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Options for Ecological Sanitation in the Artisan Fishing or Blue-Green Economy Sustainable Development with Off-shore Blue-Green Carbon Sequestration

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Authors' Note

This report is submitted to the Toilet Without Borders (TWB) Sweden as an initial concept paper for expanding or extending TWB Sweden's project conceptual assistance to Non-Government Organizations (NGOs) working as partners to the Ecological Sanitation Program to meet the Millennium Development Goals (MDGs). This report presents literature with relevance to decision-making process and financial support to both hardware and software components of the ECOSAN. The report ensures that important feasibility and sustainability points are well articulated in each section to illuminate interconnected sanitation finance issues in the Post-2015 Sustainable Development. The Post-2015 Sustainable Development targets sustainability of the MDGs in climate change vulnerable areas such as the Small Developing Island States (SDIs) or Islands in the Pacific Region. The financing mechanisms for the Post-2015 Sustainable Development are heavily focused on internal finance resource mobilization of the developing countries. Thus, Ecological Sanitation (EcoSan) and its interconnectedness with agricultural productivity may have huge role in helping small developing island coastal communities (Blue-Green Economy-UNEP) find alternative income generating activities other than seasonal artisan fishing that may become even worst in climate change.

This report is organized by the following sections:

1. Introduction
2. Summary of cases published in several reports
3. Public relations strategies and proposed action plans
4. Monetary valuation in wastewater using costs of detergents as proxy to human wastes
5. Conclusion and recommendation

" Given that long-term disposal options are limited and will constrain sustainable development, small island developing states will need to look for ways of minimizing and/or converting wastes such as sewage, into a resource (e.g. fertilizer for agriculture)."

Dave Rapaport
Vermont Public Interest Research Group

1. Introduction

The outcome of the Rio+20 Conference on Sustainable Development initiated an inclusive intergovernmental process to prepare a set of sustainable development goals (SDGs) as one global development agenda for the post-2015 period (UNESC 2014). The conference noted that Sustainable Development Goals (SDGs), green economy and the institutional framework for sustainable development were important elements of progress (ECOSOC 2012). The Post-2015 agenda includes enabling environment to support the new goals and noted that some of the previous MDGs were "too narrow" and need to be re-examined, national goals should be determined nationally, in line with global principles and goals, macroeconomic, political (democratic rights and participation) and social policies, as well as a supportive international environment (internally driven development, technology transfer, aid and labour mobility) and stronger global governance (regulation of trade and finance)(Ibid). It was emphasized that concrete, quantifiable, time-bound goals, which could be communicated in a clear and straightforward manner, must be the focus of the post-2015 UN development agenda (Ibid).

The Millennium Development Goal 7 "Ensure environmental sustainability" only includes climate change as indicator in greenhouse gas emissions. The Catholic Agency For Overseas Development (CAFOD), World Wildlife Fund for Nature (WWF) with the support of Climate Action Network-International (CANI) support the options for including more issues on climate change in the post-2015 framework (Garthwaite and Fischler 2013). The workshop sees that climate change is a clear barrier to the objective of the post-2015 process to develop a sustainable development framework with the immediate imperative of eradicating poverty (Ibid). The United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COPs) included economic, social and environmental elements of the climate issues under the UNFCCC mitigation, adaptation, technology development and transfer, and finance pillars (Ibid). There are relevant points raised in the conference and these so far are necessary to support the coverage expansion of the Ecological Sanitation. The following objectives were directly quoted from the report of Garthaite and Fischler in 2013. These are:

1. Building a low-carbon society by developing low carbon strategies in both developed and developing countries in the context of sustainable development.

2. Reducing the inequalities of climate change and building capacity to deal with climate change:
   a) by reducing the disproportionate impacts of climate change, or climate change policies, on vulnerable groups

   b) by acceleration of financial flows, technology transfer, and/or climate awareness.

A. Building a low-carbon society by developing low carbon strategies in both developed and developing countries in the context of sustainable development.

Global climate change is considered one of the most urgent environmental problems in relation to its negative impact on all of Earth's spheres (lithosphere, hydrosphere, atmosphere and biosphere) by the emissions of heat-trapping gases or greenhouse gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) that are directly or indirectly caused by burning of non-renewable resources (carbon bound in mineral oil or coal) (FAO website, viewed 2014). This environmental condition may have effects on tropical rainforests that hold the biggest living biomass on very delicate soils and may lose their fertility completely when clear cutting is performed in recent decades (Ibid).

Nitrogen and climate change. Aside from deforestation or clearing of forests, agriculture and the agricultural intensification were found to contribute to over 20 percent of global anthropogenic greenhouse gas emissions (OECD

2011 as cited in FAO website, viewed 2014). The doubling of production during the last 35 years was associated with a 6.9 fold increase in nitrogen fertilization, 3.5 fold increases in phosphorus fertilization and a 1.7 fold increase in irrigated land (Ibid). Agriculture is believed to account for roughly two-thirds of the total man-made CH_4 mainly from paddy rice fields, burning of biomass and ruminants (enteric fermentation and animal waste treatment) meanwhile aerobic agricultural soils are considered sinks for atmospheric CH_4 (Watson 1996 as cited in FAO, viewed 2014). Fertilization with mineral nitrogen has been shown to inhibit CH_4-oxidation in soils and the lower N-fertilization level in organic agriculture may therefore exhibit an advantage for CH_4 oxidation (ibid). Scientists connect the rapidly increasing rates of global warming with increases in nitrous oxide production (Ibid). Henceforth, global warming has resulted in rising sea levels, extreme weather changes, hurricanes, and swift-changing precipitation patterns (Ibid).

Nitrogen is also lost from soil systems through leaching and surface runoff carrying dissolved nutrients or sediments. This can then enter surface water ecosystems, contributing to eutrophication. Furthermore, some soils also to consume N2O, but the global sink in soils is unknown and perhaps very small (Stevenson and Cole 2001 as cited in Vu, Kim Khanh2007).

Soil as carbon storage. Soil stores carbon dioxide (CO2) and other GHGs in soil organic matter(SSSA website, viewed 2014). Soil organic matter offers several added benefits: it filters and cleans water, enhances water retention and storage, mitigates the impacts of extreme weather events, improves soil structure, reduces soil erosion, provides microbial habitats, and serves as a source of long-term, slow-release nutrients (Ibid). Strengthening soil structure and keeping water away from euthropication and contamination are climate change risks mitigation efforts to increase adaptability (SSSA website, viewed 2014). More importantly, organic agriculture can also be considered in climate change risk mitigation actions as it may counter erosion successfully as permanent soil cover is an intrinsic part the pedosphere system unlike the conventional agriculture in the tropics even flat soil gets eroded due to the use of herbicides and the lack of soil cover (Ibid).

According to the Society of Soil Science of America (SSSA) , the watershed, natural resource, and environmental sciences have shown that soil is the foundation of basic ecosystem function (SSSA website, viewed 2014) . Soil filters our water, provides habitat for billions of organisms, contributing to biodiversity; and supplies most of the antibiotics used to fight diseases, humans use soil as a holding facility for solid waste, filter for wastewater, basis of agroecosystems which provide us with feed, fiber, food and fuel, provides essential nutrients to our forests and crops, and helps regulate the Earth's temperature as well as many of the important greenhouse gases (SSSA website, viewed 2014).

Blue-green Carbon Sequestration System. This report identified only a few relevant aspects of green carbon and blue carbon sequestration in coastal areas of either big or small developing Islands. Regardless of size of the island, any areas that are archipelagic occupied by settlers or population are exposed to the risk of ecological destruction and biodiversity loss in coastal and marine ecosystem. Both the green carbon and blue carbon sequestration and sinks program should also include primarily the wastewater and ecological sanitation alternatives. One of the fastest escape route of carbon from the biosphere to the atmosphere is through the hydrological cycle especially when biochemical oxygen demand is highly required for decomposition.

Low carbon living strategies through EcoSan. Low carbon strategies can be developed by societies in the globe by protecting and enhancing both land and water as they perform storage functions for biogeochemical and nutrient cycles to continue. Carbon sink and sequestration are not exclusive to carbon dioxide rather they also keep chemical compounds bonding, ionization and other configurations in balance among carbon, oxygen, phosphorus, and nitrogen (SSSA website, viewed 2014).

Low carbon living is defined by this report as practices that may somehow include ecological sanitation and its alternatives. Recycling is one of the many components that characterized low carbon living. Clark (n.d.) remarked that biosolids like sewage sludge contains soil-enriching, plant-boosting elements found in expensive chemical fertilizers (nitrogen, phosphorus and potassium) applied to cereal and grain crops with occasional applications for forestry operations and land uses. Finnson (n.d.) also remarked that recycling human feaces and urine can make many benefits to plants as human wastes contain nutrients important to plants growth. Recycling human wastes can be done in many ways one of which is the sewage sludge, no-mix toilets, and the urine dehydration diversion toilets or EcoSan. Recycling wastes may come in many forms but the one that is more meaningful is recycling within one's spaces with healthy habits in generating and disposing wastes and create ecologically responsible culture leading to "low carbon living". Henceforth, low carbon living is a social and cultural forms of carbon sequestration and it can only developed by sturdy political and economic institutional system at the local level.

Ecological Sanitation. The new paradigm in sanitation named as EcoSan claims that sanitation systems are part of several cycles, of which the most important cycles are the pathogen-, water-, nutrient- and energy cycle (UNESCO-IHP, 2006).The WaterAid defines EcoSan as an environment friendly sustainable sanitation system which regards human waste as resource for agricultural purposes and food security in contrast to the linear waste management which views waste or excreta as something to be disposed (WaterAid). One purpose of an EcoSan system is to form a set of barriers between faeces and flies ,fields and fluids (Esrey et al, 1998).

Hoglund (2001) noted that the term *"Ecological Sanitation"* is not yet defined but the approach involves treating human excreta as a resource, sanitizing them and then recycling the nutrients contained in the excreta (Esrey et al 1998 as cited in Hoglund 2001). Ecosan is the "philosophy" concept for sustainable ecological sanitation in order to respect ecological integrity, conserves and protect freshwater, promote healthy living, as well as recycle nutrients from human excreta for agricultural production (Esrey et al, 1998). Ecosan represents a new basic understanding of wastewater handling in which faeces and urine are not considered as pollutants but instead as useful resources. In nature, there is no waste. All products of living things are used as raw materials by others as part of a cycle (Wang 2005). Accordingly, ecosan seeks to close the loop of nutrients cycle and conserve water (WaterAid). In natural system there is no waste: all the products of living things are used as raw materials by others. By flushing excreta down the toilet and turning them into sewage, we break this cycling of nutrients and create pollution problems. If instead mimic nature by turning what had been waste into valuable products, there will be no sewage of which to dispose (Rapaport 1997).

EcoSan Philosophy. EcoSan is an approach not to promote a certain technology, but rather a new philosophy of dealing with what has been regarded as wastewater in the past (GTZ Ecosan 2014). The systems of this approach are based on the systematic implementation of a material-flow-oriented recycling process as a holistic alternative to conventional solutions (Ibid). The EcoSan concept emphasizes the recovery of nutrients from the urine, faecal sludge grey water, and organic solid waste. The nutrients benefit local agriculture and, to a certain degree, substitute artificial fertilizer. Ideally EcoSan systems enable the complete recovery of all nutrients from faeces, urine and grey water to the benefit of agriculture and the minimization of water pollution (Idid b). Ideally, ecological sanitation systems enable the complete recovery of all nutrients from faeces, urine and grey water to the benefit of agriculture, and the minimization of water pollution, while at the same time ensuring that water is used economically and is reused to the greatest possible extent, particularly for irrigation purposes (Ibid).

Sanitation framework. UNESCO-IHP remarks that in order to ensure public health, sanitation approaches primarily aim at interrupting the life cycle of pathogens (UNESCO-IHP, 2006). Caution should be put into consideration in the overall framework of sustainable sanitation using ECOSAN as handling and reuse of all different types of waste products with human or animal origins involve hygiene risks (Hoglund 2001). Further, whether human excreta (faeces/urine) are reused directly diluted in wastewater (treated or untreated) that is reused, or are a constituent of sewage sludge used in agriculture, enteric pathogens will be present and able to cause infections by ingestion of the waste product or by consumption of crops that have been fertilized (Hoglund 2001).

EcoSan in Japan. The earliest history of human waste re-use was published in Saburo Matsui's study. According to him in direct quotations:

" Japan introduced the practice of reusing human faeces and urine for agriculture in about the 12th century, possibly influenced by Zen Buddhist monks who had stuclied in China. The Chinese reused human excreta in the very early stages oftheir civilization. Japan introduced various cultures and technologies from China from the 4th century AD, but the introduction of reuse of human excreta was later. There was a need to use human excreta for agriculture, because of human population pressures and food production demand. Nutrients added to agricultural fields greatly increased their productivity. China seemed to be the only civilization that positively used human excreta as nutrients for agriculture, and even food for pigs, from its very earliest development."

In 1954 the government enacted a new law of urban sanitation and the collection of municipal wastes (Public Cleansing Law), in which local authorities became responsible for collecting and treating nightsoil. Japanese civil engineers had to find a solution for the problem, studying western technology and inventing a new method (Matsui, 1997). Finally, a high-technology treatment for collected nightsoil was developed, e.g. introducing membrane filter technology to separate the activated sludge and treated water, allowing bacteria- and virus-free effluent from the treatment plant (Ibid). Nitrogen and phosphorus are biologically and chemically removed. Partial ozonation is applied for yellow color removal in the effluent (Ibid). However, salt cannot be removed from the effluent, so that dilution by groundwater is necessary to avoid affecting irrigation water, fish migration in streams, and drinking water sources (Ibid).

Public health and EcoSan. The Swedish International Development Agency (SIDA) is promoting ecological sanitation including the "don't mix" approach to human excreta (Esrey et al 1998 as cited in Hoglund 2001). Meanwhile, the World Health Organization (WHO) released Guidelines for Safe Use of Wastewater, Excreta and Greywater in 2006. Accordingly, the potential of using excreta in agriculture is recognized provided that multi-barriers are established to reduce the level of health risk at the minimum (Gensch, Miso and Itchon 2011). Multibarriers were identified as a) Source separation b) Storage and Treatment c) Application Technique d) Crop restriction e) Witholding period f) Protective equipment g) Handwashing with soap after urine handling h) Food handling and cooking i) Hygiene and promotion (Gensch, Miso and Itchon 2011). Hygienization and sanitation may refer to a treatment that reduces the number of microorganisms in a waste product to prevent negative impacts on humans and the environment (Herbst2000 as cited in Hoglund 2001). For source-separated urine the only sanitizing treatment that has been discussed is storage, a simple mean of controlling pathogen spread (Hoglund 2001). According to her, ecological sanitation in developing countries refers to a dry system where urine is diverted from the faeces.

Sanitation and sanitation system. According to Kvarnström et al (2004), "a sanitation system encompasses the users of the system, the collection, transport, treatment, and management of end products of human excreta, greywater, solid waste, industrial wastewater, and storm water." (Kvarnström, Bracken, Ysunza, Kärrman, Finnson, Saywell, 2004 p104). EcoSan is recognizing human excreta and water from households not as a waste but as a resource that could be made available for reuse, especially considering that human excreta and manure from husbandry play an essential role in building healthy soils and are providing valuable nutrients for plant (UNESCO-IHP, 2006). Human faeces are not an easy matter to handle properly as they contain many microbes that are hazardous to health. The simplest treatment for collected faeces is composting. However, this needs good quality control to prevent disease. The basic technology of composting is anaerobic bacteria processes to decompose organic material by non-harmful bacteria, controlling pathogenic bacteria in the process. EcoSan projects are more complex than conventional systems that may be needing familiarity in environmental management, or traditional knowledge of the processes and management of fecaes, urine that are intricately related to social and cultural values (WaterAid).

Winbald (2003) defined sanitation as reduction of pathogenic organisms and inorganic contaminations in waste streams by appropriate treatment (Winbald 2003). Faeces contain most of the pathogens in human excreta and are the main source for transmission of enteric infectious diseases and parasites (Winblad and Simpson-Hebert, 2004). The presence of faecal forms in water is called "Brown Water" and there are more than 120 different types of viruses may be excreted in faeces (Schönning and Stenström, 2004). In contrast to the conventional sanitation technologies that simply attempt to send what are considered unwanted wastes underground, or to bodies of water where we cannot see or predict their impacts (Rapaport 1997).

Sustainable Development and Ecosan. Sustainability of sanitation can only be achieved when it protects and promotes human health, hamper environmental degradation or depletion of the resource base, technically and economically viable and socially acceptable (Kvarnström, Bracken, Ysunza, Kärrman,Finnson, Saywell, 2004). Further Kvarnström et al (2004), identified key areas to sustainable sanitation. These are 1) Health, 2) Environment, 3) Economy, 4) Socio-culture, and 5) Technical Functions. These elements pertain to sustainable sanitation and protection people from infections. This is a part of primary health care or public health promotion. UNESCO-IHP paradigm encouraged educational institutions, universities, and technical schools to contribute to the mainstreaming of the new sanitation system--emphasis has to shift from the simple disposal to the hygienisation process of contaminated flow streams, and to resource conservation and safe reuse--by fully integrating the discourse and criteria for sustainability into their curricula and make clear criteria for sustainable sanitation while considering sanitation capacity building not as objects, but as partners for jointly developing sustainable sanitation solutions with the stakeholders (UNESCO-IHP, 2006).

B. Reducing the inequalities of climate change and building capacity to deal with climate change a) by reducing the disproportionate impacts of climate change or climate change policies, on vulnerable groups b) by acceleration of financial flows, technology transfer, and/or climate awareness.

In reference to the Capacity building for Ecological Sanitation (EcoSan) Concepts for ecologically sustainable sanitation in formal and continuing education of International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), sanitation system was viewed with paradigm shift in health and hygiene, solid waste and wastewater management, water resources management, natural resources management, environment, agriculture, urban planning, poverty reduction, food security, job creation, micro and macro economic development that overarched training of water- and environmental professionals and practitioners, briefs for policy makers particularly the Local Government Units (LGUs) and continued discourses on sanitation through research and case studies in particular (UNESCO-IHP, 2006). Matsui (1997) in his study on Nightsoil Collection and Treatment in Japan articulated that the policy of handling human excreta is also affected by other factors, such as water, the environment, religion, culture, technology (Matsui 1997).

B.1. EcoSan investment opportunities and policies

Establishment of eco-towns for eco-tourism. One of the most recent EcoSan investment oriented cases is the Erdos Eco-Town Project of Inner Mongolia where urban EcoSan system was viewed as a systematic engineering. The project was evaluated by economic measures to establish its economical efficiency, environmental protection, public utility and investors benefits or profitability (Lu, Jian and Yu 2007). The evaluation was conducted by the Environmental Science & Engineering Department of Tsinghua University and Stockholm Environment Institute (SEI) (Lu, Jian and Yu 2007). Accordingly, the EcoSan system project became an investment on pollutants and wastewater discharge controls. Investments on EcoSan are focused on sanitation processes such as dehydration or decomposition or a combination of both. The primary process aims to reduce the volume and weight of faecal material to facilitate storage, transport and further (secondary) treatment (Winblad, 2003). The purpose of secondary processing is to make human faeces safe enough to return to the soil (Winblad and Simpson-Hebert, 2004). The most important contribution of the study is its initial probe into the most suitable construction scale of the urban EcoSan system (source-separation system) converted to technical policy for massive construction of EcoSan systems in urban and town areas. Lu, Jian and Yu (2007) remarked that investment in Ecosan is higher than that of the conventional sanitary system after EcoSan system was scaled-up or broaden its coverage as conventional sanitary system appeared to be infeasible under an increasing population scenario.

Dan Wang (2005) conducted as study on the application of the EcoSan concept for integrated wastewater management at a new conference center and tourist resort in Kunshan, China with the support from the UNESCO-IHE Institute for Water Education. This case articulated the importance of integrated wastewater management with benefits of holistic development, such as conserves water and environment, recovers and recycles nutrients and organic materials.

The German architect Leberrecht Migge, in the early 20th century, proposed the concept of eco-toilet (Lu et al 2007). In 1985, the Sweden ecology expert Uno Winblad brought forward the concept of water-free eco-toilet (Lu et al 2007). Besides the sanitary functions, such kind of new products are required to be ecologically friendly (Lu et al 2007). The water-free eco-toilet is expected to accomplish "zero-pollution, zero-infection and zero-waste-discharge" as well as "reduction, harmlessness and resource" oriented development (Lu et al 2007).

Ecosan in Sweden summer cottages. In the early 1970s, the alternative dry systems in Sweden were in the market for summer cottages rather than in apartments (Drangert 1997). According to Drangert, there were one hundred ecological villages founded by Swedish people interested in reuse and recirculation of water and nutrients and saving the energy (Drangert 1997). These villages are distant from towns and residents often belong to middle-class with good education and an ability to get bank loans for their eco-house projects particularly in Norrkoping (Drangert 1997). However, an eco-village of Toarp in southern Sweden experienced shortcoming in terms of technical problems in composting process as residents were not informed about how much carbon-rich material was needed to improve the Carbon:Nitrogen ratio (Drangert 1997). Thus, well-intended interventions may fail owing to neglect of individual values or societal norms (Drangert 1997).

Ecosan in community entrepreneurship and development. Nippon International Cooperation for Community Development(NICCO) with the support of Kyoto University and University of Malawi implemented the comprehensive development project for five years in amount about 1.5 million US$ for about 10,000 people in three districts of Malawi, which consist of seven elemental programs such as (A)agriculture, (B)grain storage, (C)reforestation, (D)measures for infection, (E)human-resource development, (F)water supply and (G)ecological sanitation.

These are some extracted findings highlighted by the study of Matsui et al :

> (A)The agriculture practice depends on organic farming based on the experiences of permaculture with humananure and urine. NICCO distributed local seeds for farmers introducing local seed banks for communities.
>
> (B)Farmers did not have ways of grain storage so that the storage houses of cement and bricks were constructed for establishing the local seed banks. Further a smoking technique of protecting seeds is transferred against pests and insect attacks, which was supported by constructing modified Japanese style stoves more than 400 units.
>
> (C)NICCO planted 5,600 fruit trees, 6,000 oil extracting trees and 6,000 trees used for firewood. Moringa oleifera silviculture is well known as a means to combat poverty and malnutrition.

Further, Saburo Matsui elaborated public health impact of EcoSan by saying that although there is still under investigation how well the ecological sanitation programs did improve the water-borne diseases in the communities, the answers from the people of the NICCO project show, they feel improvement of their lives. Matsui remarked the none occurrence of cholera in the area from the time Ecosan toilet program was introduced. Additionally, livelihood for women had improved as Wives of the communities learned how to make soaps out of the seed oil from moringaoleifera and sold them in local markets, which became their good cash income (Matsui et al).

Clark (1997) discussed the political and economic implications of dry sanitation and urban gardening project using human urine as fertilizer in Morelos, Mexico. Accordingly, the project encouraged architectural inventiveness in order to offer civil society a broader range of options for example dry toilets incorporated into the interior of the house in an urban setting (Ibid). In 1993, Cuernavaca Public Works Department authorized and approved installation of dry sanitation system and conduct bacterial analysis (Ibid). The results of such actions let to the revision of several city codes to include dry sanitation system with appropriate incentives for those who use dry sanitation system, constructed wetlands and rainwater cisterns through reduction of water fees and/or tax incentives (Ibid).

Gough (1997) shared El Salvador’s experience with dry sanitation system in a long coastal area and low water coverage in the Pacific coast with support from the Government of El Salvador and UNICEF. A project was developed in a low income , high density urban squatter community in the center of El Salvador. The dehydrated faeces were used to reclaim wasteland and in nursery garden (Gough 1997). Accordingly, the government of El Salvador through the Social Investment Fund and finance by the Inter-American Development Bank built 50,263 LetrinaAboneraSeca Familiar (LASF) units between 1992 to 1994 with total investment of US 12.5 million without community participation and no education training. The evaluation presented risks of not making communities involved. This led to a conclusion that the dry sanitation is not a process of technology itself rather a process of interaction between technology and the user. Thus, hygiene education model was developed to present technology and users interactions.

Feasibility study guidelines. Prior to putting up to public and rural health investments, it is also important to see EcoSan as assets to the promotion of microbial and pathogens sequestration facility. Hence, the human wastes host are being sanitized and treated by natural process and may have later impact on public health expenditures. Beyond the economic productivity, human wastes contain nutrients that are important to plants and soil. The following are some guidelines to reconsider prior to the establishment of EcoSan facility.

Health. Water supply and sanitation systems can expose the public to two basic types of risk – the risk of infection from water-borne diseases caused by faecal contamination, and the risk of exposure to toxic or harmful substances present in the water or wastewater, for examples heavy metals, toxic organic compounds, medical residues, or hormones (UNESCO-IHP, 2006). Kvarnström et al remarked that the entire sanitary system should be hygienically safe and cover the use of the sanitary installation, collection, transport, treatment and end destination of the treated products.

Environment. This qualifies the need for a closer examination of possible detrimental effects of sanitation systems on the environment that includes recipients such as water, soil, air, during the construction and operation phase (Kvarnström et al , 2004). Hence, sanitation systems must also put quality of the treatment of products for possible reuse in agriculture into consideration (Kvarnström et al , 2004). In ecosan, the term "agricultural reuse" refers to a wide range of productive, ecosystem oriented, reuse options that also includes reuse not only of nutrients but also of grey water, the organic content of wastewater and energy in traditional agriculture--farmers fields where crops such as cereals are grown, but also in silvaculture (forestry), aquaculture, market gardening, and horticulture (UNICEF-IHP, 2006).Additionally, excrements undergo closing of nutrient cycles by recovering and using the nitrogen, phosphorus, potassium, and micro nutrients. This process helps minimize the energy and resource intensive production of mineral fertilisers and make agricultural inputs available even to the poorest farmer (UNICEF-IHP, 2006).

Economy. This refers to the condition where users have the capacity to pay for sanitation. Also this is considered as important criteria for sustainability. According to Kvarnström et al (2004), the criteria for payments of sanitation may depend on the individual's willingness to pay at a variable range of construction and O&M costs that the population may sustain.

Socio-culture. Cultural acceptance, institutional requirements, and perceptions on sanitation are the terms used to describe socio-culture element of sustainable sanitation (Kvarnström et al , 2004). Accordingly, society is more dynamic than human health and environment. Therefore the socio-cultural criteria, like regulation, perceptions on systems etc might be subject to a more dynamic change with time than criteria considering human health and the environment. Although improved human health and environment is the main objective to planners and politicians, this might not be enough to sell the sanitation concept to future users. (Kvarnström, Bracken, Ysunza, Kärrman,Finnson, Saywell, 2004).

Technical functions. Lastly, Kvarnström et al (2004) poses technical function of the system. Accordingly, it must probably be robust both within the system capable of receiving varying loads and externally able to withstand varying extreme environmental conditions including user abuse of the system (Kvarnström et al , 2004).

2. Summary of cases published in several reports Island coastal community

The Global Environment Facility (GEF) has been recognized for its substantial contribution to the global achievement of the 10 percent target of the world's land area under protection however the marine protection remains low. The GEF invested on the Small Developing Island States overall (SIDS) to provide island bright spots to invest on what works for actions to effectively conserve biodiversity, promote sustainable livelihoods, and utilize invaluable natural resources to achieve the Aichi Biodiversity Targets.

The islands constitute less than 5% of the Earth's landmass and they provide 40% of all listed Critically Endangered and Endangered species and more than 80% of known species extinctions have occurred in islands (Secretariat on the Convention on Biological Diversity 2014). Islands are estimated to provide habitat for 20% of all bird, reptile and plant species and they harbour more than 50% of the world's known marine biodiversity (Secretariat on the Convention on Biological Diversity 2014). Hence, environmental governance of islands with their maritime territories (1/6 of the Earth's total area) affects global climate, food supplies and resource cycles (Secretariat on the Convention on Biological Diversity 2014). They are home to more than 600 million people who are dependent on critical ecosystem resources (Secretariat on the Convention on Biological Diversity 2014). The SIDS biodiversity is the base of island sustainable economic progress in fisheries, forestry, agriculture and tourism (Secretariat on the Convention on Biological Diversity 2014). The island biodiversity is critically threatened as 64% of all recorded extinctions have been on islands (Secretariat on the Convention on Biological Diversity 2014).

Vulnerability of the coastal water from wastewater discharge

Rapaport (1997) studied the zero-discharge sanitation for pacific islands and other tropical coastal environments. The pacific island nations have identified critical environmental problems resulting from conventional sewage treatment technologies, including algal blooms and eutrophication in lagoons, dying coral reefs and contaminated drinking water (Rapaport 1997, p.59). This study stands on the argument that a policy of zero-discharge –based upon the presumption that excreta management should not interfere with natural systems, rather that the environment has the capacity to assimilate contamination- can protect sensitive island environment (Ibid). Coastal ecosystems are extremely sensitive to changes in water quality, and because the ground water tables in populated areas are generally high, pacific islands are extremely vulnerable to pollution (Ibid). The Biological Oxygen Demand (BOD) accompanied by high levels of nutrients starves reef creatures of oxygen and encourages the growth of aquatic plants such as seaweeds and phytoplankton that benefit more from the nutrients that prevent light reaching corals (Ibid). This is indicative of a large amount of nitrates that are toxic to corals and concentrations of phosphates inhibiting skeletal growth of corals (Ibid).

Table 1. Small Developing Island States and sanitation cases (Extracted and qouted fromRapaport, 1997)

Small Developing Island States	Cases
Cook Islands (Raratonga)	Contamination from septic systems is carried laterally by groundwater into the lagoon, contributing to increased algal growth, and high levels of gastrointestinal disease on the country's atolls bas raised concern that the use of pour-flush toilets has polluted the shallow water table
Federated States of Micronesia (Pohnpei and Chuuk)	Poorly designed septic systems and simple water-sealed toilets are frequently found directly adjacent to coastal waters, and latrines which overflow in heavy rains are common in rural areas. There is a high prevalence of water-related disease throughout the country, and a number of studies have found sewage pollution to be adversely affecting coral reefs. The Central wastewater treatment plant have failed owing to the lack of trained personnel and funding for maintenance, discharging essentially raw sewage much of the time.
Kiribati	High population densities and rapid urbanization have led to groundwater pollution from the percolation of sewage down into the water table, as well as contamination of lagoon water, beaches and shellfish with microorganisms from human excrement.
Marshall Islands	Signs of eutrophication resulting from sewage disposal are evident adjacent to settlements, and particularly near urban centres. Stagnation of lagoon waters, reef degradation and fish kills resulting from the low levels of oxygen have been well documented over the years. There is significant groundwater pollution in the Marshall Islands as well. The Marshall Islands government estimates that over 75% of the rural wells tested are contaminated with coliforms and other bacteria. Cholera, typhoid and various diarrhoeal disorders all occur.

The threat to contamination can be described by ways that conventional on-site disposal technologies caused groundwater pollution as it allowed nutrients and pathogens to migrate through porous soils to shallow aquifers (Rapaport 1997). The use of water to flush away human excreta can tax valuable and limited freshwater resources as such can also result to salt water incursion to the water table in low-lying attols and coastal areas of larger islands (Rapaport 1997). In Japan, Saburo Matsui presented night soil collection practices and system. Accordingly, human excreta are stored by each household in dry deposits in a tank. No water flushing is practised. There is a collection service by vacuum truck, once a month. The collected excreta are transferred to a dedicated nightsoil treatment plant, of which there are about 1,800 in Japan. All are operated by cities or towns, or public corporations.

3. Public relations strategies and proposed action plans

The Swedish International Development Cooperation Agency (SIDA) Department of Natural Resources and the Environment conducted Ecological Alternatives in Sanitation in 1997. The ecological alternatives in sanitation are a response to critical environmental degradation increasing disease habitat due to sewage discharges from water-borne collection systems that pollute surface waters and seepage from sewers (Anderson 1997). Additionally, septic tanks and pit toilets pollute groundwater in conventional sanitation technology based on flush toilets, sewers, treatment and discharge (Anderson 1997). The conventional sanitation technology system cannot solve these problems in areas with limited resources in terms of water, money and institutional capacity (Anderson 1997).

The meeting concluded that making the option of no-mix toilets known is an important marketing communication strategy to raise greater awareness of ecological alternatives in sanitation. Public relations plan was presented in points.

1. Create cooperation among sectors such as health, agriculture, water resources, education, mass media and social network by a task group comprised of NGOs and local government sanitation and development office.

2. Incessant trainings on ecological alternatives in sanitation and its positive impacts on health and environment must be held for all ages except for children under 5 years of age.

3. Keep the price of no-mix unit low and affordable and highlight the multiple benefits that can be attained by using the unit. For example, it can be highlighted that the no-mix system provides a cheap fertilizer which can generate an income, and localised reuse will lower transport cost and demands on institutions.

4. Group arrangements or community bond agreements must include sophisticated solutions in terms of work and finance or credit arrangements for the unit.

5. Objectives must be clear and display the following stated as reported by Anderson 1997 :

a. Continued increase in population densities with lack of access to basic sanitation for the majority of the population may increase healthcare costs. Preventive health options from ecological alternatives in sanitation are focused on reducing risks to public health and the environment. The human wastes are nutrients necessary for food production.

b. The prevention of sanitation-related diseases is the main course of nutrient removal and recycle to prevent contamination of water supplies, which has become increasingly costly.

c. Institutional and financial capability to adequately operate and maintain such systems for the entire population relies on the size of users population.

Sustainable Sanitation Alliance definition of Ecosan and Sustainable Sanitation

The main objective of a sanitation system is to 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 not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources. When improving an existing and/or designing a new sanitation system, sustainability criteria related to the following aspects should be considered as stated in the Sustainable Sanitation Alliance:

Health and hygiene: Includes the risk of exposure to pathogens and hazardous substances that could affect public health at all points of the sanitation system from the toilet via the collection and treatment system to the point of reuse or disposal and downstream populations. This topic also covers aspects such as hygiene, nutrition and improvement of livelihood achieved by the application of a certain sanitation system, as well as downstream effects (Sustainable Sanitation Alliance, viewed 2014).

Environment and natural resources: Involves the required energy, water and other natural resources for construction, operation and maintenance of the system, as well as the potential emissions to the environment resulting from use. It also includes the degree of recycling and reuse practiced and the effects of these (e.g. reusing wastewater; returning nutrients and organic material to agriculture), and the protecting of other non-renewable resources, for example through the production of renewable energies (e.g. biogas). (Sustainable Sanitation Alliance, viewed 2014).

Technology and operation: Incorporates the functionality and the ease with which the entire system including the collection, transport, treatment and reuse and/or final disposal can be constructed, operated and monitored by the local community and/or the technical teams of the local utilities. Furthermore, the robustness of the system, its vulnerability towards power cuts, water shortages, floods, etc. and the flexibility and adaptability of its technical elements to the existing infrastructure and to demographic and socio-economic developments are important aspects to be evaluated. (Sustainable Sanitation Alliance, viewed 2014).

Financial and economic issues: Relate to the capacity of households and communities to pay for sanitation, including the construction, operation, maintenance and necessary reinvestments in the system. Besides the evaluation of these direct costs also direct benefits e.g. from recycled products (soil conditioner, fertiliser, energy and reclaimed water) and external costs and benefits have to be taken into account. Such external costs are e.g. environmental pollution and health hazards, while benefits include increased agricultural productivity and subsistence economy, employment creation, improved health and reduced environmental risks (Sustainable Sanitation Alliance, viewed 2014).

Socio-cultural and institutional aspects: The criteria in this category evaluate the socio-cultural acceptance and appropriateness of the system, convenience, system perceptions, gender issues and impacts on human dignity, the contribution to food security, compliance with the legal framework and stable and efficient institutional settings (Sustainable Sanitation Alliance, viewed 2014).

4. Monetary valuation of wastewater treatment using cost of detergents as proxy price value to wastewater monetary value

According to EPA (2013) Environmental Protection Agency "National Inspection Plan: Domestic Waste Water Treatment Systems" domestic wastewater discharges are related to the human population and pose health risks to several segments of the population such as infants, pregnant women, the elderly or those with pre-existing health conditions are particularly at risk of serious health. Domestic wastewater also pose threats to coastal habitats and marine ecosystems.

Sources of domestic wastewater. Toilets, showers, sinks, wash hand basins, washing machines and dishwashers. The quality of domestic wastewater will vary with the nature of the system; the volume of waste water being produced; the design of the system; the number of people in the house; the chemicals (e.g. detergents) being used; and the nature of the domestic activities carried out in the household. The basic fundamentals of wastewater treatment in literature taken from Grady and Lim, (1980) , Peavey, Rowe and Tchobanoglous (1985) reveal that Wastewater is composed of a variety of inorganic and organic substances. Organic substances refer to molecules that are based on carbon and include fecal matter as well as detergents, soaps, fats, greases and food particles (especially where garbage grinders are used). However, oxygen is required for this process of breaking large molecules into smaller molecules and eventually into carbon dioxide and water. The amount of oxygen required for this process is known as the biochemical oxygen demand or BOD---indicator of the amount of oxygen in either wastewater or not. Oxygen serves as food for micro-organisms responsible for chemical reactions of nitrogen, phosphorus, carbon or organic matter in the water to serve as food for aquatic species.

Chemicals with posing threats. Domestic sources of phosphorus are human waste, laundry detergents and cleaning products (EPA 2013). Surplus of nitrogen and phosphorus may have serious health effects when it enters drinking water wells and stimulates eutrophication in coastal areas and put carbon sequestration facilities such as mangroves, salt marshes, sea grasses, coral reefs, and other habitats that store somewhere between 235 and 450 megatons of carbon every year. The nitrate in surface water can impact on aquatic ecosystems, particularly in estuarine and coastal waters (EPA 2013).

Health threats. Domestic sources of nitrogen are human waste, food preparation, hygiene washings, cleaning products and, to a lesser extent, laundry sources. Nitrate is highly mobile in the ground and therefore can readily enter groundwater and, if a well is located nearby, drinking water (EPA 2013). The consumption of nitrate-rich water by young children may give rise to a condition known as methaemoglobinaemia or blue baby syndrome.

Intervention wastewater treatment intervention.

The UNDP/GEF Danube Regional Project (DRP) commissioned a project, divided into three tasks, to help reduce phosphorus in detergents. The first task reviewed existing legislation, policies and voluntary commitments on the reduction of phosphorus in laundry detergents across the EU and Danube Basin. In discussion with the detergent industry, the second compiled and evaluated data on phosphorus-containing detergents and associated production structures. The third developed options for a voluntary agreement between the International Commission for the Protection of the Danube River (ICPDR) signatory countries and the detergent industry (Project information sheet on detergents and phosphates, viewed 2014).

Water consumption patterns. Table 2 presents loads of the popular elements in household wastewater by classification. It appears that nitrogen has huge total compared to phosphorus and potassium. More potassium is present in yellow and grey water . Thus an example of water consumption, the yellow water discharge is among predominant disposal. Domestic use of water is common to hand wash, facial clean and urine flush. They all use soaps and detergents except for urine and fecal flush. Table 3 and 4 shows occupancy of an eco-tourist apartment by time of stay and water consumption by practices.

Table 2. Characteristic of the main components of household wastewater (Otterpohl*et al*, 2001 ;Esrey*et al*, 2001, Fittschen and Hahn, 1998, Wittgren *et al*, 2003)a

Loads (g/c/d)	Yellow water	Brown water	Grey water	Green waste	Total
Nitrogen (N)	11.0	1.5	0.5	1.5	14.5
Phosphorus (P)	1.0	0.5-0.8	0.2-0.5	0.3	2-2.6
Potassium (K)	2.5	0.6-1.0	1.6	0.2	4.9-5.3
Explanation: The figures vary naturally by type of diet, location, climate, age, activity and health status.					

Table 3. The amount of human nitrogen production in KAZ (kg/d)a

Visitor types	Yellow water	Brown water	Grey water	Green waste	Total
Overnight	2.2	0.3	0.1	0.3	
Day	2.8	0.2	0.1	0.3	
Half Day	4.0	0.2	0.2	0.4	
Total	8.9	0.7	0.4	1.0	11.2
Explanation: o Based on Table 3-4, the number of Overnight visitor, Day visitor, and half Day visitor is 200, 500, 1450 capita per day in KAZ. o The amount of nitrogen production per capita is shown in Table 4-5. o The amount of nitrogen (kg/d) = Number of visitor (c/d)* The amount of nitrogen production per capita (g/c/d).* 10-3 kg/g. For example, the amount nitrogen from yellow water contributed by Day visitor = 500 c/d * 5.5 g/c/d * 10-3 kg/g = 2.8 kg/d.					

Table 4. The average times of different domestic water uses for each type person in KAZ (time/c/d)a

	Drinking	Cooking	Urine flush	Faecesflush	Hand wash	Face clean	Bath/shower	Laundry	Others
Overnight	8	3	4	1	8	2	1	0.2	1
Day	4	1	2	0.3	3.3	0	0	0	0.5
Half Day	2	0	1	0.1	1.1	0	0.2	0	0.3
Explanation: o Average times for water consumption is assumed based on daily knowledge in China, such as: most of people need eat three times per day, take 4 urines and 1 faeces per day, clean hands after toilet and before eating, wash faces before and after the sleep, take shower/bath once per day, wash clothes once per week. o Above "Cooking" includes all activities related with cook, such as food cleaning, and dishes washing. o Above, "Other" means the other unmentioned water using activities.									

Table 5. Monetary values of possible damage due to untreated wastewater derived from price of detergent and household size in number of days consumption (in Philippine peso)

Household population	7 days	30 days	360 days	1800 days (5 years)
50	1,750	7,500	90,000	450,000
100	3,500	15,000	180,000	900,000
500	17,500	750,000	9,000,000	45,000,000

Analogy of proxy indicator for monetary valuation

Qualifications for proxy indicators of wastewater in household is provided in the report although crude measures are provided, they can be refined in future research agenda of the experts. For comparative and similarity, the measures were contextualized by frequency of releases. Human wastes urine and feaces are common and at least everyday for all members of the households while laundry and washing can be estimated as daily chores for all members of the household, since children below 10 years old and older people are not expected to do so, the context would prefer use of detergents set at 250 ml consumption everyday although the usage may vary, it is set as assumption for this measure. Both human wastes and detergents residues are all wastes mixed up with water. The EPA set a hypothetical scenario where the greater the population of the dwelling, the greater the volume of waste water produced. Limitation of the measure : lack data on daily hydraulic loading for each person in litres and typical household occupancy. For the purpose of analogy, this section presents an assumption that the cost of possible damage caused by untreated wastewater is dependent on the price of detergent and household size . For example, assume that 250 ml was used by total number of households everyday, the amount is 5 pesos.

It can be estimated that the amount of damage to marine water or water is increasing by the number of household residing in the area. The wastewater treatment may require millions to save marine ecosystem from contamination and pollution. Wastewater treatment and reduction of pathogens in the water are important pillars of health. More importantly, health of blue carbon sequestration facilities should be protected from contamination and pollution. Since health care is socialized, it can't be qualified as affordable as the prices of vaccines and medicines for waterborne diseases are escalating that may have long term implications on health care supply chain. The increase in healthcare cost can put the local government and its constituents at greater disadvantage. Especially when population in low socio-economic areas is increasing. More child and infant mortality is expected when sanitation and safe drinking water is poor in quality. The EcoSan technology has multiple use encompassing health education, rural health, prevention, alternative livelihood and a distal carbon sequestration facility that protect the water and blue carbon sequestration facilities.

5. Conclusion and recommendations

Building low carbon society may be a huge concept but for this paper the reviews were classified to create a concept that supports the aforementioned objectives. The reviews show that EcoSan technology is significant to protected landscape and seascape whose human population live together with biodiversity in coastal areas where important blue carbon sequestration facilities are found. The recommended rationale for ecosan sustainability are as follows:

Ecosan and carbon sequestration facilities. Blue carbon sequestration facilities are located near the shore of the protected seascape while trees as green carbon sequestration facilities are located in the protected landscape. The carbon sequestration facilities need to be protected from damages caused by anthropogenic factors or human activities such as logging and domestic waste disposals in the waterways leading to the marine ecosystem.

Ecosan and public health. Daucet (2013) established a case on how ecosan prevents epidemic such as cholera in Haiti (Daucet 2013). Another case study was established by Anders Finnson's visit in Bobutan Artisan Fishing Community through Toilet Without Borders Sweden. The 29 households in the fishing village have two septic toilets and open defecation is a common practice--- the feces were covered by sand. Such practice (open defecation) is alarming due to its proximity to the marine water and possible outbreak of ascaris in the area. It is also a concern for health in eco-tourism area. Finnson coordinated with the Sustainable Sanitation Center of Xavier University to look for possible intervention. EcoSan technology was introduced and accepted by people and installed in the area for 10 household. This is still on first stage process and more education and enculturation are needed.

Eco-tourism and EcoSan. Business can be held by developing Ecotourism houses that will accommodate visitors who are interested to experience living with fisherfolk and experience ecosan philosophy. Just like that of the eco-village in Sweden, the eco-tourism cottages with ecosan toilet so far may offer a better option for sanitation and promotion of environmental concerns for the protection of the off-shore carbon sequestration and blue carbon sequestration facilities (seagrass among others).

EcoSan in eco-tourism. The village can also introduce kitchen garden and re-use of urine to the visitors. This system serves as tools to effectively communicate the message of recycling and re-use. The humanure business or conversation of fecal materials can be designed by the University , like the Xavier University in cooperation with the local NGO working for ecosan. Transportation scheme can also be designed depending on commitments of the stakeholders involved. In this case, cooperation with Water AgroForestry Development (WAND foundation), Local Government Unit, DENR, and Sustainable Sanitation Center (SUSAN) of Xavier University is prominent and are working on to launch EcoSan education and training for the fisherfolks.

Humane program intervention.This intervention has multiple effects on the artisan fisherfolk from personal growth in sanitation values to social cohesion to economic welfare to climate change mitigation awareness. The said series of human development as inherited in the program made the intervention humane.

Socio-economic impact. Eco village may provide employment, enterprise, other income options to fisherfolk if a business plan and eco-tourism management were properly conceptualized. These reviews may serve as reference for biological diversity conservation project development in protected landscape and seascape in the world especially in islands in the pacific, Caribbean, and other eco-tourism spot islands.

Wastewater management impact. Since there are problems in sewage disposals in islands especially those of the domestic wastes, the ecosan technology may help save the nutrients and re-use them for agriculture. This may reduce the amount of nutrients from human waste entering the water cycle or wastewater loading. Sewage treatment and wastewater treatment and management are expensive but that intervention depends on the Willingness-To-Pay (WTP) scheme from the residents. This program intervention covers broader concepts of access to clean coastal water, sanitation and rural community. The clean coastal water provides ecosystem services to the community for health and recreation in eco-tourism.

Wastewater Garden Sustainable Strategies . Rapaport (1997) mentioned the Center for Clean Development (CCD) toilet technology system modified by Dr Alfred Bemhart at the University of Toronto as being commercially marketed in the US as a “Wastewater Garden Sustainable Strategies of Concord, Massachusetts". Accordingly, the presence of aerate sand and gravel trenches promote the growth of aerobic bacteria which enhance of evaporation through the release of heat generated by their activity, and also make the nutrients in the wastewater more readily available to plants grown in the garden bed (Rapaport 1997).

An excerpt from Rapaport (1997) stated that an integrated CCD toilet and wastewater garden has also been designed with added capacity for use in public faciities (Rapaport 1997). The Centre for Environmental Studies at the University of Tasmania and local counterparts have successfully tested several aerobic batch composting toilet designs in the Pacific island nation of Kiribati one of which was a simple prefabricated “Cage Batch” toilet, developed originally for use in Tasmanian National Parks, which provides a combination of aeration, passive solar heating and insulation to assist the composting process (Rapaport 1997). Further, another toilet design used modified 240 litre mobile garbage bins as the digestion chambers (Rapaport 1997). It was stated in Rapaport (1997) report that garbage bin is is placed below the toilet pedestal to receive excreta, and is replaced with another one when full. Air is drawn into the bin through a cut-out near the base, and comes in contact with the bottom of the compost pile through a mesh false floor. In articulation, perforated ventilation pipes running vertically along the inside walls of the bin help to aerate the pile (Rapaport 1997).

Bellagio Principles for Sustainable Sanitation. It was considered that there is no system which is absolutely sustainable as according to SUSANA sustainability is more of a direction rather than a stage to reach. The sustainability criteria in different circumstances to the same extent will depend on the local framework and has to take into consideration existing environmental, technical, socio-cultural and economic conditions with Water Supply and Sanitation Collaborative Council's "Bellagio Principles for Sustainable Sanitation" in 2000:

Human dignity, quality of life and environmental security at household level should be at the centre of any sanitation approach. In line with good governance principles, decision making should involve participation of all stakeholders, especially the consumers and providers of services.Waste should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flow and waste management processes.The domain in which environmental sanitation problems are resolved should be kept to the minimum practicable size (household, neighborhood, community, town, district, catchments, city).

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