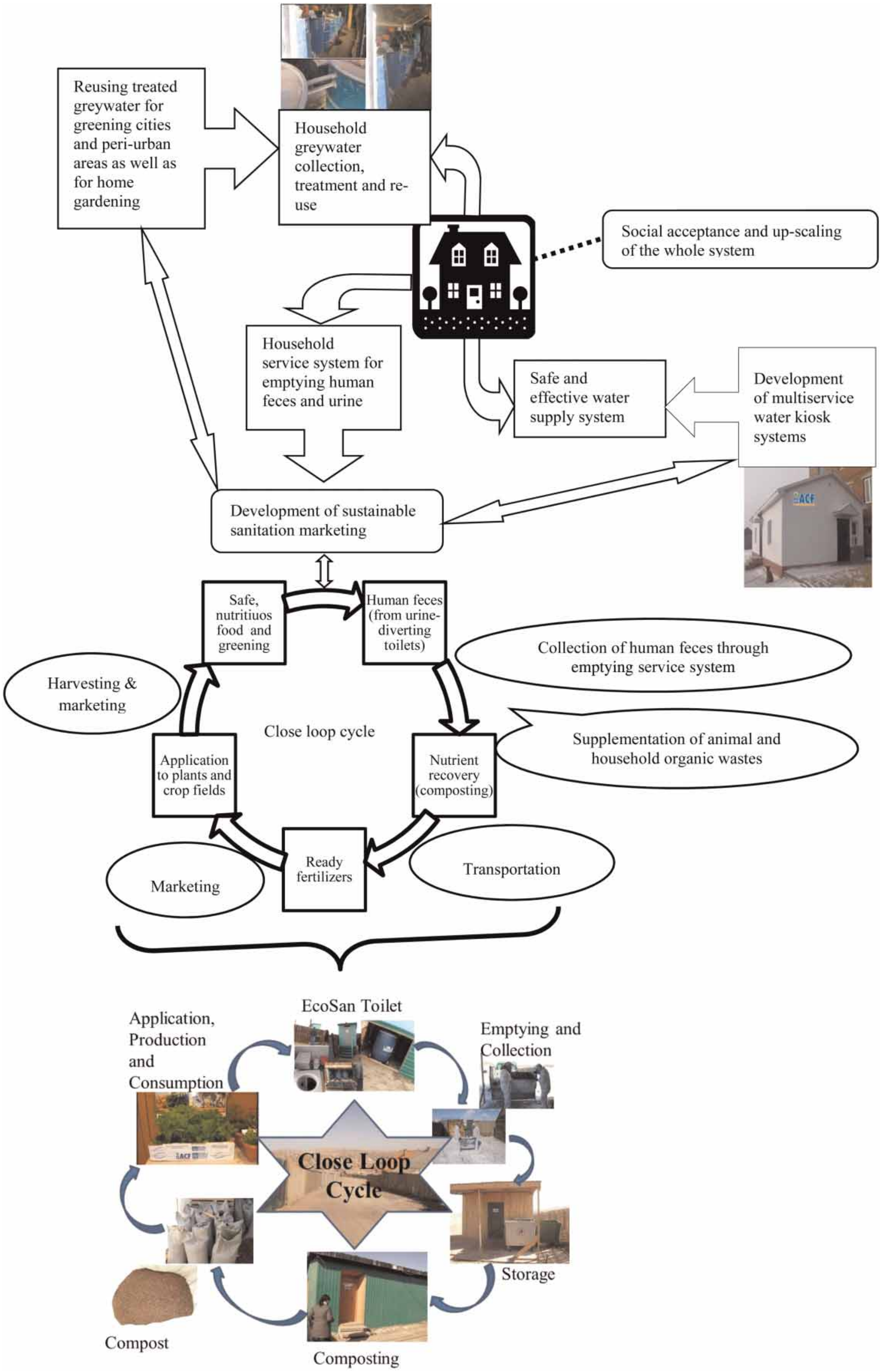

Figure 4 | SWS–SSS integration.

Table 2 | Threats before the SSS–SWS integration and their possible solutions

Factors	Threats before integration	Possible solutions
Technological	The existing unhygienic pit latrines and unsafe water supply systems, including water transportation, collection, and storage (GTZ 2008; Girard 2009; Sigel *et al.* 2012), may threaten the health of Ger area residents. The lack of a drainage system in these areas prompts the residents to drain their greywater through pit latrines, soak pits, and yards, which may cause health hazards or environmental problems	Technology innovation and sustainable sanitation technologies, such as urine-diverting toilets and household greywater treatment systems, may reduce these threats (Jenssen *et al.* 2005). The proper monitoring of water transportation, collection, and storage systems may ensure SWS. The extreme cold weather can be handled by the improved sustainable sanitation technologies (Stintzing 2007)
Political	Mongolia remains 'off track' in satisfying the sanitation MDGs (UNICEF & WHO 2012). The government lacks the willingness and interest toward implementing policies that can improve the sanitary conditions of the country, including those of the Ger areas	The proper SWS–SSS integration may motivate political leaders to formulate WASH-related policies (McGarry 1980)
Financial	The lack of financial support from the government to endorse technological innovations and improve the overall sanitary condition of the Ger areas	The success and benefits of the SWS–SSS integration may encourage the government to lend financial support as well as to involve themselves in future sustainable sanitation-related activities
Social	Despite the high demand, sustainable sanitation technologies have a low social acceptability because of the lifestyle, attitude, and nomadic mentality of the Ger area residents. Moreover, the unplanned rural migration into the peri-urban Ger areas of Ulaanbaatar threatens the effective SWS–SSS integration	SWS/SSS awareness and education may change the behavior and attitude of the Ger area residents, which may increase their social acceptance of sustainable sanitation technologies (Uddin *et al.* 2012). Sustainable and resource-oriented sanitation may contribute to the Eco-City development of peri-urban Ger areas where migrants may stay with proper planning
Health	A higher prevalence rate of waterborne diseases is observed among the Ger area residents. The children are especially prone to these diseases. Approximately 10,000 cases of diarrhea are recorded in Mongolia every year, which is the most prevalent disease followed by dysentery. The prevalence rate of hepatitis A in Ulaanbaatar is seven times greater than the international average (GIZ 2008; Uddin *et al.* 2013a). The health hazards in Ulaanbaatar may be attributed to the lack of SWS–SSS integration	The holistic/comprehensive sustainable sanitation approach can dramatically reduce the waterborne diseases in the study area and beyond (Uddin *et al.* 2012). The improved waste management, water supply and sanitation, awareness (through education and literacy), and proper drainage system can be included in the integration process to overcome these threats

extreme cold, the use of pit latrines, and the lack of political will, whereas the threats after the SSS–SWS integration include the technological innovations that deal with the extreme cold, the demand for SSS technologies, and the increased interest of central and municipal governments. The application of the SWS–SSS integration in other cases must be investigated further.

The findings support the integration of SWS into SSS to decrease the prevalence of waterborne diseases that are caused and transmitted by fecal-contaminated water to improve the overall environmental condition in Ulaanbaatar. Such integration can likewise reduce water consumption, recover resources (i.e., plant nutrients), and improve soil conditioners to fulfill future nutrient demands. Moreover, the integration can reduce the weaknesses and threats of the existing system and convert them into sustainable strengths and opportunities. The financial sources and cost recovery of the SWS–SSS integration must be explored further to lift the burden of the poor residing in the study area and in other parts of the world.

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