

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

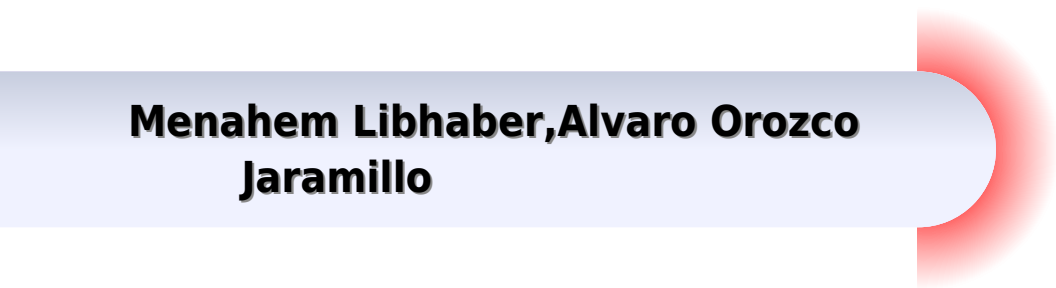
The basic characteristic of an appropriate wastewater management system is that, at a given time in history, it fits well with the local setting and culture, and that its relevance and sustainability thereby is ensured. In this context, low-cost, decentralized nature-based wastewater management systems 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

Appropriate Methods Of Treating Water And Wastewater In Developing Countries

**Menahem Libhaber, Alvaro Orozco
Jaramillo**



Appropriate Methods Of Treating Water And Wastewater In Developing Countries:

Appropriate Methods of Treating Water and Wastewater in Developing Countries George Willard Reid,1982

Appropriate Waste Management for Developing Countries Kriton Curi,2012-12-06 The importance of protecting the environment against pollution is an objective which gained international acceptance in the recent years According to the first principle of the Declaration of the United Nations Conference on the Human Environment which took place in Stockholm in 1972 man bears a solemn responsibility to protect and improve the environment for present and future generations The United Nations again in their desire to improve the sanitation conditions all over the world decided to proclaim the period between 1981 1990 as the International Drinking Water Supply and Sanitation Decade Although attempts have been made by international organizations to prevent pollution it is difficult to say that these attempts gave satisfactory results in developing countries The most common reasons of failure are a To find solutions to their environmental problems developing countries usually seek the assistance of engineers and scientists from developed countries Many times however either out of ignorance of the local condition or due to financial motivations these experts come out with solutions which are far from being considered as the most appropriate As a result the basic objective of protecting the environment is not achieved b Attempts made by developed countries to export their wastes especially the hazardous ones to the developing world is another danger and sometimes reason of failure encountered in the field of Environmental Management *A.I.D. Research and Development Abstracts* ,1979 A.I.D. Research and Development Abstracts United States. Agency for International Development,1979 Catalogue of Research Literature for Development: Food production and nutrition, development and economics, education and human resources, health, selected development areas United States. Agency for International Development. Bureau for Technical Assistance,1976 *Selected Water Resources Abstracts* ,1991 Water and the Environment J. Rose,2017-12-14 This compilation of papers provides useful insights on the differing approaches to water quality and the diversity of strategies in water quality management worldwide Considering the current situation and looking to the future the aim of this publication is to provide a sensible addition to the literature by concentrating on several important aspects of water and the environment **Logistics and Benefits of Using Mathematical Models of Hydrologic and Water Resource Systems** A.J. Askew,F. Greco,J. Kindler,2013-10-22 Logistics and Benefits of Using Mathematical Models of Hydrologic and Water Resource Systems is a collection of paper that details the experiences in the operational and logistical aspects of utilizing water resource models The title provides the general report on model structure and classification experiences of the hydrologic engineering center in maintaining widely used hydrologic and water resource computer models and the operational experience of on line hydrological simulation The selection also covers the implementation and application of a suite for the simulation of complex water resource systems in evaluation and planning studies and the use of a groundwater model in the design performance and the assessment and operation of a river

regulation scheme The book will be of great use to researchers and practitioners of hydrological sciences Water, Development and the Environment William James,1992-03-24 Water Development and the Environment presents an impressive compilation of ideas addressing the most pressing problems facing the world today Topics discussed include sustainable development water scarcity urban water pollution water resources management and management of landscape interventions The authors discuss new philosophies and procedures and provide examples of the environmental impact of water development particularly landscape changes *Appropriate methods of treating water and wastewater in developing countries* George Wayne Reid,Silas Law,University of Oklahoma. Bureau of Water and Environmental Resources Research,1975 **Drinking Water Microbiology** Gordon A. McFeters,2013-03-07 The microbiology of drinking water remains an important worldwide concern despite modern progress in science and engineering Countries that are more technologically advanced have experienced a significant reduction in water borne morbidity within the last 100 years This reduction has been achieved through the application of effective technologies for the treatment disinfection and distribution of potable water However morbidity resulting from the ingestion of contaminated water persists globally and the available epidemiological evidence Waterborne Diseases in the United States G F Craun ed 1986 CRC Press demonstrates a dramatic increase in the number of waterborne outbreaks and individual cases within the United States since the mid 1960s In addition it should also be noted that the incidence of water borne outbreaks of unknown etiology and those caused by new pathogens such as *Campylobacter* sp is also increasing in the United States Although it might be debated whether these increases are real or an artifact resulting from more efficient reporting it is clear that waterborne morbidity cannot be ignored in the industrialized world More significantly it represents one of the most important causes of illness within developing countries Approximately one half the world's population experiences diseases that are the direct consequence of drinking polluted water Such illnesses are the primary cause of infant mortality in many Third World countries **Basic Documents on Human Settlements for Developing Countries** BYGGDOK (Institute : Sweden),United Nations Centre for Human Settlements,1985 Water, the Environment, and the Sustainable Development Goals Mohammad Hadi Dehghani,Rama Rao Karri,Inderjeet Tyagi,Miklas Scholz,2023-11-16 Water the Environment and the Sustainable Development Goals details the availability of water resources on Earth in the context of sustainable resource management how these water resources are utilized and the latest sustainable techniques in water resource management Along with the latest techniques each chapter discusses future challenges and opportunities in sustainability and provides detailed case studies Sections cover water quality water pollution water borne diseases water purification transboundary waters water and energy water and the green economy water cooperation water scarcity and the relationship between water environments and sustainable development goals Comprehensively covers water resources on Earth and their relation to the UN Sustainable Development Goals Covers a wide range of promising approaches for water resource management Provides case studies to

further elucidate the progress made towards the SDGs and the latest developments in sustainable techniques Ways Towards Sustainable Management of Freshwater Resources ,2012-12-06 atmosphere and vegetation In what ways can key natural and cultural functions of water primarily elements of the water balance and the hydrological through direct interference by agriculture and cycle be altered by climate change To answer this through pollutant loads emanating from point and non point sources in settlements the small business characteristics of the hydrological cycle under pre sector agriculture and industry Too little is known sent climatic conditions are compared to those in a about the behavior of substances that enter water simulated climate with CO doubling equivalent to through human activities about their decomposition 2 twice present day levels Here the Council draws on and conversion and about the impacts they have on calculations made with the ECHAM OPYC coupled ecosystems and humans The most important factors atmosphere ocean model developed by the German influencing global water quality include acidification Climate Computing Centre DKRZ and the Max eutrophication salinization and pollution caused by Planck Institute for Meteorology MPI Simulations organic and inorganic trace compounds pesticides with the model show that more precipitation falls on and heavy metals for example Quality standards land masses in a warmer climate especially at high such as those governing agricultural and industrial latitudes and in parts of the tropics and subtropics uses have yet to be defined for many other types of while other regions have less rain The latter include use

Waste Water Treatment Technologies - Volume II

Saravanamuthu Vigneswaran ,2009-09-25 Water and Wastewater Treatment Technologies theme is a component of Encyclopedia of Water Sciences Engineering and Technology Resources in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias The Theme on Water and Wastewater Treatment Technologies deals in three volumes and covers several topics with several issues of great relevance to our world such as Urban Wastewater Treatment Characteristics of Effluent Organic Matter in Wastewater Filtration Technologies in wastewater treatment Air Stripping in Industrial Wastewater Treatment Dissolved air flotation in industrial wastewater treatment Membrane Technology for Organic Removal in Wastewater Adsorption and Biological Filtration in Wastewater Treatment Physico chemical processes for Organic removal from wastewater effluent Deep Bed Filtration Modelling Theory And Practice Specific options in biological wastewater treatment for reclamation and reuse Biological Phosphorus Removal Processes For Wastewater Treatment Sequencing Batch Reactors Principles Design Operation And Case Studies Wastewater stabilization ponds WSP for wastewater treatment Treatment of industrial wastewater by membrane bioreactors Stormwater treatment technologies Sludge Treatment Technologies Wastewater Treatment Technology For Tanning Industry Palm Oil And Palm Waste Potential In Indonesia Recirculating Aquaculture Systems A Review Upflow anaerobic sludge blanket UASB reactor in wastewater treatment Applied Technologies In Municipal Solid Waste Landfill Leachate Treatment Water Mining Planning and Implementation Issues for a successful project Assessment methodologies for water reuse scheme and

technology Nanotechnology for Wastewater Treatment These three volumes are aimed at the following five major target audiences University and College students Educators Professional practitioners Research personnel and Policy analysts Managers and Decision makers and NGOs

Drinking Water Treatment for Developing Countries Aniruddha Bhalchandra Pandit, Jyoti Kishen Kumar, 2019-03-06 Drinking water availability and safety is a major challenge faced globally and is highly pronounced in developing countries worldwide Lack of safe potable water across the globe can be attributed to industrial pollution climate change and other human activities that result in a spectrum of chemical physical and biological pollutants entering a water body Although efforts to solve this problem are well underway worldwide challenges still exist This book shines a light on drinking water treatment methods and scale of operation specifically for the developing countries Covering both conventional and emerging treatment technologies the authors discuss the removal of chemical physical and biological pollutants from drinking water with a focus on developing countries Conservation by rainwater harvesting wastewater reuse and selection criteria of feasible methods are considered in the context of issues relevant to Africa Asia Latin America and the Caribbean With case studies connecting theory to real world matters showcasing efficiencies and drawbacks this book is ideal for graduate and postgraduate level course use in engineering departments or for self study and research

Sustainable Treatment and Reuse of Municipal Wastewater Menahem Libhaber, Alvaro Orozco Jaramillo, 2012-05-31 In many countries especially in developing countries many people are lacking access to water and sanitation services and this inadequate service is the main cause of diseases in these countries Application of appropriate wastewater treatment technologies which are effective low cost in investment and especially in operation and maintenance simple to operate proven technologies is a key component in any strategy aimed at increasing the coverage of wastewater treatment Sustainable Treatment and Reuse of Municipal Wastewater presents the concepts of appropriate technology for wastewater treatment and the issues of strategy and policy for increasing wastewater treatment coverage The book focuses on the resolution of wastewater treatment and disposal problems in developing countries however the concepts presented are valid and applicable anywhere and plants based on combined unit processes of appropriate technology can also be used in developed countries and provide to them the benefits described Sustainable Treatment and Reuse of Municipal Wastewater presents the basic engineering design procedures to obtain high quality effluents by treatment plants based on simple low cost and easy to operate processes The main message of the book is the idea of the ability to combine unit processes to create a treatment plant based on a series of appropriate technology processes which jointly can generate any required effluent quality A plant based on a combination of appropriate technology unit processes is still easy to operate and is usually of lower costs than conventional processes in terms of investment and certainly in operation and maintenance Chapters in the book are organized in a practical and accessible way to Demonstrate selected unit process of appropriate technology and provide the scientific basis the equations and the parameters required to design the unit processes with some

innovations developed by the authors Highlight design procedures for selected combined processes which are in use in developing countries Propose an innovative Orderly Design Method ODM which is easy to follow by practicing engineers using the equations and formulas developed once the fundamentals of each unit and combined process have been established Provide a numeric example for the basic design of each selected appropriate technology process for a city with a population of 20 000 using the ODM and an Excel program which will be provided to the readers for download from an online web page This book is a valuable and practical resource for all wastewater treatment engineers in field and the operational managers of waste treatment facilities Authors Menahem Libhaber PhD Consulting Engineer to the World Bank and other institutions Alvaro Orozco Jaramillo MSc Consulting Engineer to the World Bank the Inter American Development Bank Biwater and other institutions in various countries

Modernization of Agriculture in Developing Countries I. Arnon, 1987 Until quite recently agriculture in most developing countries of the Third World has been largely neglected by policy makers economists and planners on the assumption that most resources should be devoted to industry However there is a growing realization that without progress in agriculture there will be economic stagnation inadequate food production and the vicious circle of poverty and low productivity will be perpetuated The great hopes pinned on the Green Revolution have only been partially realized and any success is still confined to a fraction of the areas in need of development Where the Green Revolution has been successful many problems have arisen in its wake some being anticipated but others not of which potentially the most explosive are the increasing gaps between various sectors in the rural population and between regions

WATER HEALTH - Volume II , 2010-10-24 Water Health is a component of Encyclopedia of Water Sciences Engineering and Technology Resources in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias These volumes discuss matters of great relevance to our world on desalination which is a critically important as clearly the only possible means of producing fresh water from the sea for many parts of the world The two volumes present state of the art subject matter of various aspects of water health such as Water And Health Classification Of Water Related Disease Burden Of Disease Current Situation And Trends Transmission And Prevention Of Water Related Diseases Goals Of Water Treatment And Disinfection Reduction In Morbidity And Mortality Diseases Associated With Drinking Water Supplies That Meet Treatment And Indicator Specifications New And Emerging Waterborne Infectious Diseases Safe Drinking Water In The Twenty First Century Priorities For Public Health Health Impact And Economic Costs Of Poor Water And Sanitation Water Safety Plans For Water Technologies Hygiene Promotion Institutional Issues In The Delivery Of Water And Sanitation Services Economics And Financing In The Water Sector Monitoring Drinking Water Supplies Zoonoses Acquired Through Drinking Water Microbiological Water Quality Assessment Catchment To Tap Epidemiologic Studies Of Disinfectants And Disinfectant By Products Health Effects Of Chemical Contamination Of Drinking Water Supplies Unconventional Sources Of Water Supply Point Of Use Water Treatment For Home And Travel Treatment And Safe Storage

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,1982

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