

**KOREA
INTERNATIONAL
WATER WEEK**

World Water Challenge

2018

Date September 13, 2018

Venue #315 EXCO | Daegu, Korea



Ministry of Environment



**KOREA
WATER FORUM**

KWF



Introduction

The World Water Challenge was created as a special program of the Science and Technology Process in the 7th World Water Forum to identify imminent water problems that the world is facing and to find feasible solutions keeping in mind implementation, the core value of the 7th World Water Forum. The program aims to present science and technology that are applicable to the real world and come up with the optimal solutions to defined water challenges. Since the great success of the 1st edition in 2015, the program has become one of the symbolic platforms of implementation which has been followed up in the Korea International Water Week over 3 years.

This year, the World Water Challenge 2018 will be held as one of the signature programs of the KIWW 2018. Linking Problem Owners and Solution Providers, this 4th edition of World Water Challenge is expected to serve its role as an important platform to share the ideas and know-hows towards solving the global water challenges and to forge a broad network among experts and stakeholders in water sector, focusing on scientific and technological method that have contributed to the world's awareness on the importance of role of science and technology in solving the water challenges. The best solution out of 7 selected solutions to the 5 water challenges will be decided through the final presentation and winners will be awarded at the closing ceremony of KIWW 2018.

OBJECTIVES

- to share appropriate and innovative ideas and know-hows based on science and technology that are applicable to the real world by linking problem owners with solution providers
- to raise the world's awareness on the water issues as well as the importance of the role of science and technology in solving the water challenges
- to provide a networking opportunity among participants from the water-related corporations and organizations to create a business opportunity and make an inroad into the global market by presenting those innovative solutions

OVERVIEW

- **Date & Time** September 13th, 2018 / 13:00 -17:30
- **Venue** #315(3F), EXCO, Daegu, Korea
- **Participants** Participants of final round, water-related organizations and corporations, Medias and other interested persons
- **Host/Organizer** Ministry of Environment, Rep. of Korea / Korea Water Forum

Program

Time	Contents
13:00~13:10	Opening & Welcoming Remarks
13:10~13:15	Introduction of World Water Challenge 2018 Final Round
13:15~13:35	Invited Talk : A Bucket brings Fresh Water, Sorain Bucket Ms. Hyeln SHIN, Research Student, Sungkyunkwan University Graduate School of Water Resources, Korea * <i>The winner of the World Water Challenge 2017</i>
CHALLENGE 1	
13:35~13:45	Challenge Low Agricultural Water Productivity in Urmia Lake Basin Dr. Hossein Dehghanisanij, Associate Professor, Agricultural Research, Education and Extension Organization (AREEO), Agricultural Engineering Research Institute (AERI), IRAN
13:45~14:00	Solution The Buried Diffuser : an Effective Underground Irrigation System for Optimal Water Management Mr. Mohamed Wassim Chahbani, Co-owner - Executive Assistant, Chahtech, Tunisia
14:00~14:10	Q&A and Discussion
CHALLENGE 2	
14:10~14:20	Challenge Septage Management in the Urban Areas of Indonesia Dr. Yoshitaka Ebie, Senior Researcher, National Institute for Environmental Studies, Japan
14:20~14:35	Solution Sustainable Rainbow Mr. Alaaeldin Elozeiri, Senior Student, Zewail City of Science and Technology, Egypt
14:35~14:50	Solution Septage Management through Decentralization of Septic Tanks and Community Participatory Approach Engr. Mufalo Nanyama, Technical Manager, North Western Water Supply & Sewerage Company, Zambia
14:50~15:00	Q&A and Discussion
15:00~15:10	Coffee Break
CHALLENGE 3	
15:10~15:20	Challenge Choluteca River "Mad Waters" Ms. Jessica Margarita Barahona Aragón, Honduras
15:20~15:35	Solution Qesungual Belt for Flood Mitigation Ms. Jessica Margarita Barahona Aragón, Honduras
15:35~15:45	Q&A and Discussion
CHALLENGE 4	
15:45~15:55	Challenge Problems Pertinent to Prevalence of Excessive Fluoride in Different Water Sources Ms. Ruth Habte Hailemariam, Researcher and PhD Student, Korea Institute of Civil Engineering and Building Technology, Ethiopia
15:55~16:10	Solution Low-cost and Low-tech Defluoridator Device based on Calcium Phosphate Dr. Alfredo Idini, Ph.D. Student, University Of Cagliari, Department of Chemical and Geological Sciences, Italy
16:10~16:20	Q&A and Discussion
CHALLENGE 5	
16:20~16:30	Challenge Water Insecurity in Manoka Engr. Ngongang Kondiekong Nathalie, Engineer, Ministry of Water and Energy, Cameroon
16:30~16:45	Solution Multiple Water Solutions for Water Insecurity in Manoka Islands Mr. Jos C Raphael, Secretary, Mazhapolima - District Rainwater Harvesting Mission, India
16:45~17:00	Solution Water Resource Management for Future Water Security Ms. Meesha Tandon, Independent Consultant (urban, water, sanitation and climate change), Sustainability and Adaptation Planning Foundation, India
17:00~17:10	Q&A and Discussion
17:10~17:15	Closing Remarks
17:15~17:30	Group Photo & Notification of Award Ceremony & Closing

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[Challenge] Septage Management in the Urban Areas of Indonesia / Yoshitaka Ebie

[Solution] Sustainable Rainbow / Alaaeldin Elozeiri

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World Water Challenge

2018

Invited Talk

A Bucket brings Fresh Water, Sorain Bucket

The Winner of the World Water Challenge 2017

Ms. Hyeln SHIN

Research Student, Sungkyunkwan University Graduate School of Water Resources, Korea

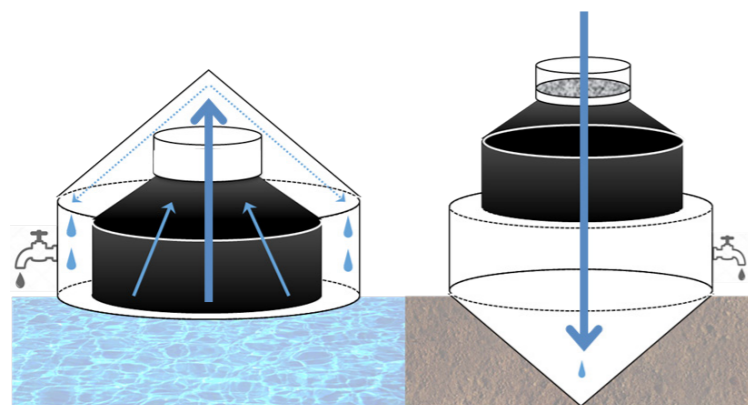
Invited Talk

A bucket brings fresh water, Sorain Bucket

- Hyeln SHIN

Residents of Kojani island, Tanzania experienced severe water scarcity because of lack of water treatment system and saline ground water. This island has four types of water supply sources. First source is pipe line water supply system from Pemba island to Kojani island, Second is brining water from Pemba to Kojani by using non-hygienic plastic buckets on wooden boats, Third is five shallow open wells and the last is artificial surface water pond used for livestock and domestic purposes. But these sources are providing technically and economically insufficient quantity or not appropriate for health because of contamination and salinity. So, these water supply sources does not properly work to provide potable water, thus alternative water supply system needs to be developed.

There are three conditions considering for the design of water supply system. First condition is the main water resources, which are saline ground water and seawater. A solar thermal desalination method would be the best option as concern that tropical climate and saline water of Tanzania. Second condition is rainfall in the island. There are two rainy seasons so that constructing adequate rain water harvesting system can supply the fresh water to residents. The last condition to be considered is sustainability. The alternative system should be easy to handle and to maintain for local people. To sum up, we proposes a water supply system enabling a solar thermal desalination and rain water harvesting, which can be easily operated by local people. These will meet all the essential conditions of the alternative water supply system for Kojani island.



We select polycarbonate (PC) as the core material for the device because it is relatively inexpensive and transparent to transmit solar heat, and also has high strength and heat resistance. We admit that Sorain Bucket can reduce cost and it is sustainable because it is not only treating water, but also storing water over night during rainy season. The life time of this system is almost permanent and its maintenance costs would be negligible. For these reasons, we claim that Sorain bucket is the realistic solution for Water Challenge in Kojani island.

World Water Challenge 2018

Challenge 1

Challenge

Low Agricultural Water Productivity in Urmia Lake Basin

Dr. Hossein Dehghanisanij

Associate Professor, Agricultural Research, Education and Extension Organization (AREEO),
Agricultural Engineering Research Institute (AERI), IRAN

Solution

The Buried Diffuser : an effective underground irrigation system for optimal water consumption and management.

Mr. Mohamed Wassim Chahbani

Co-owner - Executive Assistant, Chahtech, Tunisia

Challenge

Low Agricultural Water Productivity in Urmia Lake Basin

- Hossein Dehghanisani

The Urmia Lake Basin is a generally mountainous territory containing two of the famous Iranian volcanic peaks (Sahand, 3707 m. and Sabalan, 4810 m.), and with several vast productive plains in the valleys and around the Lake. Most parts of the Basin are located at altitudes above 1280 m and up to 4886 m above mean sea level and its within the 3 cities of West Azerbaijan, East Azerbaijan and Kurdistan. Irrigated agriculture and horticulture for long have been the main occupation in the area. Rain-fed cultivation of cereals and to lesser extent peas is also a common practice in all parts of the basin. Main winter crop in the area is cereals (including wheat and barley). Summer crops include alfalfa, potato, tobacco, cotton and cash crops (tomato, eggplant, cucumber, sugar beet, etc). Horticulture is also an important activity particularly in the West Azerbaijan. Apple and grape are the dominant garden production, while other fruits such as peaches, plums, berries, are also largely produced. Land use of the Urmia Lake Basin has been studied in several cases during the last 3 decades. Agricultural sector is the main water user in the basin. Also it is releasing significant chemical residues into water resources. It is estimated that close to 90% of water resources are used in this sector. According to 2006 data, the volume of water used in agriculture is estimated at 5600 mcm/yr. This volume has been 1800 mcm/yr in 1979. It is estimated 200,000 Tons of fertilizer and 4,000 Tons of pesticides and herbicides are applied annually. Residues of these chemicals when transferred to the water resources seriously impact their quality and ecological attributes. Basin-wide average efficiency of water use for irrigation is estimated at 30%. The traditional downslope plugging of steep foot-hills for rainfed cultivation is also a very important factor for soil erosion in the farms and sedimentation in water resources (rivers and wetlands).

The lake has faced extreme water loss in recent years due to overuse and mismanagement. Over the last thirty years the population in the lake basin has been doubled and the agricultural area fed by water resources of the lake basin has tripled. The mean annual water level is currently more than four meters below the critical level (1274 m above sea level) needed to sustain ecosystems. In October 2015, it reached to the lowest level and southern parts of the lake totally dried. A wide range of users continue to extract water from the basin that feeds the lake and precipitation decreases by 18 percent in Urmia Lake Basin (ULB) compare to its long-term record. Besides, evaporation loss rate and regional demand on water of different sectors, especially agriculture have increased. Therefore, inflows to the lake have decreased drastically and the situation has been exacerbated by continuous droughts, resulting in reduction of renewable water resources and the lake's water levels at an alarming rate.

Solution

The Buried Diffuser : an effective underground irrigation system for optimal water consumption and management.

- Mohamed Wassim Chahbani

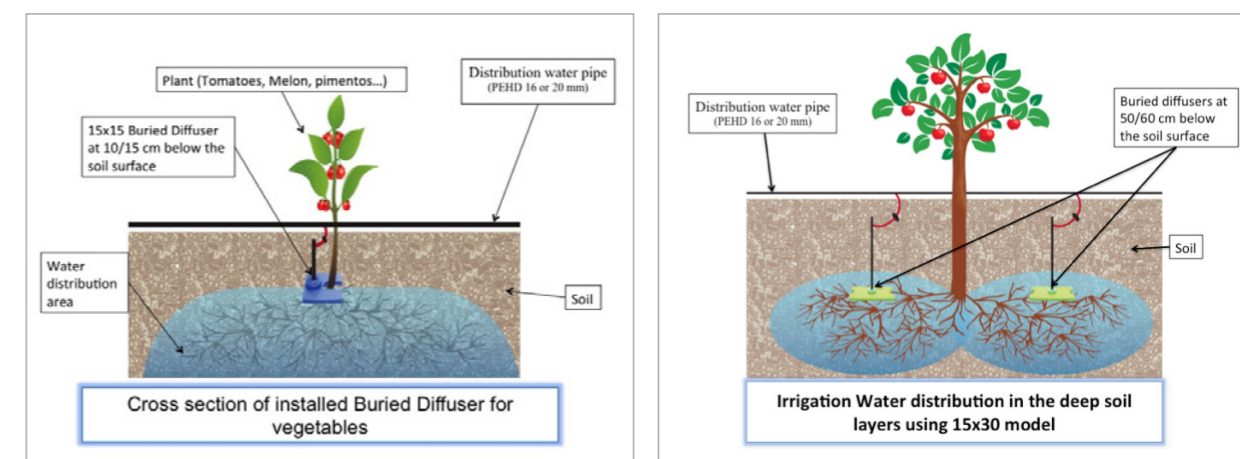
The critical situation that the Urmia Lake Basin is facing requires an immediate and effective solution, which covers every aspect of the problem, in order to deal with the ever growing population and food demand, the serious water scarcity coupled with the increase of water demand of different sectors and especially agriculture, not to mention the exponential decrease of precipitation, renewable water resources and the continuous drought.

the "Buried Diffuser" is the perfect fit for this situation and brings a sustainable solution, it allows a very efficient and effective localized underground irrigation that delivers water and nutrients to plants at the root level and thus drastically reduces water loss from evaporation and therefore dramatically reduces the level of water consumption used for irrigation, especially compared to the currently most used techniques. In addition to numerous advantages such as more plant productivity, the reduction of the number of irrigations, healthier plants and better quality crops, eliminating herbicides use, reduction of soil salinization, improved soil aeration and energy savings.

The buried diffuser is a powerful solution to multiple societal challenges such as climate change, food and water security related problems.

The system is comprised of diffusing parts, which facilitate water infiltration of the soil. A connection to a water distribution pipe helps regulate water flow to plants. The buried diffuser works with gravity, as well as conventional water pressure to ensure that crops are efficiently getting the water they need. This innovation performs better than currently widespread irrigation methods.

The Buried Diffuser covers multiple potential usages including trees, shrubs, vegetables in fields and in greenhouses, plants in containers, hydroponic and raised bed greenhouse cultivation.





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Challenge 2

Challenge

Septage Management in the Urban Areas of Indonesia

Dr. Yoshitaka Ebie

Senior Researcher, National Institute for Environmental Studies, Japan

Solution

Sustainable Rainbow

Mr. Alaaeldin Elozeiri

Senior Student, Zewail City of Science and Technology, Egypt

Septage Management through Decentralization of Septic Tanks and Community Participatory Approach

Engr. Mufalo Nanyama

Technical Manager, North Western Water Supply & Sewerage Company, Zambia

Challenge

Septage management in the urban areas of Indonesia

- Yoshitaka Ebie

Indonesia is the fourth most populous country in the world with a total population of more than 260 million people, of which about 52% live in urban areas. It has been predicted that by 2025, 67.5% of population will live in cities. This situation will create a huge burden for basic urban infrastructure, especially related to water and sanitation systems.

It is estimated that about 95% of the human waste in Indonesia ends up untreated or partially treated in septic tanks before being discharged either into open water bodies or onto soil, contaminating the living environment, and causing huge negative impacts to human health and economic development.

More than 90% of Indonesian households still rely on onsite sanitation systems, especially septic tanks. However, due to poor design and performance, effluent and sludge generated from septic tanks (often referred to as "septage"), which are rich in organic compounds and nutrients, are often discharged directly into environment, thus exposing a threat of contamination to soil, and both surface and groundwater sources, and human health. In addition, this septage is often illegally discharged into the open environment, or improperly treated or re-pumped into sewerage system without proper treatment (e.g. Bandung city), despite the fact that more than 150 septage treatment plants have been constructed in medium and large cities across the country over the past 20 years, but unfortunately only less than 10% of them are in use and well-operated due to both inefficient septage treatment technologies, and insufficient septage for treatment since there is few demand for septage emptying/desludging from households.

This problem is also commonly found in many other countries in Asian region such as Vietnam, Laos, Cambodia, Bangladesh, India, Philippines, etc. According to a recent study, it is estimated that Indonesia experience a loss of 56 trillion Rupiah or \$4.2 billion each year due to the poor quality of sanitation (World Bank, 2017).

In term of septage management, Indonesia is now facing major challenges at both regulatory and practical level, due to (i) lack of attentions and investment from local and central government; (ii) weak enforcement of regulations and practical standards; (iii) lack of detailed guidelines on the standard design and proper maintenance of septic tanks, which leads to improper treatment of domestic wastewater; (iv) lack of demand for septage emptying and collection from households, and illegal and uncontrolled septage discharge into water bodies by private companies; (v) lack of integrated approach for both urban domestic wastewater and septage management; (vi) and especially lack of appropriate business model for septage management, which could facilitate the involvement and investment from private sector. These

are all major challenges, which have been identified based on our case study on septage management in Bandung city of Indonesia. Unless these challenges can be solved, otherwise it is impossible for Indonesia to achieve the country's targets as set in the National Medium-Term Development Plan (RPJMN) 2015-2019 as well as Sustainable Development Goal 6, especially the target 6.2 and 6.3 on sanitation and improved water quality, respectively.

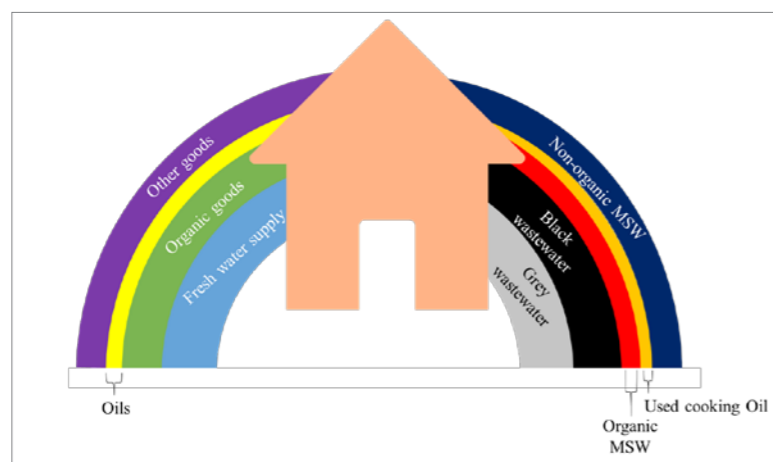
Solution

Sustainable Rainbow

- Alaaeldin Elozeiri

A water droplet wandering in the sky met with a group of twinkling photons after traveling 150 million km journey. These photons leave the droplet separated, but yet they are still in harmony forming the impressive "Rainbow". Down at the surface of the Earth, humans are consuming various resources that are converted to various sorts of waste streams, but unfortunately these streams are not in harmony, but are being mixed together and left to the environment and future generations to suffer from their combined hazardous effects.

This proposal aims to develop a new approach for domestic waste management in general and municipal wastewater in specific. The proposed system "Sustainable Rainbow" is developed as a decentralized unit in order to avoid many infrastructure, economic and policy constraints. Sustainable rainbow is a system to establish a harmony between domestic waste streams just like the photons; so that the big image is the sustainable processing of domestic waste streams aiming to efficiently recover their nutrients and energy. The proposal's idea and implementation strategy is reflected on the situation of urban areas in Indonesia whose main way for wastewater handling is the on-site large septic tanks to hold the wastewater for years. The economic stress pushed many residence to have leakage in their septic tanks in order to decrease the cost of evacuating the tank. In context, this proposal holds economical return as a main parameter in its design.



Solution

Septage Management through Decentralization of septic tanks and Community participatory approach.

- Mufalo Nanyama

Indonesia's city of Bandung has symmetrical environment like the North western city in Zambia named Solwezi with a population of about half a million. High industrialization as a result of copper mining activities has created a burden for basic urban infrastructure relating to water and sanitation. However, the decentralization approach to sanitation has improved the whole septage management. A project on Decentralization of septic tanks through a community participatory approach yielded tremendous results. The key phenomenon was to reduce Non-point source pollution to point source pollution which allows monitoring and management. Conversely, in the case of Bandung City, lack of understanding on the needs of proper maintenance of septic tanks and proper septage management has impacted on strategies for any improvement. There is need to disseminate information on septic tanks in communities through flyers and radio programs. The community should be involved under such programs like Community Participatory Approach (CPA). Teach House holds the basic conditions associated with septic tanks construction like; water tightness of septic tanks, surrounding soil structure, hydraulic consideration in tank sizing and adoption of Communal anaerobic digesters (ADs).

The lack of coordination among relevant stakeholders group can only be resolved by the PDAM. As the main operator and state company, PDAM should do an audit and map a Septage Flow Diagram (SFD) to know exactly how many septic tanks are available in Bandung City and possible daily flows that will require desludging. Private operators should be monitored by local agencies to ensure 100% of collected septage is delivered to treatment plants without any losses to avoid contamination. Introduction of monthly performance indicators by PDAM will improve co-ordination, as local agencies that regulate private sector operations will have monitoring tools to enhance accountability.

Poor performance of onsite sanitation system has to do with assessment before construction. Water tightness of septic tanks, surrounding soil structure and hydraulic consideration of tanks is critical. However, in Bandung City; decentralization of septic tanks is non-negotiable. Grouping of users instead of multiple septic tanks is the start point. In a City of 2.5 Million people at 95% utilization of septic tanks means 2.4 Million people require 395,800 septic tanks if we consider 6 persons per house hold. By decentralization through grouping of septic tanks, only 79,000 septic tanks will be required for the same population resulting in 20% reduction in non-point pollution. Introduction of decentralized plants that can cover 200-300 households will further reduce the pollution by 30%-50% and improve septage quality by 70% (Jeannette et.al 2017).



Lack of septage treatment facilities in Bandung City requires immediate and long term strategies. The long term solution will require investment in modern Waste Water Treatment facilities. On the other hand, the immediate and less costly intervention is grouped House hold septic tanks and decentralization .Grouped septic tanks should be designed as dome shaped to increase compressive strength and water tightness; the main advantage is harnessing gas out of these Communal anaerobic digesters (ADs).This is a clear promotion of waste-to-energy strategy that provides sanitation and clean energy co-benefits.

Challenge 3

Challenge

Choluteca River “Mad Waters”

Ms. Jessica Margarita Barahona Aragón

Honduras

Solution

Quesungual Belt for Flood Mitigation

Ms. Jessica Margarita Barahona Aragón

Honduras

Challenge

Choluteca River “Mad Waters”

- Jessica Margarita Barahona Aragón

In Tegucigalpa, capital of Honduras in Central America, the majority of its urban dwellers are experiencing numerous environmental and ecosystem burdens which are increasing simultaneously at unprecedented speed. In one hand, the capital city has been devastated by several landslides and flooding caused by the increase of the water levels of the Choluteca River and its tributaries during the rainy season. In every flooding event, the economy of the city is paralyzed as the markets and commercial areas are most affected by the water overflow. The vulnerability to flooding has also paralyzed some assets located in the historic districts the city. Lots located near the riverside are completely degraded and some have been abandoned becoming a nest of drugs and gangs. The floods produced by the Choluteca River and its tributary are a cause for constant concern. On the other hand, during summer the capital is affected by the drying up of its water resources, so that long water rations have been prevailing already for many years.

The actual situation of the country poses a big dilemma: the limited economic capital is mostly oriented to providing basic necessities for their citizens and improving on priority areas of economic development. Thereby, mitigating the causes and effects of natural catastrophes tend to cripple more its struggling economy and slow more its development.

Since the passing of the a major hurricane –hurricane Mitch in 1998- and after its legacy of destruction within the city, the Choluteca River has been subject to several analyses and project formulations in order to diminish its flooding and landslide impacts. However, these plans have been mostly engineered-based, or consist of large civil engineering projects that are focused in certain areas of the urban waterfront, yet, rivers under severe stress are those where development and land uses within the catchment also have completely ignored their impact and influence on the river system. The catchment area is too frequently forgotten in strategic planning. The challenge, therefore, is to recognize that river and catchment are a single unit and should be treated as such.

Solution

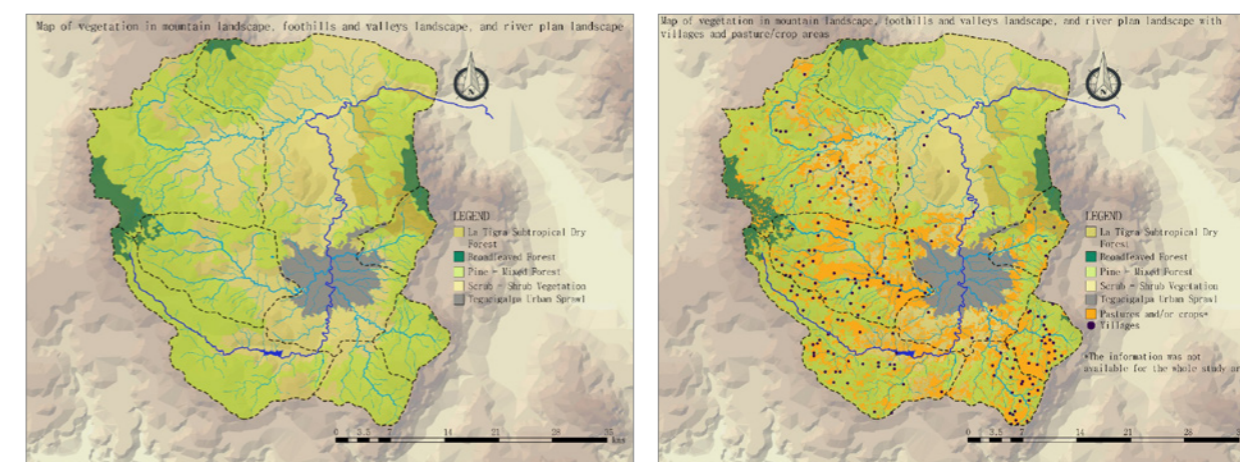
Quesungual Belt for Flood Mitigation

- Jessica Margarita Barahona Aragón

The approach to address the Choluteca River “Mad waters” issue is oriented to watershed planning and management. Knowing that each watershed has unique living and nonliving components that interact, with one element responding to the action or change of another, the watershed represent the most logical basis for mitigation strategies. Moreover, considering the most of the rain falls in the mountains and not in the city, the mountainous region become key to flood alleviation strategies.

Through an analysis of Landscape Systems and by overlaying biophysical layers of information it was possible to understand that the watersheds that fed the Choluteca River possess forests with vegetation that are key to collect rainwater and reduce the runoff water. Due to its association with epiphytic vegetation, which can retain water up to 20 times their dry weight and can maintain stable water flow even in times of water shortage, the cloud forests and mixed forests play an important role as collectors, managers and stabilizers of the water flow of rivers and streams.

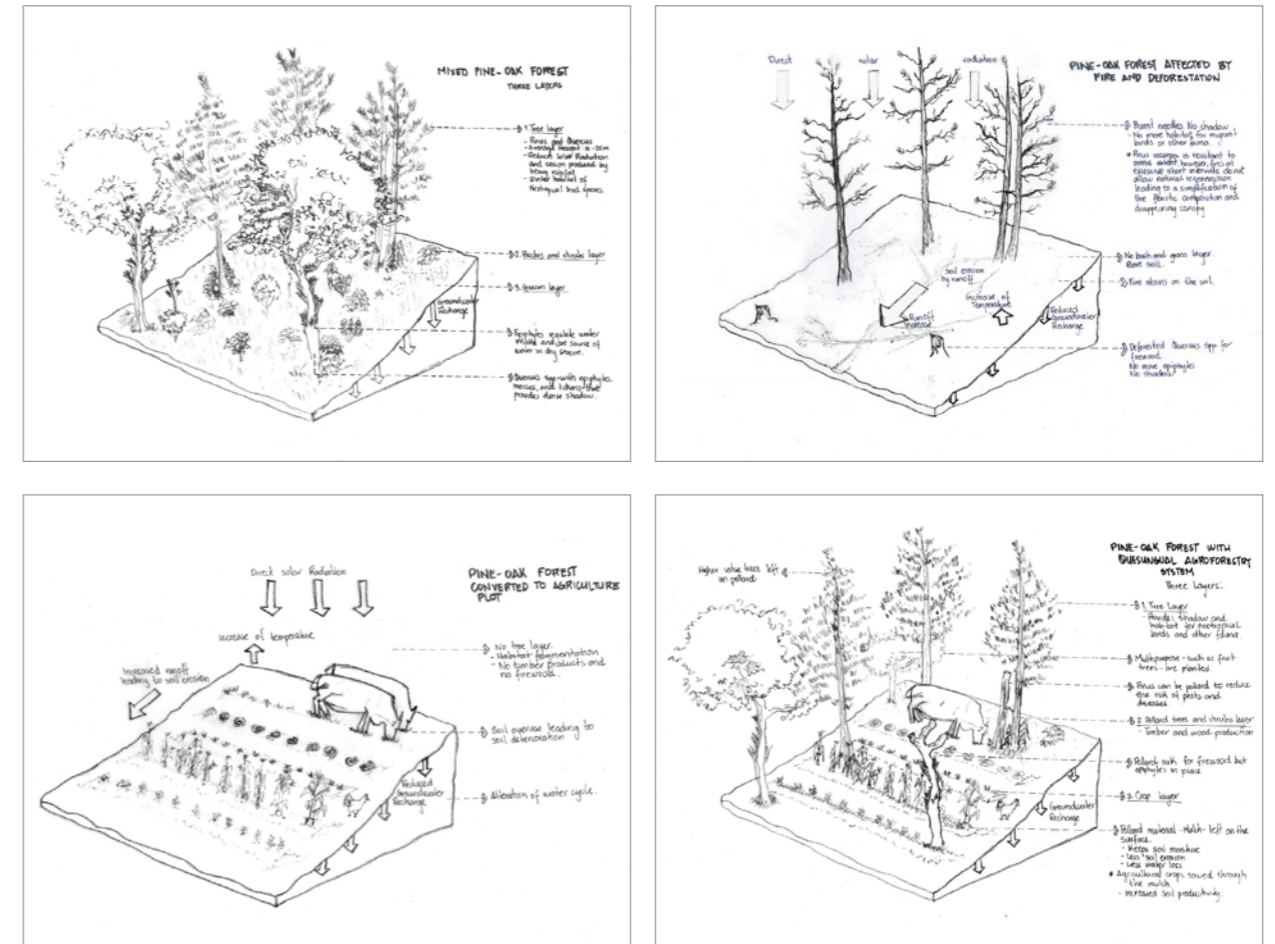
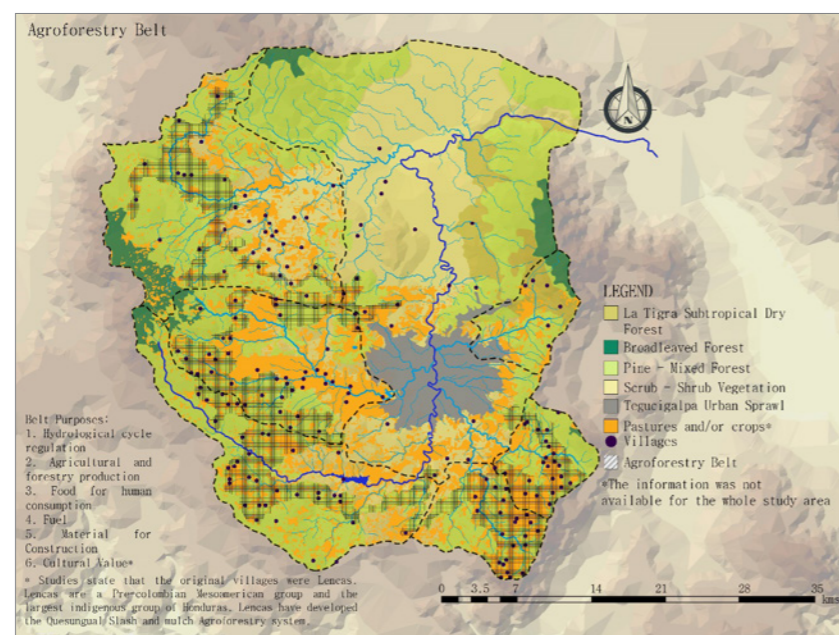
The extremely rich biodiversity as it reflects in plant life is a precious asset. However, many villages are, and tend to be located in the medium elevations - due to climatic conditions and type of vegetation propitious for logging and domestic use- imposing stress in the environment through land-use mismanagement, deforestation and changes in the native vegetation that is influenced by forests fires and by the use of fire as a generalized tool in practices of lot cleaning and expansion of the agricultural frontier.



Yet, the prohibition of agricultural activities does not exist as a possibility since it represents the only source of income for most of the inhabitants of the region. Thus, the solution to the threats of the watersheds require prescriptions that are viable in productive, economic and biological terms while at the same time increase the biodiversity and helps maintain the native vegetation, which is an important regulator of water flows.

As such, an agroforestry belt strikes as a strategy suitable for such purposes. Within the belt, the Lenca's Quesungual Agroforestry System can be implemented. This system, originated in the country, aims to restore forest cover, improve soil and water conservation while crop productivity is also increased. The system abandons slash-and-burn practices. It combines selective thinning and pruning of native tropical forests with the planting of annual crops, and improved grasses with no burning, zero tillage/direct planting and spot fertilization. It additionally uses tree biomass as permanent soil cover.

Since farmers use different criteria for selecting trees to thin and/or to retain, the adoption of the system results in a diverse landscape mosaic composed by three layers of vegetation: trees, pollarded trees with shrubs, and agricultural crops. The most distinctive feature of the system is the existence of pollarded shrubs and non-slashed multipurpose trees such as high-value timber and fruit trees. This feature could help maintain the valuable epiphytic layers in the broadleaf forests and mixed forests of the watershed.





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Challenge 4

Challenge

**Problems Pertinent to Prevalence of Excessive Fluoride in
Different Water Sources**

Ms. Ruth Habte Hailemariam

Researcher and PhD Student, Korea Institute of Civil Engineering and Building Technology, Ethiopia

Solution

**Low-cost and Low-tech Defluoridator Device based on
Calcium Phosphate**

Dr. Alfredo Idini, Ph.D.

Student, University Of Cagliari, Department of Chemical and Geological Sciences, Italy

Challenge

Problems Pertinent to Prevalence of Excessive Fluoride in Different Water Sources

- Ruth Habte Hailemariam

Fluoride is the most reactive, nonmetallic, harmful inorganic substance affecting the ecosystem and the human health (when it's ingested above the standard 1.5 mg/L). A human being can ingest fluoride in to its body through food, water, breathing air, drugs and cosmetics. Fluoride in any water source is believed to emanate either from the parent material rocks or from different anthropogenic effects (mainly industrial wastewater). Higher amount of fluoride ion in ground and surface water sources (up to 2,800 mg/L) has been recorded in different countries such as Australia, Middle East, South America, North Africa, Ethiopia, Kenya, Thailand, China, India and others. Nowadays, more than 200 million people from more than 35 nations across the world are suffering from excess fluoride in water. The existence of excess fluoride in the water has negative effect both on the aquatic life and to the human well beingness. Most countries' local government has a standard for fluoride level in drinking water and for disposal of wastewater effluents.

A fluoride concentration in water bodies as low as 0.5 mg/L can adversely affect freshwater invertebrates and fishes. In aquatic animals, fluoride is accumulated in tissues and inhibit the entire metabolic processes of small animals. These impact on such small animals might lead to the collapse of entire ecosystems as such the effect of fluoride ion in the entire biosphere is significant enough to touch all the aquatic and terrestrial animals. Fluoride also hazardous to the human health. Any amount of fluoride over 1.5 mg/L have its own negative impact. For instance fluoride amount 1.5–4.0 mg/L causes dental fluorosis, 4.0–10mg/L cause dental and skeletal fluorosis and greater than 10.0mg/L cause paralysis, crippling fluorosis.

Its effect also leads to other internal disease including cancer and malfunctioning of body organs. To avoid this environmental health impacts, fluoride removal from different water sources has drawn big attention for extended period of time for the reason that it's complete removal is very difficult to be attained by the conventional methods such as precipitation, ion exchange, adsorption and coagulation. Therefore, an efficient and cost-effective advanced water treatment options based on the state of art technologies is urgently required to liberate vulnerable people and the ecosystem. Various membrane based and hybrid system technologies has been forwarded as one of the best available innovative defluoridation technologies for the removal of excess fluoride from industrial wastewater and from drinking groundwater sources.

Solution

Low-cost and Low-tech Defluoridator Device based on Calcium Phosphate

- Alfredo Idini

Natural fluoride contamination in waters is a serious issue that affects East African Rift Valley, especially the rural areas of Ethiopia, Kenya and Tanzania, resulting in a low quality of water and also in its scarcity given that many wells and springs are, up to now, too strongly contaminated to be used. Exposure to fluoride concentration > 1.5 mg/L via drinking water can cause deformities of hard tissue named skeletal and crippling fluorosis and, in the worst cases, neurological concerns. Furthermore, the scarcity of drinking water causes social-humanitarian issues, i.e. water conflict and migration flows, and prevents a normal community growth.

An effective defluoridation method should be: (i) low-cost to make even the poorest part of the population able to access to drinkable water; (ii) low-tech based, easy to use and distribute in order to reach the population regardless of where people live; (iii) highly efficient to avoid waste of water resources; (iv) free of collateral effects on water quality. Such a method has not yet been developed until now. These requirements are essential to enhance the quality of life and health of rural populations, the most susceptible to fluoride contamination. Furthermore, a decentralized distribution of cheap and simple defluoridators guarantees the population to exert a direct control on the local water resources leading to a mitigation of social problems and potential supply conflicts.

For these reasons we propose a very cheap, easy-to-produce, recyclable synthetic phase able to remove fluoride from water, and a simple, low-scale defluoridator device. The solid phase is a calcium phosphate composed of Octacalcium Phosphate (OCP), which is the precursor of apatite. The device essentially consists of a tank (in which water and the solid material are put inside) equipped with a tap on the bottom (for water recovery) and an overhead stirrer on the top that guarantees the better interaction between water and solid phase. A filter paper placed below the tap removes the solid residue after the fluoride uptake. Within the tank the OCP, in the presence of F⁻-rich water, transforms into fluorapatite removing fluoride from water; laboratory tests show that 1 g of Ca-phosphate can easily uptake more than 25 mg/L of fluoride in few hours. After the treatment the water is drinkable and the device can last indefinitely.

Tank dimension can be variable from ten to several tens of liters, thus the device can be fitted for different needs, from single family in-house use to villages in-source use. The stirring inside the tank can be obtained through electricity (e.g. solar power, rechargeable batteries, generators) or through human or animal

energy. All the described features of this method meet the above-mentioned requirements (low-cost, high efficiency, low technology, ease distribution) for an effective defluoridator.

Here below we describe a test, performed at the laboratories of the University of Cagliari (Italy) with a ten-liter tank, that demonstrates the strength of our proposal. This study is a part of the FLOWERED project funded by the European Union's Horizon2020 Research and Innovation Program.

<http://www.floweredproject.org/en/index.php>



Challenge 5

Challenge

Water Insecurity in Manoka

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Solution

Multiple Water Solutions for Water Insecurity in Manoka Islands

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Water Resource Management for Future Water Security

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Challenge

Water Insecurity in Manoka

- Ngongang Kondiekong Nathalie

Manoka is Cameroon Island located in the Littoral Region, in Wouri Sub-province. The quality of drinking water from boreholes in Manoka Island is a major problem for the drinking water supply for the inhabitants. Particularly in dry season, the salinity of the seawater increases more than 35g / liter in the sea. This increase of salts directly influences the quality of the water of borehole certainly due to intrusion of the seawater into of the water table. This has given rise to high cost of living.

The sachet of water costs in average 50 FCFA (0.88US\$) for 0.30cl and 1200 FCFA (2.13US\$) for the 10liter cans, yet the human body needs at least 1 liter of water a day. The large quantities of water contained in the plastic bags and cans pass through the canoes from neighboring towns: Douala, which is about 23km away. Plastic drums of 250 liters, which amount to 3,500 FCFA (6.22US\$) including transport, that is 1000 FCFA (1.77US\$) of transport and 10 FCFA (0.017US\$) per liter. Available domestic waters are dirty, salty and often muddy. Face with this seaming desolation, the public authorities are still indifferent on how to solve this problem. Presently, no process has been triggered to improve the living conditions of the inhabitants.

The core issue is the quality of the drinking water of borehole which remains dirty and salty during the dry season and unsafe for the local populations in total lack. The cause remains the intrusion of seawater to the unconfined aquifer which is exacerbated by climate change. This couple with the lack of political will of the public authority to salvage this people has remained a dilemma.

Solution

Multiple Water Solutions for Water Insecurity in Manoka Islands

- Jos C Raphael

The Manoka is an Island in the west coast of Cameroon located in the Littoral Region, in Wouri Sub-province. The number of inhabitants is about 20000. It is geographically rich with high precipitation rate above 3000 mm. The soil condition can be coastal sandy. Traditional water resource is manually dug wells where the fresh water was available 2 to 4 meter below ground level. Saline ingress to the coastal well which is the main fresh water resources that experiencing water contamination. There are other problems such as deforestation of mangroves, mosquito breeding, human induced water pollution from waste and plastics, illiteracy etc and so on. And therefore, a single water panacea is not applicable when it is viewed in the Integrated Water Resources Management (IWRM) Regimes. However, pivotal intervention on the primary water resource of the Manoka that is manually dug wells is quite possible. It is known as Well Recharging from Roof Rainwater Harvesting which is being practiced in the large tracts of coastal wells in the state of Kerala, India since 2008. This programme is known as Mazhapolima Well Recharging.

According to this solution, roof rainwater harvesting is directed to the dug wells and small ponds seen in the coastal areas. Rainwater injection /deposit to the wells and water bodies can reduce the saline ingress to these resources. The rainwater normally has low density in comparison with sea saline water. Hence the weight of low density rain water into the well over sea saline intrusion will push down it along with the excess nutrients and contaminants through the inter spaces between sands at the bottom of the well making Well Water safe.

The underlying theory is based on Ghyben and Herzberg relation of geological sciences (1887-1901). Precisely, if the ground water table goes down along the coastal belt for one meter, saline ingress to the coastal water bodies will be advanced 40 meters through underground in a proportion of 1:40. It is related to the density of sea saline water and density of coastal fresh aquifer filament / water. This has been happening in Manoka Island for the past 100+ years. And therefore, it is important to flush out the saline water through the ground level applications and controls. Rainwater injection to the wells and water bodies can reduce the saline ingress to these resources. Also it is important to check the saline ingress through handmade bunds with local materials and new types of Tidal Barrages at the delta points along with well recharging.

Constructing large open ponds with machinery / manual at a depth of 2 to 4 meters would be beneficial for rainwater harvesting into these ponds naturally without any roof harvesting installations. This no doubt would suppress saline ingress underneath / through underground. However, if highly energized heavy pumping is opted from these recharged wells and ponds, it would defeat such efforts to combat the saline ingress. Similarly, Well-Pond protecting side walls are essential to avoid flooded water to mix in.

Solution

Water Resource Management for Future Water Security

- Meesha Tandon

This problem is arising due to over abstraction of ground water hence, following measures need to be taken as this problem will increase further with climate change impacts:

- Short term solution: Dilute groundwater (through storage and recharge of traditional wells and deep tube wells). Only roof top water should be used to maintain water quality of aquifer. Proposed measures include:
 - ▶ Roof top recharge for wells: By connecting existing rooftops to wells using drainage pipes and filtration media (low cost techniques for filtration and recharge are available). This can dilute water in the shallow aquifer and reduce the concentration of contaminants. Preferably location of recharge point should be some distance from the abstraction point to ensure adequate natural filtration.
 - ▶ Roof top recharge of borewells: Similar recharge methods (like ring well filtration or prefabricated rainwater tank connected to borewell) can be used for recharge of borewells also. This method has been extensively used in the Indian context.
 - ▶ Store and reuse rainwater: Rooftop runoff can be stored in tanks with or without filtration media and can be reused for secondary purposes to reduce requirement for freshwater.
 - ▶ Short term solution implementation can be taken up in a decentralized manner (at household or community level). Matching the water quality with the use to reduce the demand for fresh water is important. Secondary uses can be provided for using recharged water or stored water or reused water.
- Long term: Since Manoka has abundant rainfall even during driest months, in the long term, Manoka has to complement groundwater abstraction with surface water sources through creation of artificial water bodies or tapping of existing ones. Catchment areas of these water bodies will have to be managed with community participation to check contamination of source and reduce siltation of source. A holistic approach based on integrated water resource management with community involvement is required for water security in the long term.

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