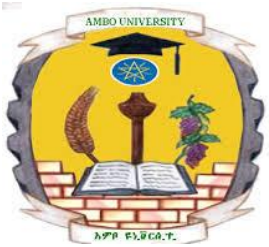

Reclamation of wastewater with contemporary and economical techniques in developing countries: A case study of Ethiopia, East Africa.

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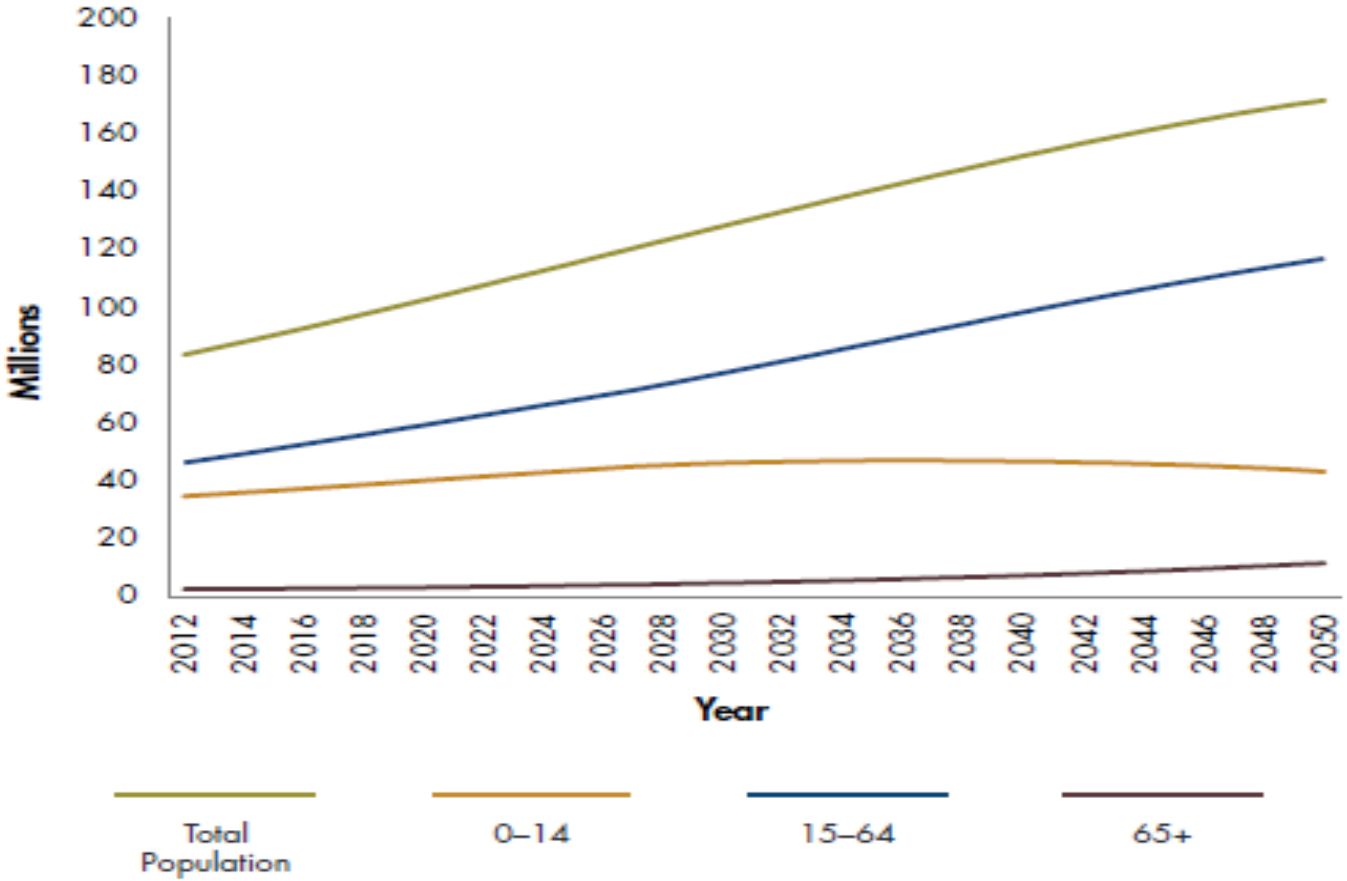
Ethiopia
Capital: Addis Ababa
FINLAND
ESTONIA
LATVIA
LITHUANIA
BELARUS
POLAND
GERMANY
UKRAINE
KAZAKHSTAN
UZBEKISTAN
TURKMENISTAN
TURKEY
SPAIN
MOROCCO
ALGERIA
LIBYA
EGYPT
MAURITANIA
MALI
NIGER
SUDAN
CHAD
ERITREA
YEMEN
SENEGAL
BURKINA FASO
GUINEA
BENIN
TOGO
NIGERIA
GHANA
LIBERIA
COTE D'IVOIRE
CENTRAL AFRICAN REPUBLIC
CAMEROON
ETHIOPIA
SOMALIA
Mogadishu
UGANDA
KENYA
DEMOCRATIC REPUBLIC OF THE CONGO
RWANDA
BURUNDI
TANZANIA
SEYCHELLES
ANGOLA
ZAMBIA
MALAWI
MOZAMBIQUE
ZIMBABWE
NAMIBIA
BOTSWANA
MADAGASCAR
COMOROS
MAURITIUS
REUNION
LESOTHO
SOUTH AFRICA
INDIA
NEPAL
SRI LANKA
INDIAN OCEAN
South Atlantic OCEAN

INTRODUCTION

- Ethiopia is one of the fast developing country among sub-Saharan Africa.

- Ethiopia is popularly known as "**the Horn of Africa**" in among African countries with population is about 84,320,987 (2012 census).

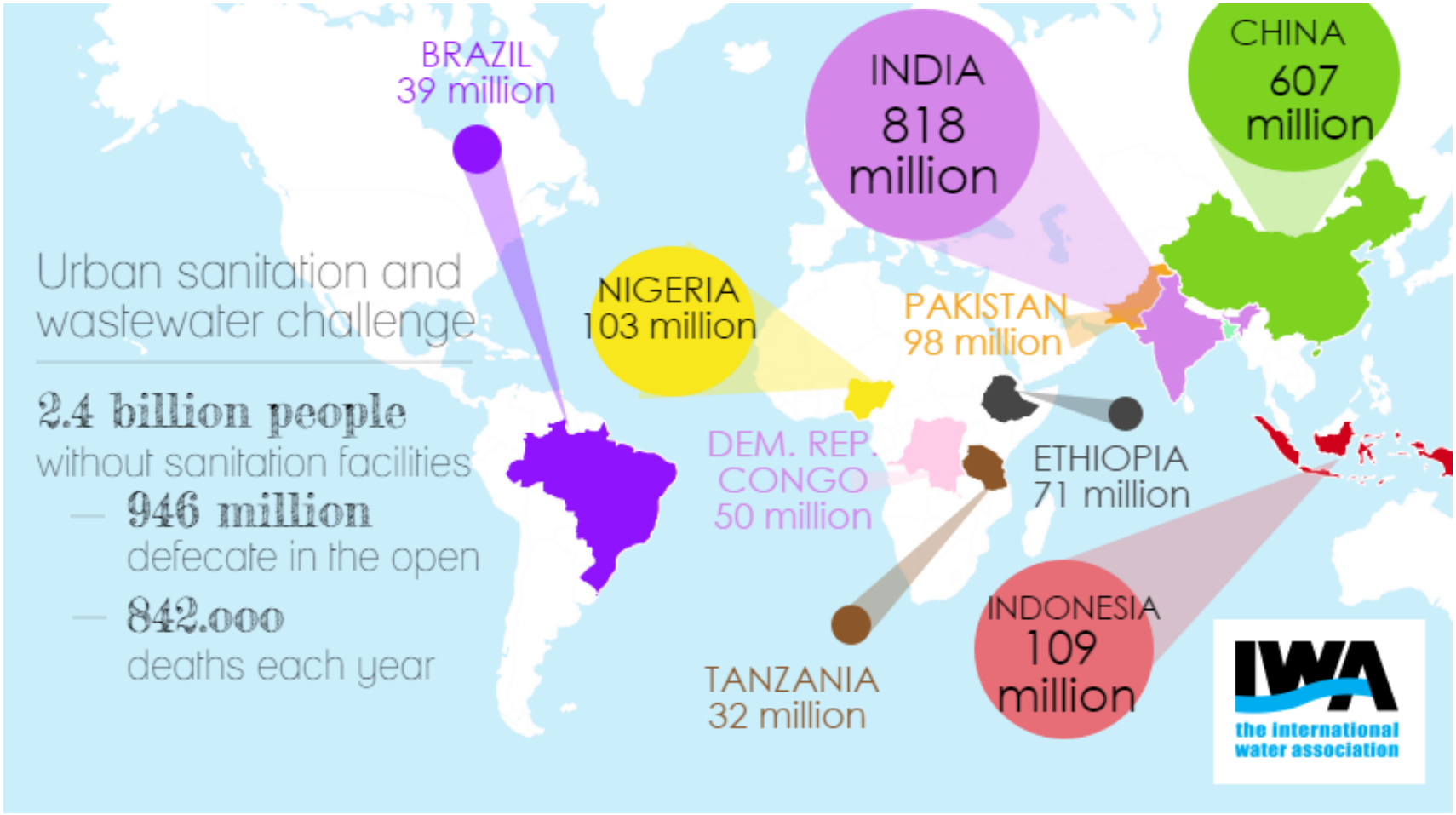
INTRODUCTION



Total Population by Age Groups, 2012–2050

(Source: Alemayhu Bekele and Yihunie Lakew , Ethiopian Public Health Association, July 2014)

INTRODUCTION



INTRODUCTION

- Water demand has alleviate due to population growth, high migration rate to unplanned urban area and low structured management in water sector.

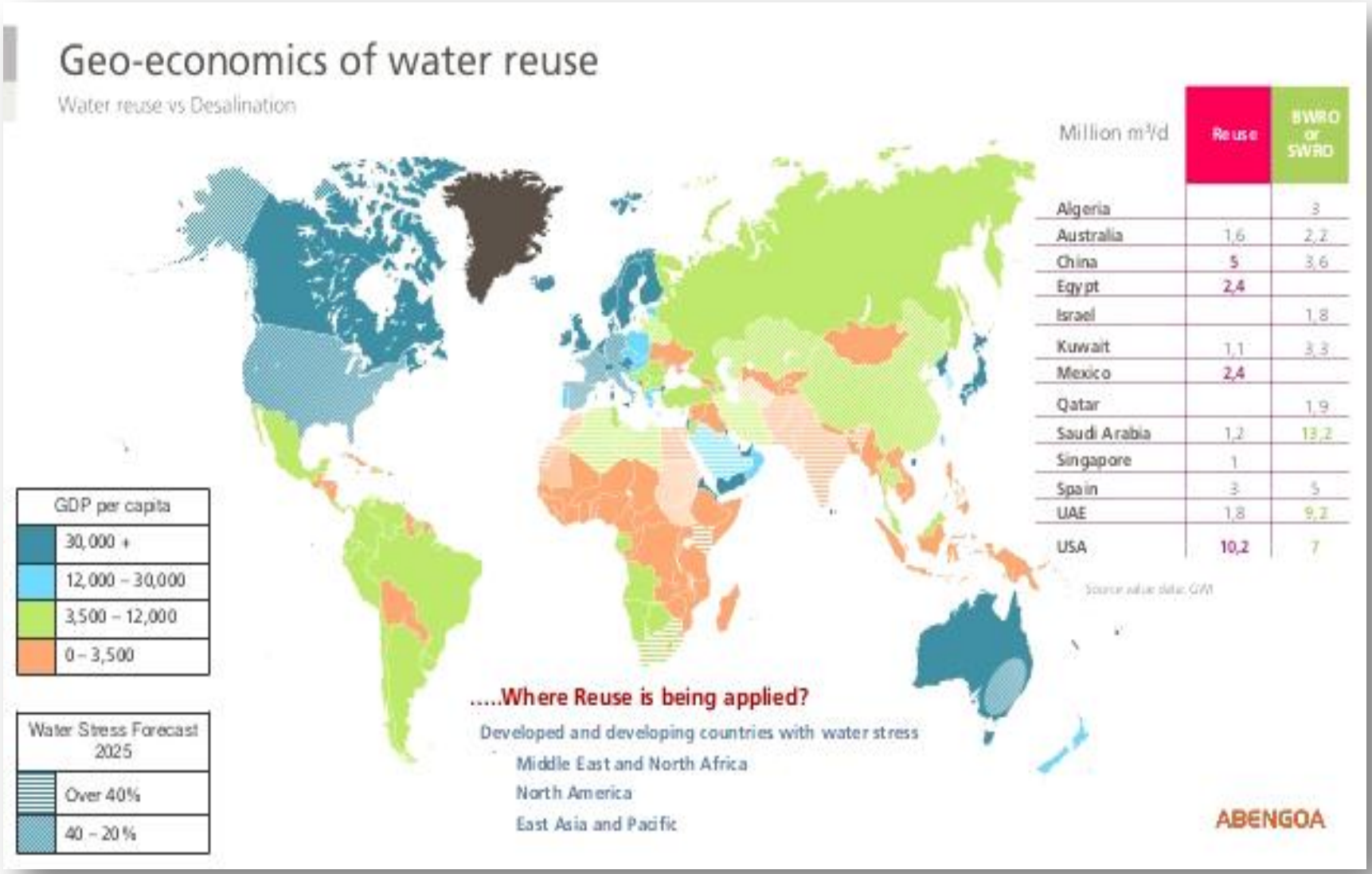
- 80% of the wastewater are directly disposed into surface and ground water bodies; which generates
  - water borne diseases,
  - decreases the quality of life, and
  - undermines the attractiveness of cities to foreign investors, competitiveness of tourism, water intensive industries, fisheries and agriculture.

INTRODUCTION

- The Ethiopian government constituted Environmental Protection Authority (EPA, 1997)
  - set laws for environmental pollution control (proclamation number 300/2002).

- Ethiopia has vision, to reach the UAP and GTP II targets
  - ensure the highest quality of life embracing a beautiful and healthy natural environment
  - free from the harmful effects of water in the urban areas By 2025

INTRODUCTION



City wise estimation of wastewater in Ethiopia

Sl No	Major City Name	Estimated Current Population	Estimated Wastewater generated (m^3/day)	Discharged after Municipal Wastewater treatment (in %)
1	Addis Ababa	6,500,000	398,985	7.5
2	Mekelle	300,000	34717	0.35
3	Bahir dar	221,991	25,538	0.22
4	Adama	350,000	33,527	0.041
5	Hawassa	240,000	26483	Less than 0.22
6	Jimma	2,486,155	19,607	0.029
7	Dire dawa	341,834	32,387	Less than 0.05
8	Gondar	180,000	32,411	0.07
9	Harar	110457	More than 16257	0.1

Table : Estimate Wastewater generation, 2014

(Sources: Minstry of Water Irrigation and Energy, 2015 and The Federal democratic republic of Ethiopia, 2017)

WASTE WATER TREATMENT STRATEGIES IN ETHIOPIA

- University level wastewater treatment
- Textile wastewater treatment
- Coffee processing wastewater treatment
- Irrigation wastewater treatment

University level wastewater treatment

- conventional activated sludge system followed by a field infiltration system

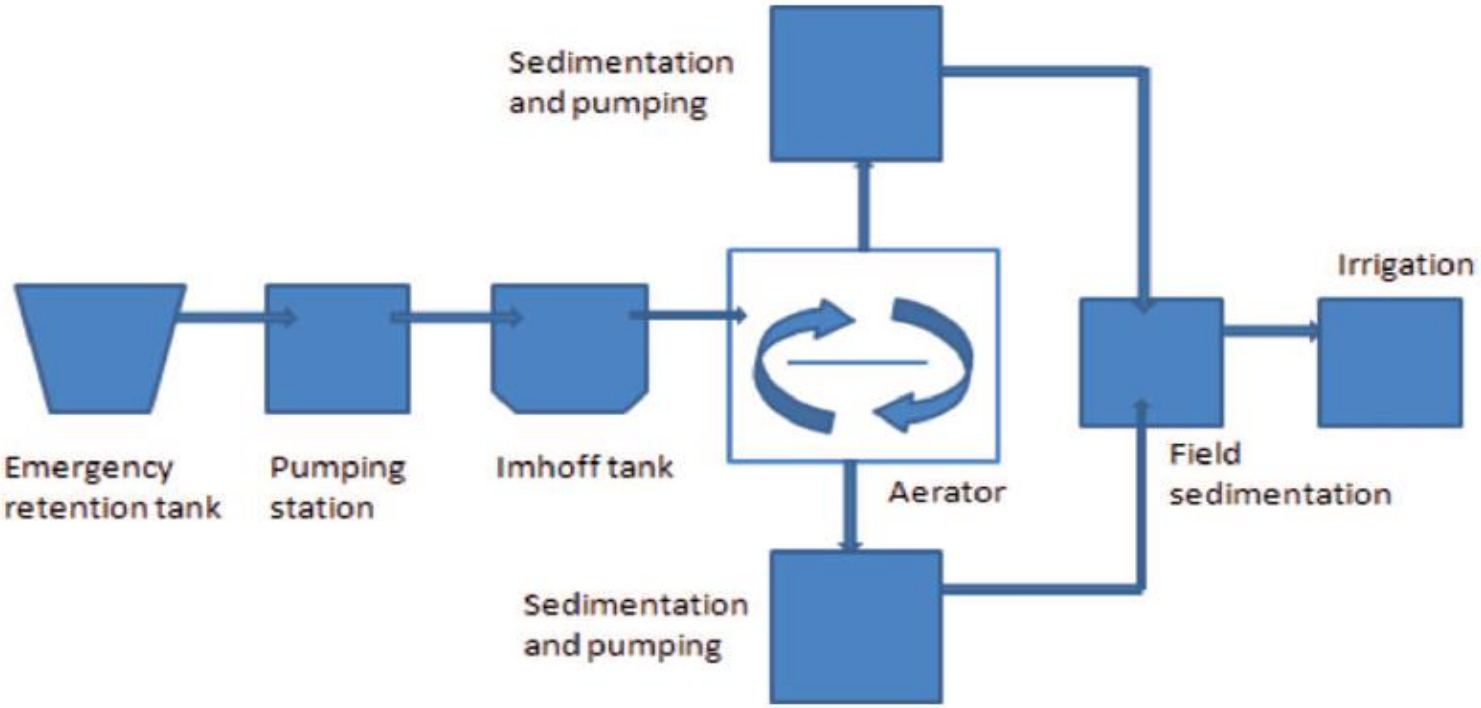


Fig 1: a schematic diagram for conventional wastewater treatment system

Source: (Haddis et al., 2014)

University level wastewater treatment

- this has been planed by the Federal Ministry of Education for seven University like
  - Hawassa University (HU),
  - Adama University (AU),
  - Mekele University (MU),
  - University of Gondar (UoG),
  - Jimma University (JU),
  - Addis Ababa University (AAU) and
  - Kotebe College of Teacher Education (KTC)

University level wastewater treatment

- promising result of
  - removal of about 95% of BOD and
  - 84% of COD, respectively.
  - Total suspended solid and total Nitrogen has been removed up to 97% and 40% respectively.
- Challenging
  - While wastewater treatment plant of AU, AAU and KTC institute do not working properly due to **failure of activated sludge system and sedimentation tank** and finally their result differ from the above mentioned data

Textile wastewater treatment

- According to ETIDI, Ethiopian textile processing units consumed about **14,250,406 Kg** of various types of dyes and chemicals in 2011.

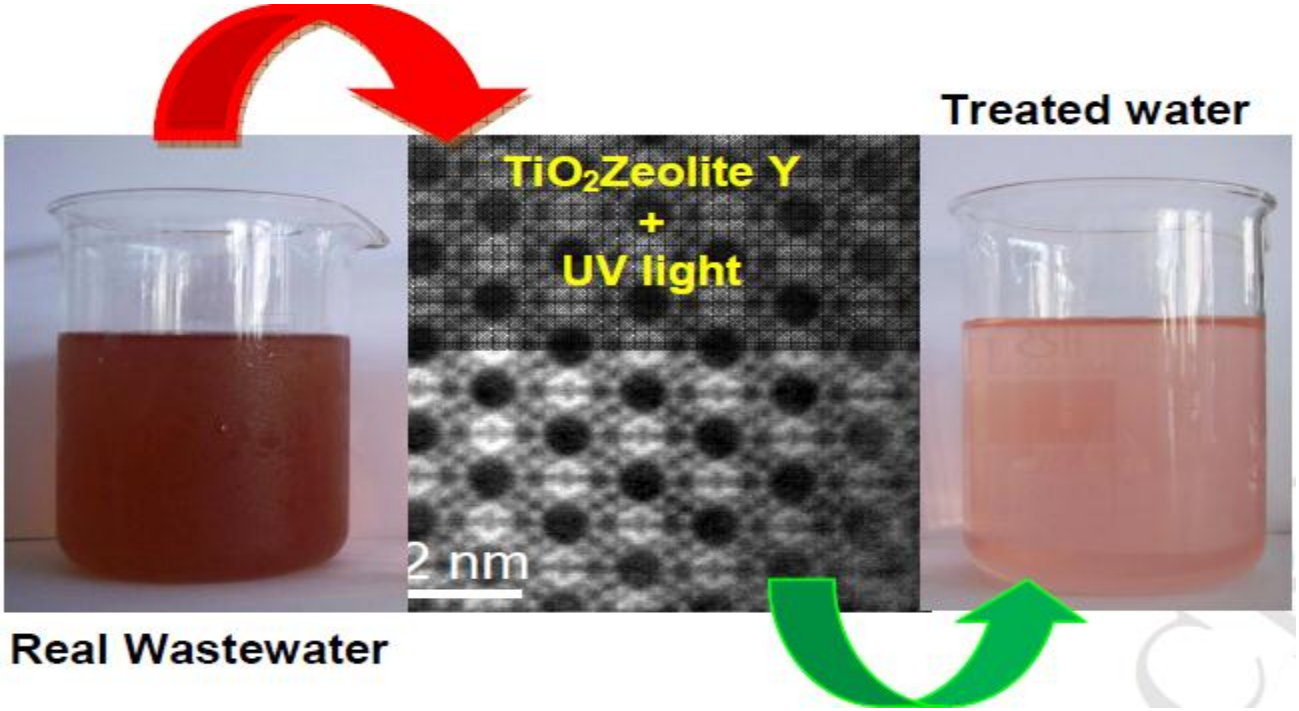


Fig Use of different zeolite and UV light for textile wastewater treatment
(Source: Guesh et al., 2016)

Textile wastewater treatment

- Integrated wastewater management with zeolite and UV light showed promising results
  - ✓ Especially to remove the methyl orange (MO) and TOC

- 10% loaded TiO_2-Zeolite Y yielded up to 20 times higher mass
  - ✓ normalized turnover rate (TOR) than pristine TiO_2

- Using10% loaded TiO_2-Zeolite Y and pristine TiO_2, respectively
  - 84% and 49 % removal removal of total organic carbon (TOC)

Textile wastewater treatment

- The reusability of this photo catalyst was tested and
- only 5% decline in methyl orange (MO) contamination was observed after three cycles

- While Zeolite Y with SiO_2/Al_2O_3 ratio of 60 loaded with 10 and 40% TiO_2 (another research finding)
  - gave the highest TOR in the degradation of the model pollutant (MO)

Textile wastewater treatment

- Bioremediation is also promising tools For example

1. ***Lysinibacillus sphaericus* SK13** and ***Aeromonas hydrophila* SK16** demonstrated significant potential for decolorization of Remazol Red RR, Reactive Red FB and Reactive Yellow FR Joyfix Red RB dyes.

Textile wastewater treatment

- Bioremediation is also promising tools For example

1. ***Geobacter metallireducens*** can reduce metals such as Iron, lead, chromium, uranium, fluoride and mercury

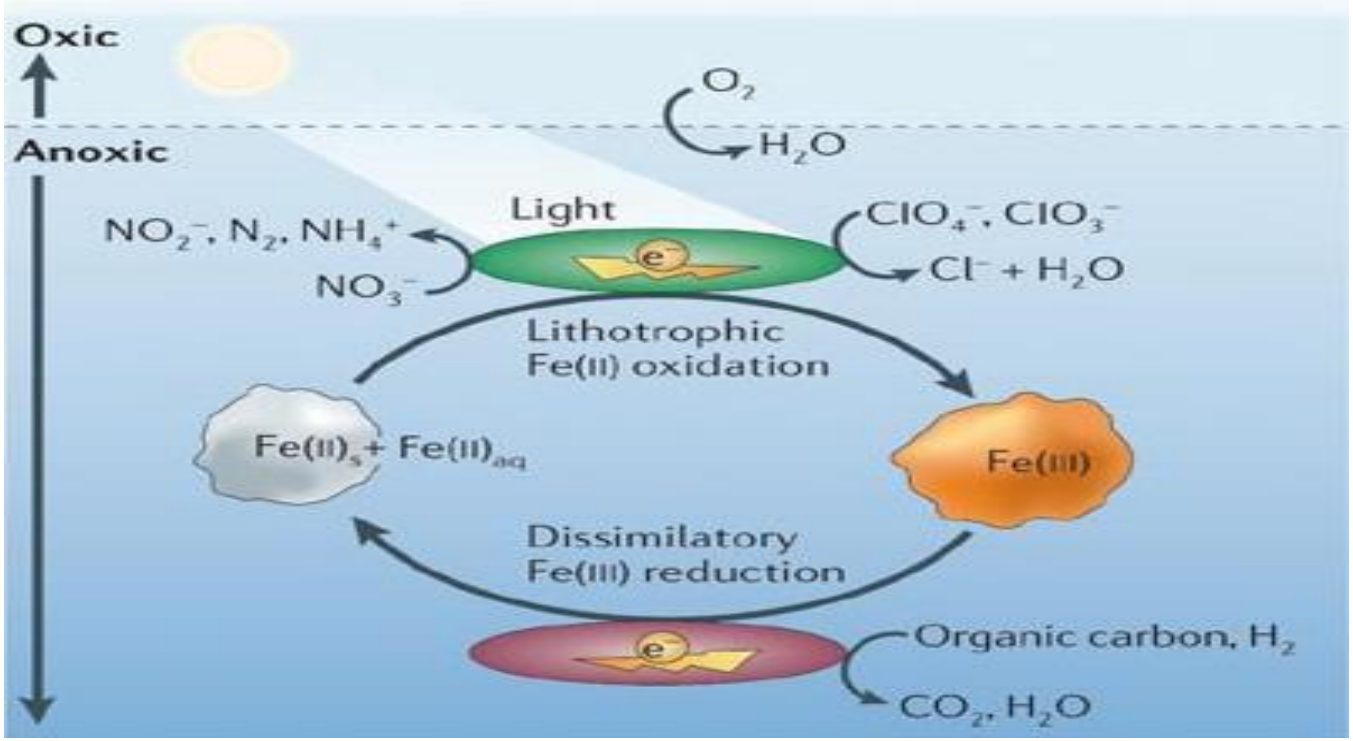


Fig : Iron ion transformation by Geobacter (Source: Lovley & Phillips, 1988).

Coffee processing wastewater treatment

- Ethiopia is the origin of highland coffee (Coffea arabica Linnaeus), with annual production about **500,000-700,000 tones**. This has traditionally been tended and harvested as a wild tree in the highland forests of south western Ethiopia

- The total number of coffee processing plants in Ethiopia has now surged to **2156**
- The presence of yeasts and CO_2 produced and the acidic characteristics of the water organic load (BOD_5 and COD), nutrients (nitrate and phosphate) and suspended solids.

Avocado Peel Carbon

- Using avocado peel carbon (APC) the high amounts of COD and BOD were reduced by 98.20% and 99.18%, respectively.
- Treated water can be used in irrigation practices and disposal to stream

Coagulation-flocculation and advanced oxidation processes

- Natural organic matter present in coffee processing wastewater can be removed.
- The results showed reduction of COD by 67% when coagulation-flocculation was used. UV/H2O2/O3 oxidation process removed COD by 87% as well as colour and turbidity

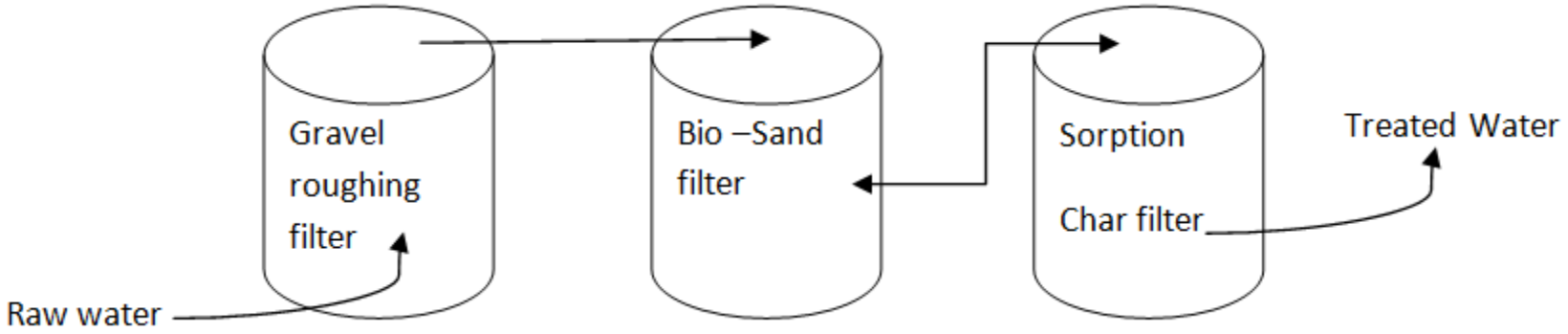
Irrigation wastewater treatment

- Agriculture is one of the largest occupations in Ethiopia. About 85% of the population is engaged in agricultural sector producing products like cereals, coffee, oilseed, cotton, sugarcane, vegetables, khat, cut flowers, hides, cattle, sheep, goats, fish.

- Organochloride pesticides such as dichloro diphenyl trichloroethane (DDT) and endosulfan are used in irrigated farms in Ethiopia

BIO-CHAR

- Bamboo, eucalyptus, logan and pine logs where used as feedstock.
- Multi-barrier treatment was used which included gravel filter, bio-sand filter and sorption char filter.
- Removes dissolved organic matter, biodegradables and synthetic organic compound (SOCs) like pesticides, pharmaceuticals and hydrocarbons



CONCLUSIONS

- These economical treatment techniques for reclamation of waste water from houses, Universities, agricultural sector, textile and coffee processing industries can be a novel way to improve the life of people.
- Heavy metal poisoning due to natural and anthropogenic reason is common in Ethiopia.
- Bio-remediation using microbes like *Geobacter metallireducens,* which can reduce metals such as Iron, lead, chromium, uranium, fluoride and mercury can be a useful tool.
- There are many coffee processing units whose wastewater can be reused for irrigational purpose after treating with Avocado peel carbon.
- The last area of interest is agricultural sector because 85% of population of the country is engaged in it. Removal of pestcides using bio-char made of local wood will be a good option. based wastewater treatment which can remove not just dissolved organic matter, biodegradables as well as synthetic organic compound (SOCs) like pesticides, pharmaceuticals and hydrocarbons which cannot be removed by other low cost techniques.
- This paper's motive is to highlight the need and possibility of low-cost treatment techniques which can easily make the wastewater reusable for various purposes rather than drinking. This will help to save the portable for future and increase its sustainability
- Research in this area needs to be more problem-oriented and utilize natural and local products; in other words more localized problem-solving research is required to make the solutions viable, economical, eco-friendly and acceptable to the general public.

FUTURE PROSPECTS/CHALLENGES

- TiO2challenges are the fast recombination rate of photo-generated electron/hole pairs, short excitation wavelength, i.e. large band gap, relatively poor adsorption capacity, and difficulties in recycling.
- zeolites have been most favourable to be used as TiO2 supporters to improve the recovery efficiency and adsorption capacity
- However, there is no report showing full characterization data supporting the role of zeolites in lowering the electron/hole recombination rate of hybrid photo-catalyst.

- Dye is the hardest constituent which have a number of structural varieties such as acidic, reactive, basic, disperse, azo, diazo, anthraquinone-based and metal-complex dyes.
- Bio-remediation is simple set-up, less expenditure, functional simplicity, reduced sludge quantity, eco-friendliness
- More studies are required about the microbes present in ethiopia at vicinity of the plants

TWW

FUTURE PROSPECTS/CHALLENGES

- **Avocado peel Carbon is economical alternative for Coffee processing wastewater.**
- **Ethiopia needs to promote it production as well as there is need of more research on other prospective carbon products .**

- **Chemical coagulation-flocculation and photo-oxidation processes are usually insufficient when used on their own for the reduction of COD and color in industrial wastewater.**
- **Combination of both have synergistic effect so need more study with multi-barrier approach.**

CWW

FUTURE PROSPECTS/CHALLENGES

- **A limited number of studies have been conducted on the simultaneous oxidation of different classes of organo-chloride compounds and their relative performance with regards to photo-catalyst adsorption selectivity.**
- **limited study is done for unrelated compound groups since they provide a bigger challenge in that molecular transformations are not easily tracked and kinetic feedback is subjected to a high degree of speculation.**

- **low cost treatment, char filter absorbers using Bamboo, eucalyptus, logan and pine logs have good market in Ethiopia.**
- **More such native plants should be tested as per the availability in the studied country**

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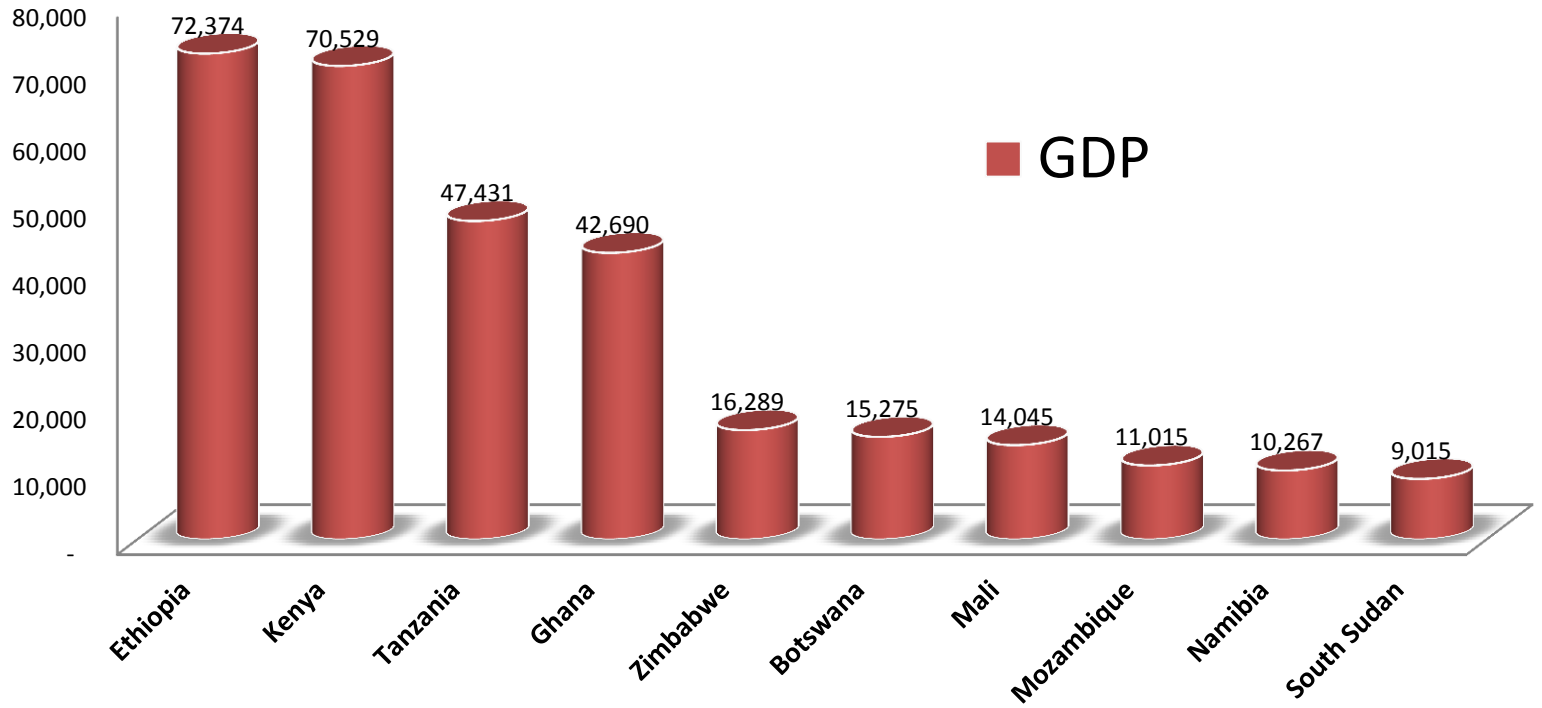
FUTURE PROSPECTS



Few Sub-Saharan Africa Countries *(Source: data.worldbank.org)*

- Sub-Saharan countries are growing at rapid speed in respect of population and industrialization, among them Ethiopia can be a model for others.

ACKNOWLEDGE

- First We would like to thank to Almighty for everything.

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Erta ale, the most active volcano in Ethiopia

Wenchi Crater LakeAddis Ababa,Ethiopia

The Nile river, Bhair Dar, Ethiopia

Thanks