Protection of the Marine Environment in Developing Counties: Management of nutrient inputs

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Abstract

The management and treatment of sludge in developing countries, from on-site sanitation systems has neither been addressed by problem holders nor by researchers. All septic tanks need to be desludged regularly in order to maintain a certain level of treatment efficiency and minimize ecological and eventual marine pollution incidences. Practices followed in developing countries are discussed and lessons learned are emphasized for promoting sustainable community development. Stakeholder identification and participation and their cooperation through the process, as well as new regulations on service provision and management procedures are addressed in this study.

Keywords: Waste water, coastal zone, faecal sludge, nutrient control.

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1.0 Introduction

On a global scale, approximately 80 per cent of marine pollution arises from land-based activities such as urban development, agriculture, manufacturing, transport, energy production and day-to-day domestic activity. The types of pollution include litter and oils, municipal waste waters, nutrients and sediments, radioactive waste, heavy metals and persistent organic pollutants. Once in the marine environment, the pollutants are absorbed by marine life, settle in river mouths and on the ocean floor, or follow currents and eddies to distant locations. The pollutants pay no attention to national maritime boundaries or the sensitivity of the ecosystems they impact upon.

When pollution levels rise to unsustainable levels the impact is felt not only by living marine ecosystems but by the economic sectors depending on them. These can include tourism, fisheries, and hospitality and transport sectors. Public health can also be affected, as can foreshore protection, aesthetics and public amenity. Under the United Nations Convention on the Law of the Sea (UNCLOS) parties have a responsibility to protect the marine environment from land-based activities. In 1995 the international community agreed to the non-binding Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) and reaffirmed its commitment in this regard at the 2001 Intergovernmental Review of the GPA. Under the GPA, governments are invited to develop National Programmes of Action for the Protection of the Marine Environment from Land-based Activities (NPA). NPAs are intended to be long-term iterative processes that are action oriented and contribute to national sustainable development strategies. Varying legal and social frameworks mean that NPAs must respond to the uniquely specific circumstances and priorities of each country.

In urban areas of developing countries, on-site sanitation (OSS) systems predominate over water-borne, sewered sanitation. OSS comprises non segregated household and public toilets, aqua privies and septic tanks. In Bangkok, Manila and Jakarta, e.g., in the order of 65 % of the houses served are linked to OSS.

Table 1 shows the quality of faecal sludge and its great diversity between countries, which should be seriously considered when planning treatment facilities. In sub-Saharan Africa, more than 80 % of houses in large cities and up to 100 % in towns are served by on-site sanitation facilities (Strauss et al. 2003). Due to water scarcity and intermittent water supply services and financial-economic reasons, area-wide, sewered sanitation is not suitable in most urban settlements.

Small-bore or low-cost satellite sewer systems might prove feasible in some selected urban areas. It is unlikely, though, that sewerage will be the predominant sanitation option-of-choice in developing countries in the foreseeable future. On-site sanitation installations will serve the growing urban populations in developing countries for decades to come. As a consequence, growing quantities of faecal sludge will have to be managed. Experts analyze the main problems identified along the “FS management path” (collection, haulage, treatment, and reuse or disposal) preventing effective excreta management. Proposals

include institutional, regulatory, economic, financial and technical measures that enable improved management of faecal sludge.

Table 1: Faecal Sludge quality in different cities (GVCS on Sanitation and Hygiene-01/08) Source: GVCS on Sanitation and Hygiene Report –January 2008

	1 Accra Septage	Accra Public toilet Sludge	2 Bangkok Septage	3 Manila Septage	4 US EPA Septage
COD	7,800	49,000	14,000	37,000	43,000
BOD	600 -1500	7,600		3,800	5,000
TS	11,900	52,500	16,000	72,000	38,800
TVS (%)	60	69	69	76	65
pH	7.6	7.9	7.7	7.3	6.9
COD/BOD	6-12	6.4		9.7	9
COD/TS	0.7	0.9	0.9	0.5	1.1
Helm.eggs no/l	4,000	25,000		5,700	

All units except pH and the ratios (COD/BOD, COD/TS) are in mg/l unless otherwise stated.

On the other hand, environmental threats from tourism include severe limitations in terms of land and space resources, damage from the construction of roads, pressures on the terrain, flora and fauna, damage to archaeological sites, visual pollution, congestion, and activities which may diminish the value and image of tourist sites and the marine environment.

Sustainable agricultural development must take account of such critical issues as allocation of production factors in sustainable agriculture, sustainable use of water, risks to sustainable agriculture, and prudent use of pesticides.

2.0 Technological Aspects

All septic tanks need to be emptied regularly in order to function efficiently. The current practice in many developing countries is to empty the septic tank when it is full or blocked. There are also no proper septic sludge treatment facilities. The sludge collected from the septic tanks is usually being discharged to unauthorized drying beds eventually penetrating water bodies and providing nutrient enrichment of marine ecosystems which leads to pollution events, the extent of which depend largely on the functionality of the marine ecosystem. Over-enrichment, in general, is an excessive increase in primary production caused by the load of excess nutrients (i.e. nitrogen, phosphorus) from human activities (Kathijotes N. 2009).

In order to improve the situation that creates various environmental problems the

Sarawak Sewerage Service informs us on a design of a Wastewater Treatment Plant for 100,000 PE (population equivalent). The site has sufficient land for future expansion of up to a total of 4 modules that will achieve the final capacity of 400,000 PE. Completion date of the project is given as the 14th October 2012.Capacity building measures however should be taken, in order to create an efficient faecal sludge handling system, where sewerage is not available, as well as sludge application on land after conditioning.

A proper handling process for handling faecal sludge is presented in figure 1. The sludge should be carried by authorized vehicles to the treatment facilities. For various reasons as explained below, constructed lagoons or even wetlands are considered most appropriate. A sediment retention and nutrient removal treatment system that uses natural chemical ,physical and biological processes involving wetland vegetation, soils and their associated microbial populations to improve water quality. Research has shown that treatment wetlands can be more affordable, reliable and practical to build and operate, as well as more sustainable, than conventional treatment technology.

Treatment wetlands are designed to use water quality improvement processes occurring in natural wetlands, including high primary productivity, low-flow conditions and oxygen transport of anaerobic sediments. Treatment wetlands also help to minimize odor problems, reduce labor costs associated with hauling and applying effluents besides providing aesthetic and wildlife benefits.

In general, faecal sludge bio solids should find a secure market, in order to avoid uncontrolled disposal, and be useful to agriculture and soil conditioning. A high organic load will, independently of the source, affect the dissolved oxygen levels, thus impairing aquatic organisms. Additionally, the nitrogen or phosphorous washed into water bodies leads to non sophistication, and subsequent oxygen depletion, facilitating the growth of toxin-produced algae (Chorus&Bartram, 1999).

In general, and in order to avoid negative effects of using excreta in agriculture, the following should be considered (Foster et al., 2004): a. improved agricultural practices; b. establish criteria (safe distances, depth of extraction, appropriate construction) to operate wells used for water supply around the area of application and c. routinely monitor groundwater and eventually coastline water.

Identified capacity building needs include: Wastewater Re-use (potential, acceptance); Qualities, Characteristics, Sampling and Analysis of Sludge or faecal sludge (FS); Design of Inexpensive Treatment Facilities-Design know-how; Training of Unskilled Operators; Basic Strategic Solutions for Improved Sludge Management for Decision Makers; Institutional Infrastructure Organization, and others.

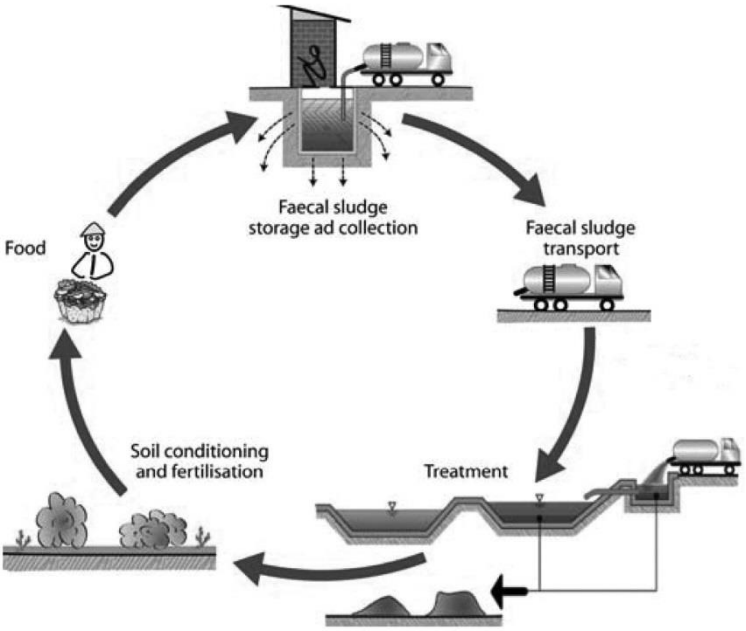

Figure 1: Proper handling process of faecal sludge (Eawag-Sandec, 2006)

3.0 Lessons Learned

Together with reviews of relevant projects, the lessons learned are expressed below:

- Treated or untreated waste water effluents, agriculture and aquaculture together with human wastes are the major sources of pollution with the Cladofora macro alga causing nuisance to the shoreline.
- The occurrence of endangered species and the presence of well preserved habitats in coastal waters are evidence that the marine environment is still in good state.
- Sludge collection, hauling and treatment are top management issues in developing countries
- In the absence of governmental support, initiative and policy, moving in of small enterprises and NGO's set up satisfactory sludge management
- Municipalities in development countries should take a responsible role in the overall planning, implementation and enforcement of sludge management regulations. Whenever they did, their involvement gave considerable positive results.
- Sewerage systems offer tremendous improvements to sea protection.

- Strict regulations as to waste water management including all other effluent disposals around the coastal zone are necessary and should be enforced.

4.0 Recommendations

Adaptive management as well as Preparation of Best Practice Guides should be embedded. Training is necessary, in on site sanitation and sludge management in appropriate institutions and at all professional levels.

The International Ocean Institute (IOI) offers the following approaches and experiences to interested parties: Constructed wetland models and their effective design, operation and implementation; Capacity Building and on-site actual training and tailor made projects on waste water and sludge treatment and applications (Larnaca and Lemesos Sewage Boards are ready to offer training). Research and Consultation on Wastewater Reuse as Related to Coastal Protection – Nutrient Control (Cyprus University of Technology); Strategic Planning for stakeholders consultation approach, community based participatory approach and knowledge based capacity building for governmental function levels on learning by doing basis (adaptive management); The International Ocean Institute offers these training programmes on adaptive management to meet public consensus and agreement, through scientific advice from national experts; and Ocean Learn : Capacity Building and Training: Opportunities through IOI's partnerships and International Cooperation, WMO,IMO, IOC, UN University, etc; The Expertise and Support of IOI's World Network should also be noted.

5.0 Conclusions

Promising initiatives to establish improved FS management are under way, from which lessons can be learnt. An array of tools from which stakeholders can choose has been identified. They comprise systematic planning based on stakeholder identification and their cooperation (integrated with urban sanitation planning); regulations on services provision and management procedures; fee structuring and money fluxes (flux reversal!); involvement of emptying services to private entrepreneurs; rules to secure a competitive market; appropriate treatment options; securing the market for bio solids sale. Potential solutions suiting local conditions and needs, such as the ones discussed in this document, should be further developed and tested in pilot/demonstration projects. They should be monitored and evaluated in order to establish practical, action-oriented recommendations complemented by capacity building programmes.

References

Barreiro, W. C. (2003). Septage Management in the Cities of Haiphong and Danang: Eawag / Sandec, Switzerland. 18 p.

Bolomey, S., Koné, D., Strauss, M. (2003). Amélioration de la gestion des boues de vidange par le renforcement du secteur privé local : Etudes et Outils Cas de la Commune VI du District de Bamako. Eawag / Sandec,Switzerland. 48p. http://www.sandec.ch/FaecalSludge/Documents/Renforcement_secteur_prive.pf

Cofie, O., Agbottah, S., Strauss, M., Esseku H., Montangero, A., Awuah, E. and Koné, D. (2006). Solid-liquid separation of faecal sludge using drying beds in Ghana: Implications for nutrient recycling in urban agriculture. Water Research, Vol.40(1); 75-82.

Chorus&Bartram, 1999 toxic cyanobacteria in water. Geneva WHO.

CREPA Bénin (2002). Gestion des Boues de Vidange au Bénin: Etat des Lieux. Project report, February.

Foster et al., 2004, urban waste water as groundwater recharge.evaluating and managing the risks and benefits. Washington DC, The World Bank.

Heinss, U., Larmie, S.A., Strauss, M. (1998). Solids Separation and Pond Systems for the Treatment of Septage and Public Toilet Sludges in Tropical Climate - Lessons Learnt and Recommendations for Preliminary

Ingallinella, A. M., Sanguinetti, G., Koottatep, T., Montangero, A. and Strauss, M. (2002). The challenge of faecal sludge management in urban areas - strategies, regulations and treatment options. Water Science and Technology, 46, pp 285-294.

Jeuland, M. (2002). Economic Aspects of FS Management in Bamako, Mali. Unpublished project report, March.

Kathijotes N. (2006) "Wastewater Reuse for Irrigation: an Acceptable Soil Conditioner?" Conference on Water Observation and Information System for Decision Support BALWOIS 2006, F.Y.Republic of Macedonia

Kathijotes N. (2008), "Wastewater Reuse for Irrigation: Soil Salinity Evaluation of Irrigated Areas and Examination of Contamination Hazard" 2nd International Salinity Forum, Water and Society – Global issues , Adelaide, Australia

Kathijotes N. (2009), "Protection of Coastal Cities - Preview of the EU Policy as applied to the Mediterranean Coast of Cyprus", IHAR-American Society of Civil Engineers Congress, ISBN: 978-94-90365-01-1, Vancouver, Canada

Strauss et al. 2003. Urban excreta management- situation, challenges and promising solutions. Asean Waterqual2003, IWA Bangkok, Thailand