

APPROPRIATE AND SUSTAINABLE WASTEWATER MANAGEMENT IN DEVELOPING COUNTRIES BY THE USE OF CONSTRUCTED WETLANDS

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ABSTRACT

Constructed wetland systems for wastewater management may have great potential in developing countries as robust and decentralized solution. A case study from Koh Phi Phi Island in Thailand where a constructed wetland system was established after the destructions by the tsunami in 2004 is described. The project includes a wastewater collection system for the main business area of the island, a pumping station, a multistage constructed wetland system, and a system for reuse of treated wastewater. The wastewater is treated to meet the Thai effluent standards for total suspended solids and nitrogen, but because of inadequate pre-treatment and removal of oil and grease prior to the system, the standards for oil and grease and BOD are not met. The experiences from the project illustrate, that despite the appropriateness of the system, and the fact that safeguards were prepared beforehand, the system is only partly a success, mainly because no key-person or key-authority took responsibility for managing the system.

KEY WORDS

Constructed wetlands, tsunami, wastewater management, developing countries, ornamental flowers.

1. Introduction

Malfunctioning wastewater management systems in developing countries have become a growing concern during recent decades. The high-tech centralised sewer and treatment systems used in the more developed countries cannot be readily adopted in developing countries because the political, educational, legislative, institutional, and financial systems are often inadequate. Yet the needs are growing, but the resources are scarce, and there is therefore an urgent need for a shift in the approach to wastewater management and planning.

Wastewater management systems in developing countries should be based on the principles of sustainability and appropriateness. Most developing countries have not yet made investments in centralised sewer and treatment systems, and therefore have potentials for experimenting with new and perhaps more suitable short- and long term

concepts for wastewater management. The idea that wastewater management systems in developing countries should be based on the principles of appropriateness and sustainability have been advocated in a recent book *'Sustainable Wastewater Management in Developing Countries – New paradigms and Case Studies from the Field'* published by the authors [1]. Here we summarise the ideas put forward in the book and illustrate the principles by a case story from Thailand. We hope that the lessons learned from the planning, design, implementation and follow up of this wastewater management system can assist in developing a more appropriate and sustainable wastewater management practice in developing countries in the future.

2. Appropriateness and sustainability

The basic characteristic of an appropriate wastewater management system is that, at a given time in history, it fits well with the local setting and culture, and that its relevance and sustainability thereby is ensured. In this context, low-cost, decentralized nature-based wastewater management systems are highly interesting and relevant for developing countries. The concepts of use and reuse, closed-loop systems, recovery, low energy consumptions also points towards the future, as do concepts of integrating urban planning and wastewater management strategies to conserve urban nature resources. Future wastewater management systems should therefore be recovery-based closed-loop systems rather than traditional disposal-based linear systems. Such systems would promote conservation of water and nutrient resources, improve urban environments and contribute to public health, the local economy and the protection of aquatic ecosystems. Systems should be fitted to the local physical, social and institutional context and include a cultural appropriateness reflecting the local perception of e.g. soil, land, recycling and human waste.

3. Fundamentals in developing countries

A number of issues are fundamental to working with wastewater management systems in developing countries. These issues are, however, often overlooked or ignored

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Municipal Wastewater Management in Developing Countries Zaini Ujang, Mogens Henze, 2006-04-30 Municipal Wastewater Management in Developing Countries discusses various approaches to municipal wastewater management in order to protect both public health and the environment with the major focus being on waterborne diseases. Developing countries can be divided into two main categories: i.e. countries in transition with higher growth rates where industrialisation and urbanisation are taking place rapidly and countries with slower growth rates. It is important therefore that approaches should be tailor made and site specific. In general, the major trends of water pollution control have significantly contributed to the development of conventional sanitation approaches in terms of legal and financial frameworks as well as technological enhancement. Despite advances in the science, engineering and legal frameworks, 95 per cent of the wastewater in the world is released into the environment without treatment. Only five per cent of global wastewater is properly treated using the standard sanitation facilities mainly in developed countries. As a result, the majority of the world's population is still exposed to waterborne diseases and the quality of water resources has been rapidly degraded, particularly in poor developing countries. The challenge now is to provide the world's population, especially the poor, with adequate water and sanitation facilities. Despite billions of dollars of investment spent every year, billions of poor people are still suffering and dying because of poor sanitation. At the beginning of this century, about 1.1 billion people lived without access to clean water compared to about the same number in 1990. 2.4 billion without appropriate sanitation compared to 2.3 billion in 1990 and four billion without sound wastewater disposal. The future scenario that water resources will be further depleted by a growing world population will be coupled with environmental degradation due to poor pollution control, particularly in most of the developing countries. In order to address the issue of water and wastewater management in developing countries, it is necessary to take into consideration the segments of the society itself, particularly the types of housing areas. The segments will indicate the level of socio-economic mentality and knowledge which is important for any planned changes in their life style and social engineering. It is also important to segregate the funding framework of any proposed projects. High income urban communities, for instance, are generally willing to pay for sewerage services and higher water supply tariffs; therefore, a designated system can be accordingly provided. Over the past 10 years, serious criticism has been given to the conventional sanitation approach; consequently, many definitions, concepts and characteristics have been proposed on sustainable sanitation. Sustainable sanitation is a relevant concept in order to achieve the Millennium Development Goals by 2015 of providing water supply and adequate sanitation for developing countries. Sustainable sanitation is flexible in approach, any community, poor or rich, urban or rural, water rich or water poor, country and requires lower investment costs compared to conventional sanitation approaches. It is also important to note that the framework of sustainable sanitation is much easier to adopt in developing countries where water supply and sanitation infrastructures are still in the developing stages. In some

developing countries no public facilities are available therefore it is an ideal condition to start a new infrastructure with a new framework This comprehensive reference prepared by leading international authorities will provide an invaluable reference for all those concerned with the management of sanitation services in developing countries worldwide

Municipal wastewater management in developing countries Zaini Ujang,Mogens Henze,IWA.,2008 **Urban Water Engineering and Management** Mohammad Karamouz,Ali Moridi,Sara Nazif,2010-01-20 Based on recent research this book delineates a systems approach to urban water hydrology engineering planning and management It covers a range of classic urban water management issues such as the modeling of urban water cycles urban water supply and distribution systems demand forecasting and wastewater and storm water collection and treatment The text also includes a discussion of water governance and disaster management in urban areas Against this background the authors discuss the importance of understanding the principles of simulation optimization multiple criterion decision making and conflict resolution for successful integrated urban water management *Domestic Wastewater Treatment in Developing Countries* Duncan Mara,2013-06-17 Affordable and effective domestic wastewater treatment is a critical issue in public health and disease prevention around the world particularly so in developing countries which often lack the financial and technical resources necessary for proper treatment facilities This practical guide provides state of the art coverage of methods for domestic wastewater treatment and provides a foundation to the practical design of wastewater treatment and re use systems The emphasis is on low cost low energy low maintenance high performance natural systems that contribute to environmental sustainability by producing effluents that can be safely and profitably used in agriculture for crop irrigation and or in aquaculture for fish and aquatic vegetable pond fertilization Modern design methodologies with worked design examples are described for waste stabilization ponds wastewater storage and treatment reservoirs constructed wetlands upflow anaerobic sludge blanket reactors biofilters aerated lagoons and oxidation ditches This book is essential reading for engineers academics and upper level and graduate students in engineering wastewater management and public health and others interested in sustainable and cost effective technologies for reducing wastewater related diseases and environmental damage

Waste Recycling and Resource Management in the Developing World B. B. Jana,2000 *Industrial Wastewater Treatment and Disposal* International Association on Water Pollution Research and Control. International Specialised Conference,E. Malikides,1992 This International Specialised Conference brought together scientists engineers managers and administrators from all over the world to discuss problems and new ideas as well as to share experiences regarding the problem of treatment and disposal of industrial wastewaters These proceedings cover the treatment of wastewaters from specific and diverse industries national policies and methods of control design and operation of wastewater plants and removal of hazardous chemicals **Wastewater** Pay Drechsel,Manzoor Qadir,Dennis Wichelns,2015-03-11 The books provides a timely analysis in support of a paradigm shift in the field of wastewater management from treatment for disposal

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Wastewater Irrigation in Developing Countries Hillel I. Shuval,1990 **Manual of Environmental Research for Developing Countries** H. F. Ludwig,2006 *Appropriate Technology Information for Developing Countries* United States. National Technical Information Service,1980 *Knowledge Review* ,2001 Proceedings of the ... World Congress on Water Resources ,1974* Sick Water? ,2010 Given that a healthier future needs urgent global action for smart sustained investment to improve wastewater management this report tackles the current challenges faced in wastewater management Part I of the report addresses the pressing challenges faced in the management of wastewater and how it may be influenced by population growth urbanization and climate change Part II looks at possible solutions regarding these challenges and how current techniques can be modernized through innovation Water Management ,2002 *World Resource Review* ,2002

Transboundary River Basin Management and Sustainable Development Jan Cornelis van Dam,J. Wessel,1993

Wastewater Treatment and Reuse for Metropolitan Regions and Small Cities in Developing Countries Müfit Bahadır,2017-01-27 Sustainable Water Management is essential for the social economic and environmental growth of developing countries Many of those had very high population growth rates in the last century resulted in fast urbanization and strengthened by heavy migration from rural areas to the cities either of big or small size Water supply of good quality and adequate quantity especially in countries with semi arid regions and appropriate sewerage systems and treatment of wastewaters impaired severe constraints for the population Nevertheless many alternatives for wastewater treatment were developed with the participation of universities and research institutions as well as by practitioners Substantial efforts have been directed towards the search of good alternatives for domestic sewage treatment in metropolitan regions and small cities in developing countries in order to comply with their particular economic and environmental conditions The use of

conventional treatment technologies as well as advanced alternatives for treatment and post treatment of wastewater issues of plant scales in centralized and decentralized systems and possible reuse of the effluents were aimed to present on this workshop and to discuss theoretical and practical aspects The main objectives of the workshop were i to share experiences knowledge and research between different partners ii to discuss major problems and challenges in the field of wastewater treatment and reuse in Metropolitan Regions and Small Cities in Developing Countries iii to present suitable treatment technologies for domestic wastewater for the removal of recalcitrant substances and micro pollutants from domestic sewage and industrial effluents and iv likeliness of reuse of treated wastewater in urban areas in the industry and in agriculture Individual topics dealt with were v alternatives for domestic sewage treatment in metropolitan regions and small cities vi anaerobic processes for the treatment of domestic sewage and industrial wastewaters vii stabilization ponds viii aerobic granular sludge ix post treatment processes x centralized and decentralized systems and xi water reuse

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Table of Contents Municipal Wastewater Management In Developing Countries

1. Understanding the eBook Municipal Wastewater Management In Developing Countries
 - The Rise of Digital Reading Municipal Wastewater Management In Developing Countries
 - Advantages of eBooks Over Traditional Books
2. Identifying Municipal Wastewater Management In Developing Countries
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Municipal Wastewater Management In Developing Countries
 - User-Friendly Interface
4. Exploring eBook Recommendations from Municipal Wastewater Management In Developing Countries
 - Personalized Recommendations
 - Municipal Wastewater Management In Developing Countries User Reviews and Ratings
 - Municipal Wastewater Management In Developing Countries and Bestseller Lists
5. Accessing Municipal Wastewater Management In Developing Countries Free and Paid eBooks
 - Municipal Wastewater Management In Developing Countries Public Domain eBooks
 - Municipal Wastewater Management In Developing Countries eBook Subscription Services

- Municipal Wastewater Management In Developing Countries Budget-Friendly Options
- 6. Navigating Municipal Wastewater Management In Developing Countries eBook Formats
 - ePub, PDF, MOBI, and More
 - Municipal Wastewater Management In Developing Countries Compatibility with Devices
 - Municipal Wastewater Management In Developing Countries Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Municipal Wastewater Management In Developing Countries
 - Highlighting and Note-Taking Municipal Wastewater Management In Developing Countries
 - Interactive Elements Municipal Wastewater Management In Developing Countries
- 8. Staying Engaged with Municipal Wastewater Management In Developing Countries
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Municipal Wastewater Management In Developing Countries
- 9. Balancing eBooks and Physical Books Municipal Wastewater Management In Developing Countries
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Municipal Wastewater Management In Developing Countries
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Municipal Wastewater Management In Developing Countries
 - Setting Reading Goals Municipal Wastewater Management In Developing Countries
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Municipal Wastewater Management In Developing Countries
 - Fact-Checking eBook Content of Municipal Wastewater Management In Developing Countries
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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