The European Union's Water Sector Reform Programme Phase II (WSRP–II) for Egypt

EU-EGYPT Water Talks
4th Event
WATER AND WASTEWATER SECTOR IN EGYPT: "SUSTAINABILITY, OPPORTUNITIES AND CHALLENGES"

Workshop Report
(14 – 15 March 2016)

2016 (Final Version)

This Report has been prepared with the financial assistance of the European Union. The views expressed herein are those of the speakers and therefore in no way reflect the official opinion of the European Union.

This Event is funded by
The European Union

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1. INTRODUCTION

1.1 GENERAL

As a part of the Egyptian- European cooperation efforts in water and wastewater sector, Egyptian & European officials inaugurated the fourth **"EU-EGYPT WATER TALKS"** event in Cairo to exchange views on national investment projects in the water sector.

The two-day event gathered over **150** experts; academics; senior government officials and project managers of donor agencies.

2.1 BACKGROUND

A series of events under the main Title **"EU-EGYPT WATER TALKS "** make part of the Water Sector Reform Program – Phase II visibility actions aiming to raise awareness of the European Union's continued commitment to the sustainable development and the millennium development goals in water sector in Egypt.

The first of these Events was held in Cairo on **April 2014** with collaboration with the Ministry of Housing and the Holding Company for Water and wastewater under the Title "**EXPANDING THE HORIZON FOR INNOVATIVE STRATEGIES IN WATER AND WASTEWATER SECTOR IN EGYPT**". This event aimed to discuss and exchange views about the reform program of water sector.

The Second event held in Alexandria in **2015**, discussed key reform benchmarks addressed in the **WSRP-II**.

The Third event addressed the important theme of "**INTEGRATED PLANNING FOR THE NATIONAL PROJECTS IN THE WATER SECTOR"**, topics related to the National Land reclamation project, Innovative Strategies Towards Integrated Water Resources Management, and other mega national projects in the water sector were discussed under that platform.

EU-Egypt Water talks are funded by the European Union within the framework of the Water Sector Reform Programme-II **(WSRP-II)**. Following the success of **WSRP- PHASE I** with total Grant of **€80 million**, the EU and the Government of Egypt agreed to allocate an additional grant of **€120 million** for phase two of Egypt's **WSRP (WSRP-II)**. Phase two is scheduled to be implemented between **2011-2015** and is to be distributed according to a new set of jointly agreed reform benchmarks. The beneficiaries are the Ministry of Water Resources and Irrigation, Ministry Housing and Urban development and Ministry of Finance in addition to the Holding Company for Water and Wastewater. The overall objective of the **WSRP-II** is to support the Egyptian government in continuing its water sector reform program in accordance with the National Water Resource Plan **2005-2017 (NWRP 2005-2017)** and of the recently adopted Water and Wastewater Sector Development Policy **(WWSDP)**. The overall budget is **€120 million** (**€10 million** as a Technical Assistance to the ministries).

3.1 CONTENTS OF THE REPORT

This report consists of **8** sections as follows::

1- Introduction.

2- Executive Summary.

3- Opening Speaches.

4- First Session: Overview of Water & Wastewater Sector In Egypt.

5- Second Session: Desalination.

6- Third Session: Rural Sanitation.

7- Fourth Session: Treated Wastewater Reuse.

8- Conclusion & Recommendations.

2. EXECUTIVE SUMMARY

The fourth event of **EU-EGYPT WATER TALKS** is co-hosted with the Egyptian Ministry of Housing, Utilities and Urban Communities **(MHUCC)** under the title "**WATER AND WASTEWATER SECTOR IN EGYPT: SUSTAINABILITY, OPPORTUNITIES AND CHALLENGES**".

The event aims to enhance the exchange of expertise and knowledge amongst water and wastewater professionals to support continuing reform program of water sector.

The main topics discussed during the event are:

- **Overview of the water & wastewater sector in Egypt:**

A brief overview on the water and wastewater sector, showing the previous progress across the whole sector and the expected challenges during the upcoming years as well as the EU role in helping Egypt facing these challenges.

- **Desalination**

This session focused on the sea water desalination, as a part of the solution for covering the service gap in Egypt. The session presented the new techniques used for desalination worldwide, as well as the recommendations for preserving the marine life from the desalination plants outcome.

- **Rural sanitation**

This session presented the current situation of sanitation in rural areas and the recommended strategies to expand the coverage considering the modern techniques for rural and low cost sanitation.

- **Treated wastewater reuse**

This session presented the new techniques for wastewater treatment and the recommended fields of reuse according to the effluent quality.

- **Conclusions & recommendations**

Discussions about the outcome conclusions & recommendations for the previous topics.

The following table presents the agenda of the workshop.

SUBJECT	CODE	SPEAKER	TITLE
Welcome & Opening Speaches			
Speech Of Ministry Of Housing, Utilities And Urban Communities	OP-01	Dr. Sayed Ismail	Ministry Of Housing, Utilities And Urban Communities
Speech Of Head Of Cooperation- EU	OP-02	Mr. Diego Escalona	Head Of Cooperation , EU Delegation To Egypt
EU-Egypt Cooperation In Water/Wastewater Sectors	OP-03	Dr. Ayman Ayad	Senior Manager For Water And Utilities, EU, Egypt

SUBJECT	CODE	SPEAKER	TITLE
1st Session: Sector Overview			
Overview On The Water And Wastewater Sector	OV-01	Dr. Abdelkawy Khalefa	Professor of Sanitary And Environment Faculty Of Engineering Ain Shams University
Presentation Of National Water Resources Plan (NWRP)	OV-02	Dr. Mohamed Noureldin	Professor of Irrigation And water resources Faculty Of Engineering Ain Shams University
Joint Integrated Sector Approach (JISA): First Package of Investment Projects for MWRI	OV-03	Dr. Ibrahim Moahmed Mahmoud	Planning Sector, Ministry of Water Resources and Irrigation (MWRI)
2nd Session: Desalination			
Technology Of Desalination	DS-01	Dr. Mohamed Haikal	Expert at the National Research Center- Ministry Of Housing, Utilities And Urban Communities
Seawater RO Desalination: Process Steps, Site Selection & PPP Issues	DS-02	Mr. Conner Kenny	International Expert- WSRP-II EU Funded Project
New Code For Desalination	DS-03	Dr. Mohamed Desoky	Professor of Sanitary And Environment Faculty Of Engineering Ain Shams University
3rd Session: Rural Sanitation			
Rural Sanitation: The Way Forward	RU-01	Dr. Fatma Algohary	Head of Water Pollution Research Department National Research Centre
Road Map For Study The Water Supply And Collection And Treatment Of Wastewater	RU-02	Dr. Diaa Salah El Din Elmonayeri	Professor At Environmental Engineering Department, Zagazig University, Egypt
Sustainable Rural Sanitation- Approach Or Technology?	RU-03	Dr. Mahmoud Abdelazeem	Professor of Sanitary And Environment Faculty Of Engineering Ain Shams University
Sustainable And Innovative Pilot Scale Technology (200 M^3/D) For Domestic Wastewater Treatment In Rural Areas	RU-04	Dr. Abdulazeem Negm	Department Of Environmental Engineering, Egypt-Japan University Of Science And Technology

SUBJECT	CODE	SPEAKER	TITLE
Egypt Rural Sanitation: Understanding Contextual And Compositional Rural Transformations	RU-05	Dr. Sawsan Bakr	Professor of urban planning, faculty of Engineering, Cairo University
Egypt Rural Sanitation: Understanding Technology Mapping	RU-06	Dr. Ahmed Gaber	Professor of Sanitary And Environment Faculty Of Engineering, Cairo University
4th Session: Treated Wastewater Reuse			
Scientific Research In The Field Of Human Resource Development In Water And Wastewater Sector	TR-01	Dr. Yehia Kamal	Professor of Irrigation And Hydraulics Faculty Of Engineering Ain Shams University
Advanced Technologies For Water/Wastewater Treatment	TR-02	Dr. Amer El-Kalliny	Water Pollution Research Department, National Research Centre
Conclusion, Recommendations & Closure			

3. OPENING SPEACHES

1.3 SPEACH (OP-01):

"Speech of Ministry of Housing, Utilities and Urban Communities"

By Dr. Sayed Ismail

(Ministry Of Housing, Utilities And Urban Communities)

Main Points:

- Briefing about the challenges facing the sustainability for water sector in Egypt.
- Cooperative efforts between the Egypt & the EU.
- The vision of the Ministry Of Housing, Utilities And Urban Communities for the water & wastewater sector management.
- The main pivots for the sector's development are:
  1- Optimization & reuse.
  2- Enhancing the communications between the stakeholders.
  3- Encouragement of the private sector.
  4- Adopting modern technologies.
  5- Reviewing the current regulatory laws.
- Main objectives of the Ministry Of Housing, Utilities And Urban Communities.
  1- Expanding the desalination at the costal line governments.
  2- Expanding the wastewater treatment services.
  3- Optimization of the treated wastewater effluent usage.

2.3 SPEACH (OP-02):

"Speech of Head of Cooperation - EU"

By Mr. Diego Escalona

(Head of Cooperation , EU Delegation to Egypt)

Main Points:

- Briefing about the water & wastewater problems in Egypt.
- EU commitment to the water sector development in Egypt.
- Overview of the previous events.
- Overview of the current event.
- EU strategy towards the sector.
- Presenting examples of the projects and programs performed by the EU for the sector's development.

3.3 SPEACH (OP-03):

"EU-Egypt Cooperation In Water/Wastewater Sectors"

By Dr. Ayman Ayad

(Senior Manager For Water And Utilities, EU, Egypt)

Main Points:

- Overall relations between the European Union and Egypt are governed by an Association Agreement **(AA)**.
- Bilateral Cooperation – Instruments.
- EU-Egypt Cooperation in Water Sector in Egypt Main Aspects are:
  1- Investment in infrastructure.
  2- Capacity Building.
  3- Institutional Reform.
  4- Sector (Budget) Support.
- Main Projects/Interventions:
  1- Improved Water and wastewater Services Programme-I.
  2- Improved Water and wastewater Services Programme-II.
  3- Kafr El Sheikh Waste Water Expansion Program.
  4- National Drainage Program – Phase III.
  5- Water Sector reform Programme -Phase II.
  6- TA-component Programmes.
  7- Global Allocation -Technical Studies.
  8- Regional Water Programmes.
  9- Donor coordination.

- Future Challenges.
- Potential future Support.
- Proposed Pillars of Support are:
  1- Integrated Investment in W/WW sectors in Egypt.
  2- Coordination mechanism for improved water & wastewater investment planning.
  3- Local community Awareness Raising and Coordination.
  4- Institutional Support to the Regulatory Authorities.

4. FIRST SESSION: OVERVIEW ON WATER & WASTEWATER SECTOR IN EGYPT

1.4 PRESENTATION (OV-01):

"Overview on water & wastewater sector in Egypt"

By Dr. Abdulkawy Khalifa

(Professor of Sanitary And Environment Faculty Of Engineering Ain Shams University)

Main Points:

- Briefing on the current situation of the water & wastewater sector.
- The governmental efforts for expanding the service coverage.
- Briefing on the reform of the sector from **2004** under the main umbrella of the Holding company for water & wastewater.
    1. Establishment of the Holding Company (Presidential Decree **No:135/2004**).
    2. Transfer of municipalities to subsidiary companies in each governorate.
    3. Establishment of Egyptian Water Regulatory Agency **(EWRA)** Presidential Decree **134/2004**.
- Main pivots for the sector reform.
    1. Determination of objectives.
    2. Assigning strategic plans required for achieving the objectives.
    3. Creating a substantial database.

4. Creating a motivating organizational structure.
5. The optimal usage of available resources.
6. Follow-up to achieve the goals.
7. Involvement of the stakeholders.

- The goals achieved from the reform are:
  1. Provide quality service to customers.
  2. Protection and Development of investments.
  3. Preparation of specialized human resources.
  4. Improving institutional performance level.
  5. Increase awareness about water issues Development.
  6. Achieve financial independence.
- The vision, mission & strategic objectives of the holding company for water & wastewater.
- The available resources for funding and some examples of previous projects.
- The EU aids during the reform.

2.4 PRESENTATION (OV-02):

"Current situation for water supply and the national plan for water resources"

By Dr. Mohamed Noureldin

(Professor of Irrigation And water resources Faculty Of Engineering Ain Shams University)

Main Points:

- Water resources characteristics in Egypt and its impact on the urban development.
  1. Nile river.
  2. Groundwater
  3. Rain (storm) water.
- The main challenges facing the water management in Egypt are:
  1. Limitation of water resources.
  2. Population growth.

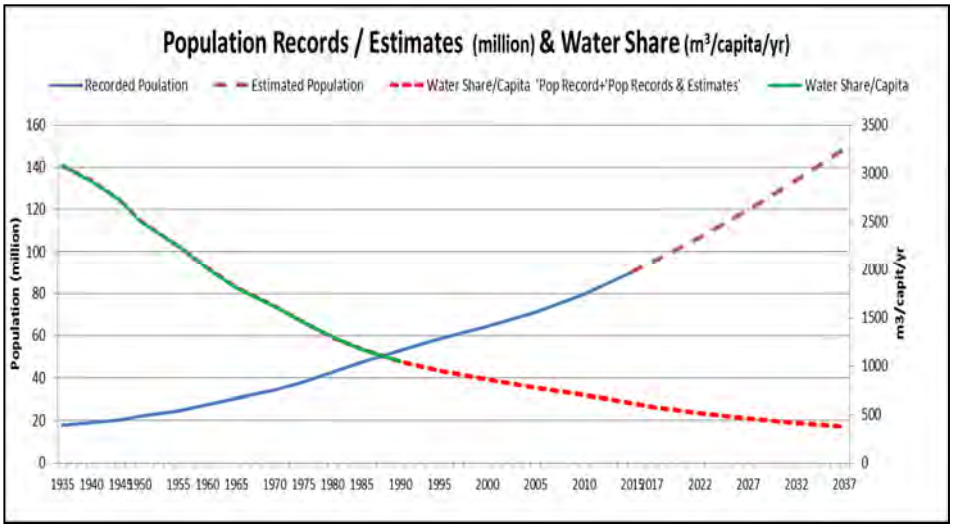

Figure (1): Population growth vs. estimated water share per capita

3. Low water usage efficiency.
4. Increasing rates of development in Upper Nile countries, and its impact on Egypt's water share.
5. Climate changes (increasing & decreasing of rain fall in the upper Nile countries).
6. The complexities of the institutional system and the exchange of information.

- Future predictions for Nile river supply.

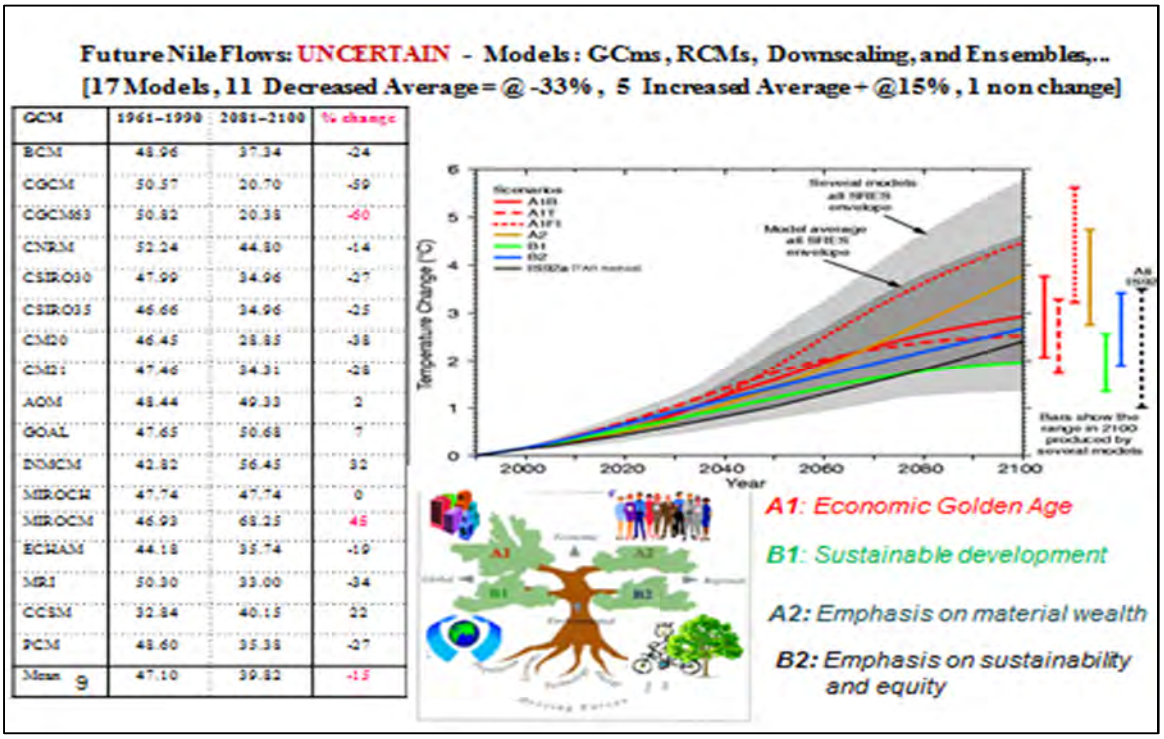

Figure (2): Future predictions for Nile river supply according to the predicted climate changes

- The objectives for the national plan for water resources **(2017-2037)** are:
    1. Support the government in the further implementation of water sector reform program, according to the objectives of the **2005-2017** National Water Resources Plan.

2. Update the National Water Resources Plan **(2005-2017)** and the extension of the time frame to **(2017-2037)**.
3. The development of regional water resources plans of the provinces selected pilot **(2017-2037)** (Qena, Al Behera, Fayoum, Kafr El-Sheikh and Damietta)

- Methodology for the current water resources management are:
  1. Development of the water resources.
  2. Rationalization of water usage.
  3. Protect water from pollution.
- Prioritization of the water usage, which can be summarized as follows:
  1. Potable water supply.
  2. Water supply for industrial uses.
  3. Water supply for agricultural uses.

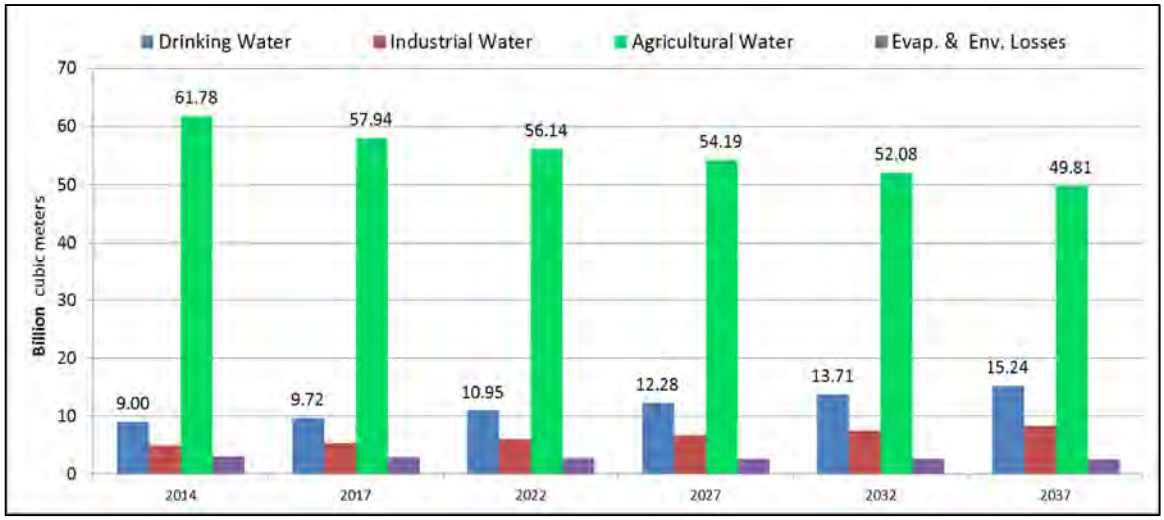

Figure (3): Scenario for water allocation between competing sectors

- Future scenarios are:

  A. Water resources scenarios (Climate changes and the upper Nile projects' impact).

B. Water demand scenarios (Population growth, economic growth rate, industrial & agricultural sectors growth rates)

- Gap analysis of the previous plan.
  1. Diagnosis.
  2. Intervention.
  3. Revision.

3.4 PRESENTATION (OV-03):

"Joint Integrated Sector Approach (JISA) - First Package of Investment Projects for MWRI"

By Dr. Ibrahim Mohamed Mahmoud

(Planning Sector, Ministry of Water Resources and Irrigation)

Main Points:

- The Ministry of Water Resources and Irrigation aims to enhance investment- of agricultural water management, in collaboration with the concerned Government of Egypt agencies and development partners.
- The overall objective is to protect and use water resources more efficiently and effectively and thereby maximize the returns per water resources.
- The joint approach by **MWRI** and its development partners to achieve this is referred to as the Joint Integrated Sector Approach **(JISA)**.
- **JISA** is an integrated approach aims at finding a mechanism of coordination among all the **8** contracting entities within **MWRI** (as a first Phase) to reach the required harmonization between **NWRP** and the ministry investments.
- Sector framework in the Irrigation Sector.
- Some examples for using the Joint Integrated Sector Approach **(JISA)** in **MWRI** projects.

5. SECOND SESSION: DESALINATION

1.5 PRESENTATION (DS-01):

"Technology for desalination"

By Dr. Mohamed Haikal

(National Research Center- Ministry Of Housing, Utilities And Urban Communities)

Main Points:

- Overview of the desalination technology as an important source for potable water.
- Global desalination Market share.

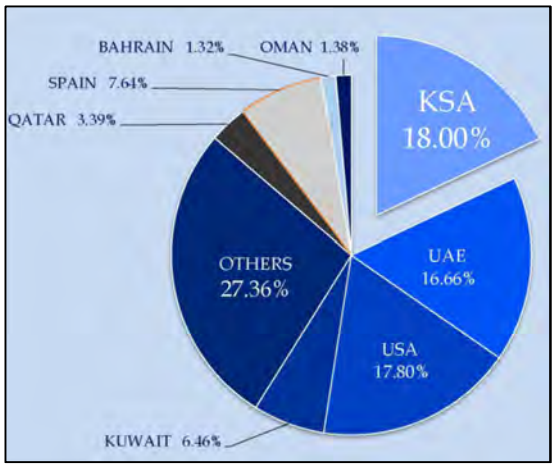

Figure (4): Global desalination Market share

- Desalination Technologies classification based on the separation process adopted are:
  1. Membrane.
  2. Thermal.
- Desalination Technologies classification based on the type of energy used are:

1. Mechanical energy.
2. Thermal energy.
3. Electrical energy.

- Types of Desalination techniques:
  1. Electro-dialysis Reverse **(EDR)**.
  2. Multistage Flash **(MSF)**.
  3. Multi Effect Evaporation **(MED)**.
  4. Mechanical Vapor compression **(MVC)**.
  5. Thermal Vapor compression **(TVC)**.
  6. Freezing.
  7. Zero Liquid Discharge **(ZLD)**.
  8. Reverse Osmosis **(RO)**.

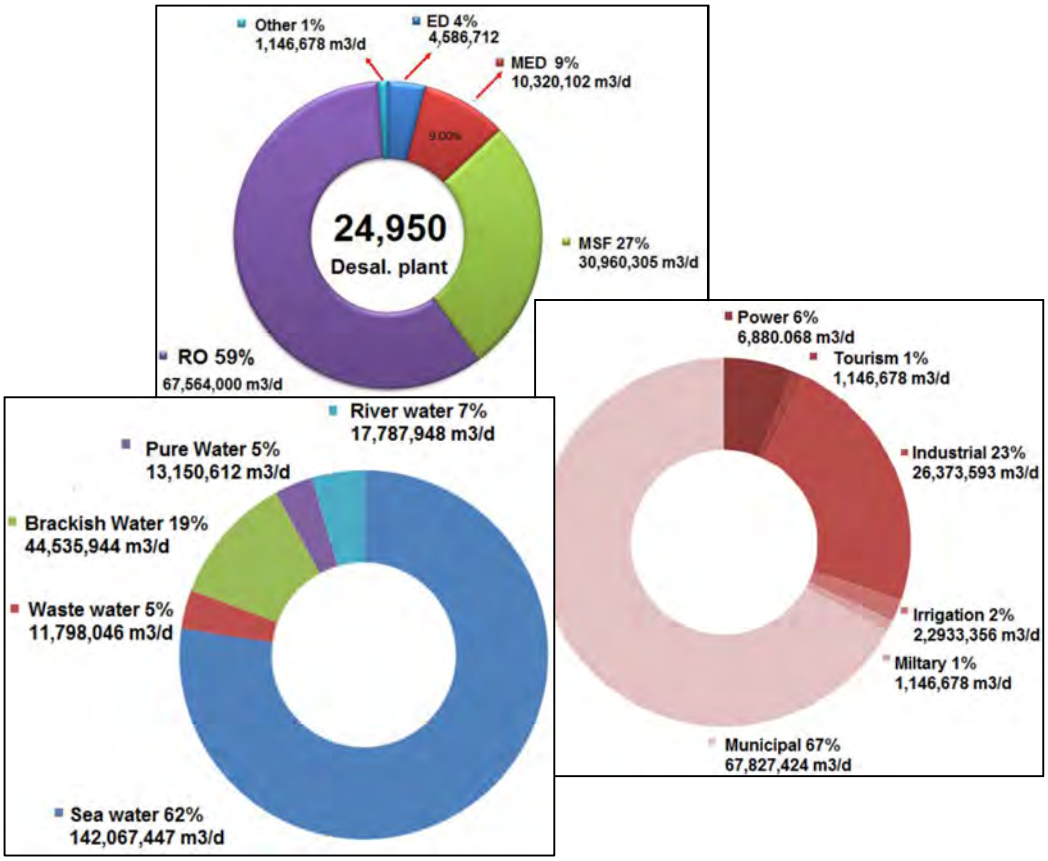

Figure (5): Desalination technologies distribution, source and uses worldwide

- **RO** Development fields are:
  1. Power.
  2. Membrane.
  3. Pretreatment.
- Integrated Solution.

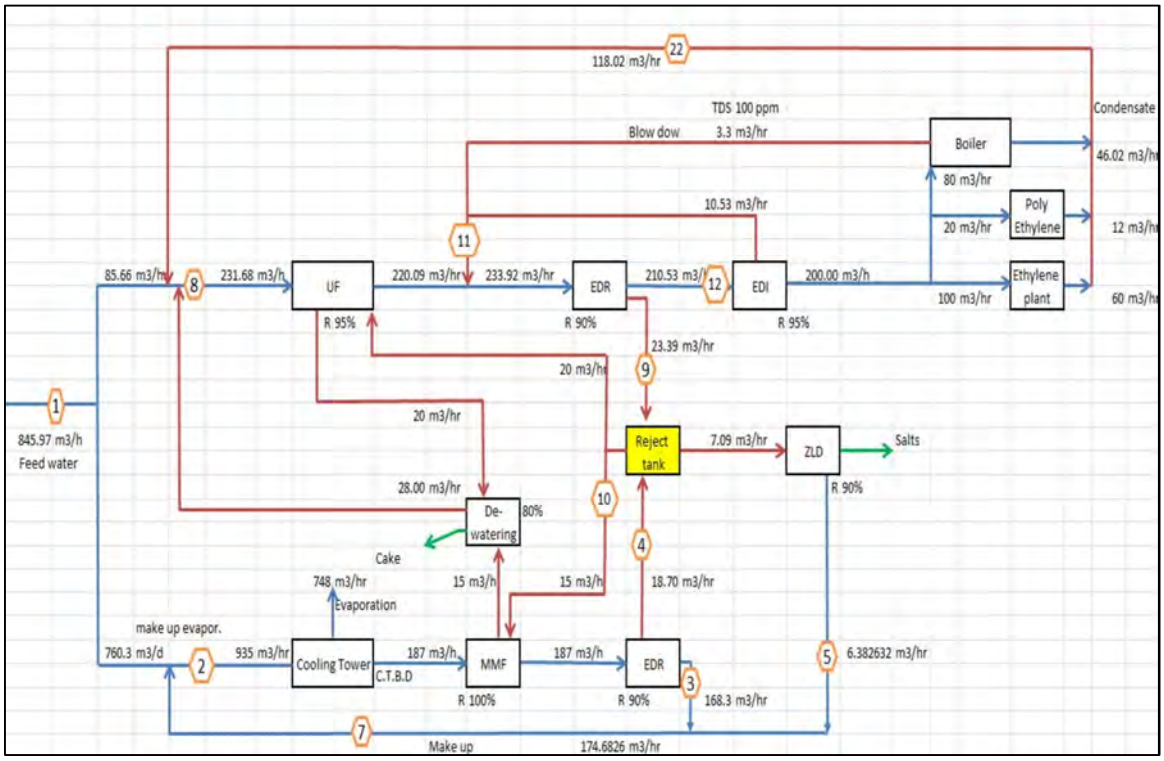

Figure (6): Schematic diagram for integrated desalination system

2.5 PRESENTATION (DS-02):

"Seawater RO Desalination: Process Steps, Site Selection & PPP Issues"

By Mr. Conner Kenny

(International Expert- WSRP-II EU Funded Project)

Main Points:

- Briefing about the desalination technologies.

Figure (7): RO train

- Examples for the brine utilization.
- Salt from RO Brine Not Viable.
  1. A **10,000 m^3/d** plant could produce potential **600 tons** of solar salt **(NaCl)**, and **400 tons** of other salts.
  2. Seawater concentration **40 g/l**, RO brine **60 g/l**, Saturated brine **260 g/l**. Massive area need for evaporation **1.3km x 1.3km**.

3. **400 tons** of waste salts (bitterns) need disposal, not same composition as sea which causes environmental problems.
4. Salt transport needs bulk ship transport at the site.
5. Salt business has no interface with the water production business. Only really possible if solar plant already exists.

- Regulations for the site selection of the desalination plants.
  1. Select site close to the users, reduce pumping.
  2. Avoid boat anchorage areas.
  3. Avoid Wadis, rainfall causes high solids in the sea.
  4. Need **10m-15m** Water depth intake and outfall.
  5. Need an open location for good brine dispersion.
  6. Coast Strip in high demand, build **2-3km** inland only put the pump station on the coast.
- Criteria for diffusers installation to minimize the effect of the outcome of the plants on the marine life.

Figure (8): Brine diffusers

- **PPP** desalination issues.
  1. Off taker must take full plant capacity, do not over size the plant
  2. Power supply and stability must be by off taker
  3. The product water distribution network must be ready before plant completion.
  4. Environmental Impact Assessment must be done by Off taker. Outfall location, waste disposal, brine dispersion modeling.
  5. More than **100,000 m^3/d** projects need **1 year** feasibility and survey work, **1.5 year** tender and financial close & **EIA**, **2- years** construction. Total cycle **4-5 years**.
  6. Ensure good Minimum Functional Specification used, not developer Specs.
  7. Use Independent Engineers to monitor **WPA** (Water Purchase Agreement) for construction, performance testing and operation.

3.5 PRESENTATION (DS-03):

"New code for desalination"

By Dr. Mohamed Desoky

(Professor of Sanitary And Environment
Faculty Of Engineering Ain Shams University)

Main Points:

- Desalination is a separation process used to reduce the dissolved salt content of saline water to a usable level.
- The importance of the desalination code.
  1. The Code document focuses on the production of clean municipal and rural water supplies from sea or brackish water sources.
  2. The desalination process contains intake, process, and outfall.
  3. The process has some considerable environmental concerns.
  4. The intake has an environmental impact on the surrounding fauna and flora.
  5. The outfall has an environmental impact on the life surrounding the area of the outfall.
- Advantages of seawater desalination.
  1. Offers a seemingly unlimited, steady supply of high-quality water.
  2. The production of fresh water without impairing natural freshwater ecosystems.
  3. More energy intensive **(~ 3 to 4 times**) compared to conventional technologies for the treatment of fresh water.
  4. Concerns about the potential environmental impacts of large-scale SWRO plants.

- Energy requirements of desalination processes.
- Code contents:
    1. Data design and preliminary studies.
    2. Intensive water quality and the types of outfalls.
    3. Pretreatment process.
    4. Reverse osmosis.
    5. Post treatment process.
    6. Control and monitoring system.
    7. Conditions for the architectural and construction design.
    8. Performance and acceptance tests.
- Types of intakes.
    1. Perforated pipe.
    2. Shore intake.
    3. Submerged intakes.
    4. Channel intakes.
    5. Wells intakes
- Pre-treatment steps.
    1. Suspended solids are removed by filtration,(sand or cartridge).
    2. pH adjustments (lowering) are made to protect the membrane and control precipitation of salts.
    3. Ant scaling inhibitors are added to control calcium carbonates and sulfates. Iron, manganese and some organics cause fouling of membranes.
    4. A disinfectant is added to control Biofouling of the membrane. Disinfection can involve chlorine species, ozone or UV light and other agents.

5. De-chlorination, Marine organisms, algae and bacteria must be eliminated, and if chlorine is used, it should be neutralized prior to contact with the membrane.

- Energy recovery devices.
  1. Pelton wheel.
  2. Hydraulic turbo charger.
  3. Pressure exchanger.
  4. Dweer.
  5. Aqualung.

6. THIRD SESSION: RURAL SANITATION

1.6 PRESENTATION (RU-01):

"Rural sanitation: The way forward"

By Dr. Fatma El Gohary

(Head of Water Pollution Research Department
National Research Centre)

Main Points:

- Background on the environmental policy in Egypt.
- Strategic objectives of the environmental policy:
- Problems of Water Quality in Egypt.
  1. Deteriorating water quality.
  2. Degradation.
  3. Polluted water.
- Existing Situation of sanitation in Egypt.
- The Reasons of the slow Coverage with sanitation systems are:
  1. Steady increase in potable water house connections.
  2. The implementation of large scale conventional treatment systems.
  3. The high capital, operation, and maintenance costs.
- Constraints of low coverage with sanitation systems.
- Objectives of sewage treatment.
- Treatment options:
  1. Towns and cities are provided by sewer network and central treatment plants.

2. For rural areas and city outskirts, on-site sanitation systems are more appropriate.

- In some cases it may be preferable not to install sewers, but to continue to use existing on-site sanitation technologies such as cesspools and septic tanks.
- In other cases, sewers may be installed only for a block of houses connected to a communal septic tank. The effluents of the septic tanks are collected in a small bore sewer system and treated at a central treatment plant.
- Under certain circumstances, however, the high-cost solution for connecting to a city sewerage network is the only feasible technical solution.
- The reasons of the failure of some treatment plants may be due to one or more of the following reasons:
  1. Increase in potable water supply.
  2. Population increase.
  3. Social behavior (connection of animal yards to the sewer system).
  4. Lack of skilled personnel.
  5. Unavailability of funds for maintenance and rehabilitation.
- Criteria for an effective treatment system.
- Sludge Disposal.
- Challenges facing enforcement of water related legislations.
  1. Legal standards are often rigid and uniform.
  2. Legalization itself, does not create sufficient economic incentives for the development and utilization of clean technologies.

2.6 PRESENTATION (RU-02):

"Road Map For Study The Water Supply And Collection And Treatment Of Wastewater"

By Dr. Diaa Salah El Din ElMonayeri

(Professor At Environmental Engineering Department, Zagazig University, Egypt)

Main Points:

- The main objectives of the road map for wastewater treatment.
  1. Encouraging low-cost technologies..
  2. Decrease the power consumption.
  3. Ease the operation & maintenance.
  4. Reduce area used in the treatment process.
- The energy potential in Egypt from wastes

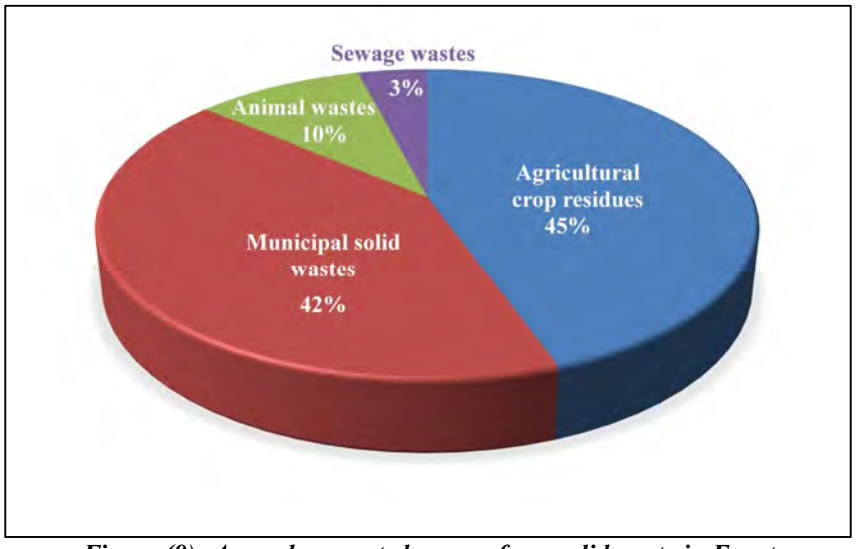

Figure (9): Annual generated energy from solid waste in Egypt

- The proposed research points.
  1. Collection of wastewater (Vacuumed & small bores).

2. Treatment of sludge.
3. Industrial wastewater treatment.
4. Self-purification of water streams.
5. Solid waste.
6. Low cost technologies for small villages.
   - ✓ Characteristics of wastewater in Egyptian villages.
   - ✓ Anaerobic reactors in Egyptian villages.
   - ✓ Bio-tower reactor.
   - ✓ The fluidized bed reactors.

- The regulatory laws for the water & the wastewater sector in Egypt shall be updated to cope with the modern techniques & technologies.

3.6 PRESENTATION (RU-03):

"Towards Sustainable Rural Sanitation–Technology Or Approach?"

By Dr. Mahmoud Abdulazim

(Professor of Sanitary And Environment Faculty Of Engineering Ain Shams University)

Main Points:

- Rural sanitation problem diagnosis.
- Conventional technologies disadvantages:
  1. Cost is unpredicted and unaffordable.
  2. Operation & mayonnaise are remarkably high.
  3. Not suitable for villages.
- **DEWATS** (**DE**centralized **WA**stewater **T**reatment **S**olutions) examples.
  1. Koom Dabaa village, Quena – ESDF **1999 – 2004**.
  2. MKV – GTZ Pioneer Project - **2002 – 2008**.
  3. Dandara – ESDF.

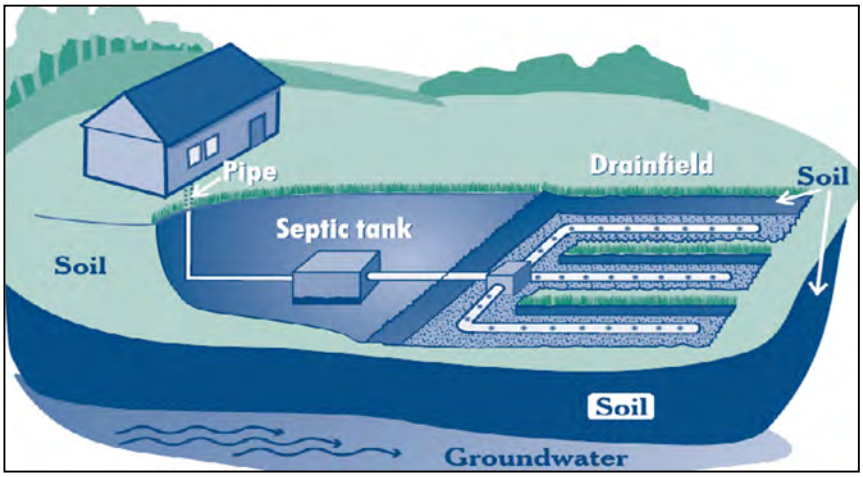

Figure (10): DEWATS system example

- Implemented technologies for **DEWATS**.
  1. Grease Trap and Grit Chamber.
  2. Septic Tank.
  3. Imhoff Tank.
  4. Anaerobic Filter.
  5. Baffled Septic Tank.
  6. Hybrid System.
  7. Biogas Plant.
  8. HGF.
  9. VSF.
  10. UASB.
  11. PONDS.
- Thinking small (Decentralization) is more practical for rural sanitation for the following reasons.
  1. Minimum mechanical and electrical Operation & Maintenance.
  2. Great savings in agricultural lands.
  3. Reliable, sustainable and simple.
- Socio-Engineering shall be considered, which means more involvement between the designers & the community that they are willing to serve. Moreover, the community itself shall be involved in all the phases of the project (design, execution & operation).
- Start From South for cleaner Nile.
- Sustainability is approach not technology.

4.6 PRESENTATION (RU-04):

"Sustainable and Innovative Pilot Scale Technology (200 m^3/d) for Domestic Wastewater Treatment In Rural Areas"

By Dr. Abdulazim Negm

(Department Of Environmental Engineering, Egypt-Japan University Of Science And Technology)

Main Points:

- The importance of proper sanitation and its reflection on the human health.
- Advantages of the Pilot Scale Technology **(200 m3/d)** for domestic wastewater treatment which has been implemented in Borg Al Arab city- Alexandria.
- The new technology shall be considered and further studies to be applied to identify its beneficial usage.

Figure (11): Pilot Scale plant in Borg Al Arab city-Alexandria

5.6 PRESENTATION (RU-05):

"Egypt Rural Sanitation: Understanding Contextual and Compositional Rural Transformations"

By Dr. Sawsan Bakr

(Professor of urban planning, faculty of Engineering, Cairo University)

Main Points:

- Background.
  1. Egypt's natural and planning regions.
  2. The study area: Regional Classification.
  3. Population and Administrative Subdivisions.
  4. Regional shares- population, cities and villages.
  5. Dakhalia, Sharika and Behira jointly had **1485** villages accounting for **55.8%** of all villages in Lower Egypt and **33.5%** of all villages in Egypt. Jointly they had a rural population of **13.756 million**, which accounted for **51.87%** of Lower Egypt's rural population and **28.16%** of Egypt's rural population in **2014**.

Region	Regional Share of Urban population	Regional Share of Rural Population	Regional Share of Total population	Regional Share of Villages	Regional Share of Cities
Urban Gov.	40.98	0.09	17.58	0.19	5.75
Lower Egypt	28.10	54.00	42.92	56.45	43.68
Upper Egypt	28.01	44.88	37.67	37.14	36.40
Frontier Gov.	2.91	1.03	1.83	6.22	14.18
Egypt	**100.00**	**100.0**	**100.0**	**100.0**	**100.0**
Excluding Frontier Gov.	**97.09**	**98.97**	**98.17**	**93.78**	**85.82**

Figure (12): Urban and Rural Population Shares by Region - 2014

- Compositional Transformations.
  1. Demographic Characteristics.
     - ✓ The high total fertility rate in Rural Upper Egypt, which has about 11 million poor inhabitants – **50 %** of the **22 million** poor Egyptians reported in **2012/2013**.
     - ✓ Egypt's very young population demands greater investment and targeting of projects for job creation, provision of housing, infrastructure, and social services (health and education).

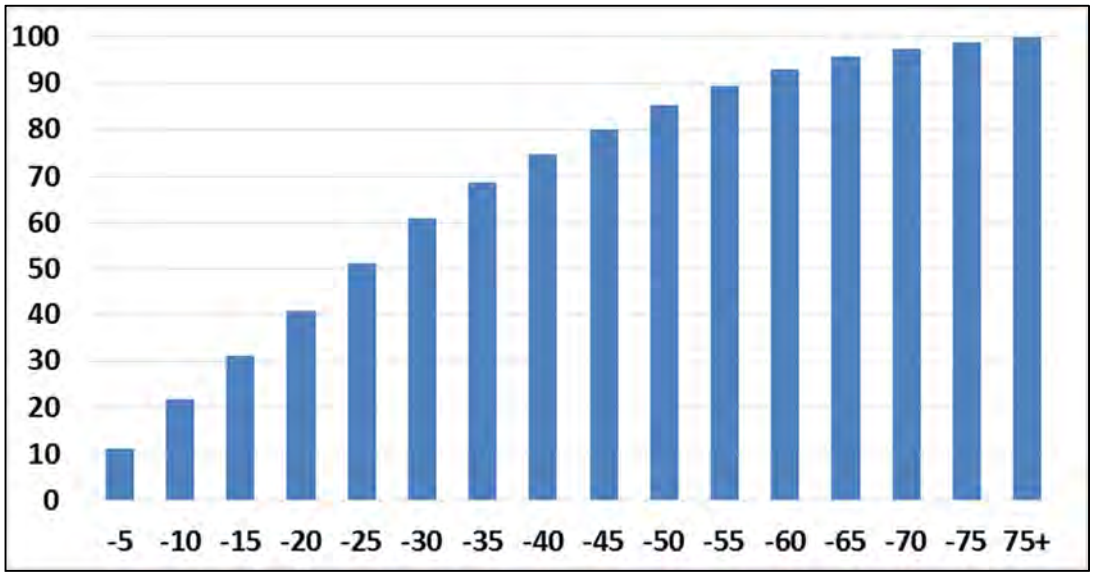

Figure (13): Cumulative Distribution of 2014 population by age group

- ✓ In contrast to the post **1952** revolution period, with high migration rates mainly State driven, internal migration rates declined during **1970s**, stabilized in the mid **2000's**, and reached **6.1 %** in **2010**.
- ✓ Almost **61 %** of migrants in cities came from other urban areas
- ✓ **47.8 %** of migrants living in rural areas came from other rural areas.

- ✓ Lower Egypt is the prime destination for those who migrate for work followed by Cairo.
- ✓ Migrants from Lower and Upper Egypt tend to migrate within their home region.

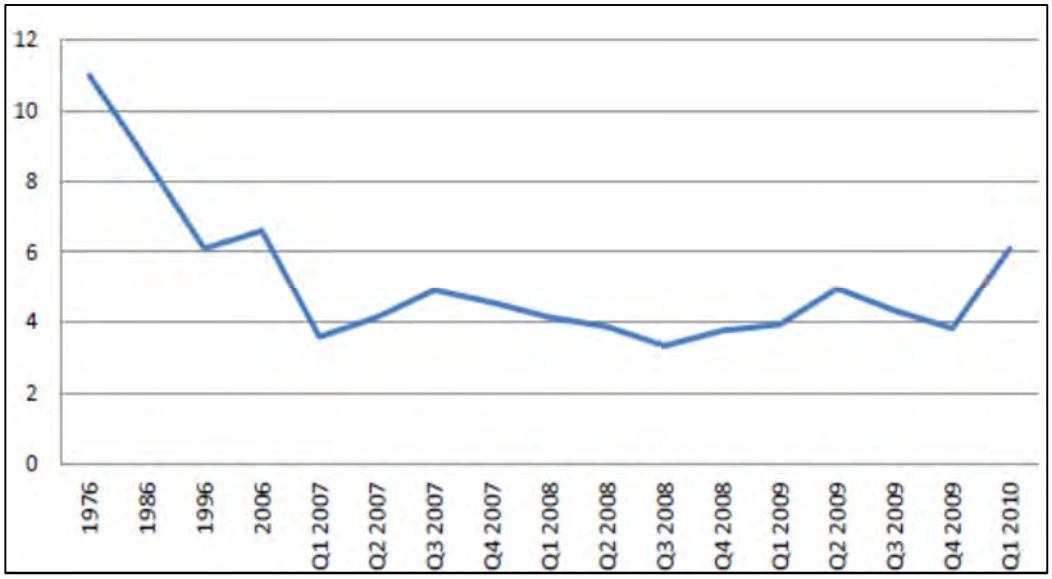

Figure (14): Internal migration rates

2. Socio Economic Characteristics.

- ✓ Egypt's population continues to have low educational levels. **42.2 %** had no schooling in **2006** compared to **68.5 %** in **1986**, Only **12 %** had above medium and university education.

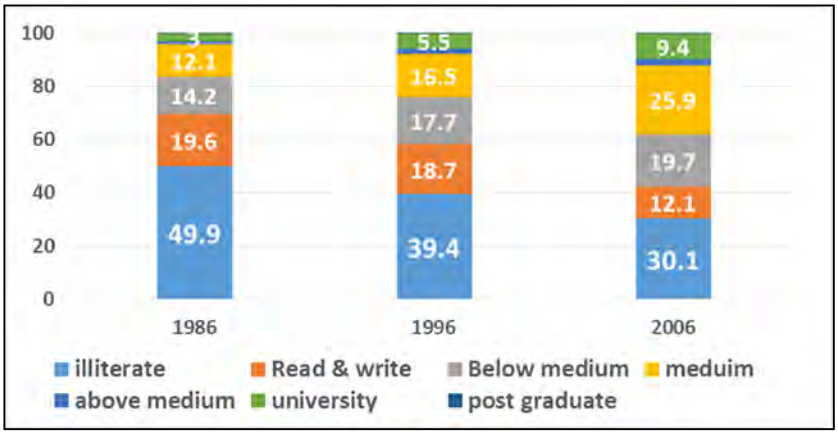

Figure (15): Educational Attainment Levels

- ✓ **2004-2010**: Employment grew from **18.7** to **23.8 million** and unemployment declined from **10.3 %** to **9.0 %**, **2010-2014**: Slow employment growth and rising unemployment rate reaching **13 %** in **2014**. Volatile very high female unemployment. rate (**about 25 %**). In **2014** there were **3.65 million** unemployed persons including **2.0 million** males.

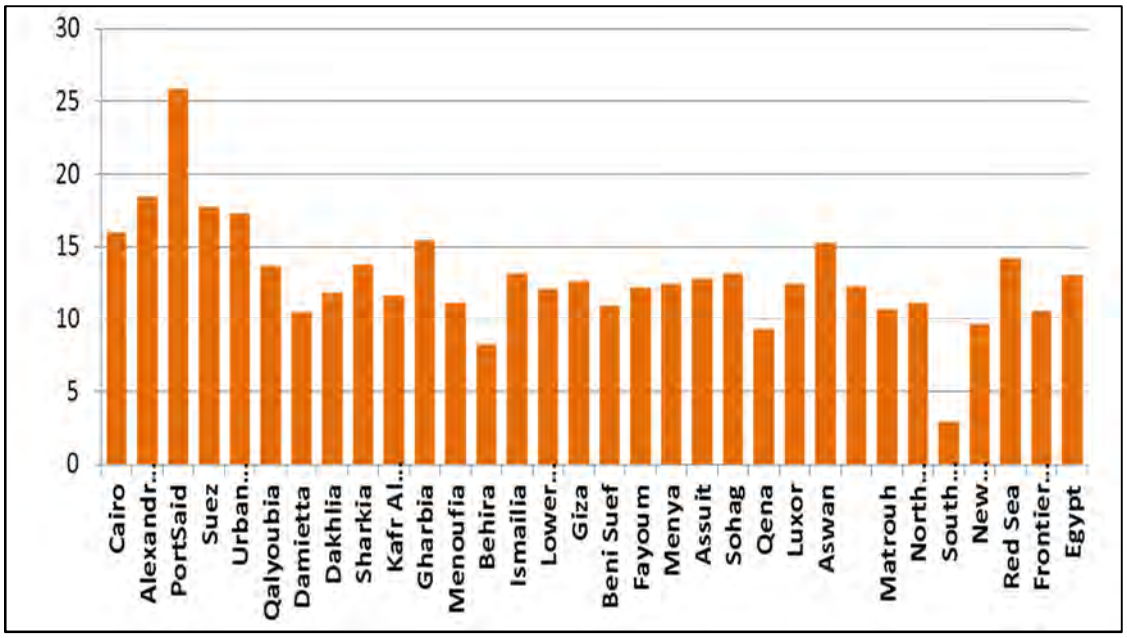

Figure (16): Percent unemployed persons in 2014

- ✓ Steady increase in % poor population over the **2008-2013** period, reaching **26.3 %** in **2013** compared to **16.7 %** in **2000**.
- ✓ Upper Egypt faired the worst with **26.5 %** of its urban population and **49.4 %** of its rural population below the poverty line.
- ✓ Steady increase in % poor children over the **1999-2013** period, reaching **28.8 %** in **2013** compared to **21 %** in **1999**.
- ✓ Rural Upper Egypt faired the worst with **51.2** % of its children living below the poverty line.

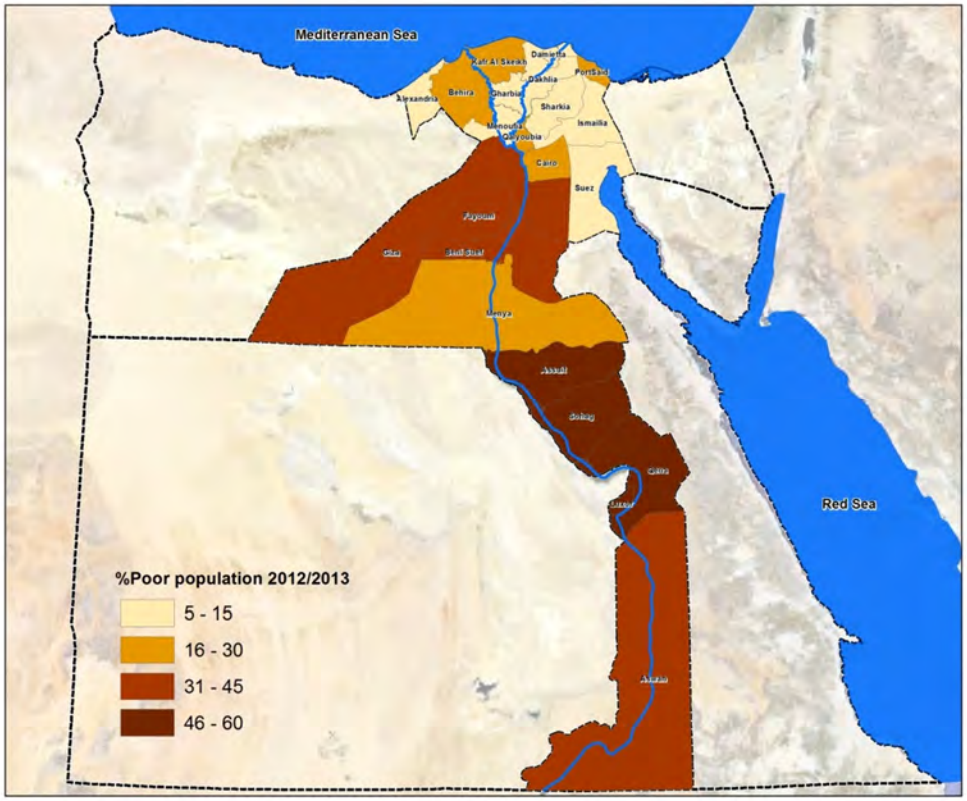

Figure (17): Classification of governorates according to percent poor pop. 2012/2013

3. Child Health.

✓ under-five mortality is lower among urban children (**23 deaths/1000 births**) than rural children (**34**) Urban governorates have the lowest rates followed by Lower Egypt.

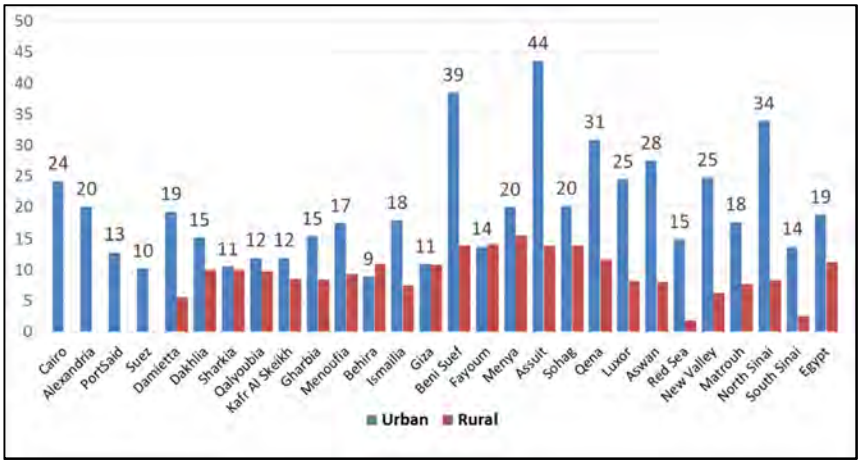

Figure (18): Infant Mortality Rates in Egypt's governorate in 2013

- Contextual Transformations.
  1. Spatial Characteristics of rural settlements.
     - ✓ Egypt's human settlement system is characterized by urban primacy and a dense fabric of hamlets, villages, "mother villages," and small towns.
     - ✓ The Rural Settlement system is characterized by the large number of settlements less than **10000** and the growth in the number of villages with more than **20,000** population.
     - ✓ There are 738 settlements (villages) with a population larger than **10000** accounting for **18.71 %** of total rural population.
     - ✓ **50 %** of the rural population lived in **1526** villages with populations greater than **5000** persons.
     - ✓ There are **26404** rural settlements (mostly hamlets) with populations less than **1000** accounting for **18 %** rural population.
     - ✓ Land uses change **1984-2007** indicates that agricultural land increased by **19.7 %** , human settlements increased by **132.5 %**.
     - ✓ Population density in human settlements declined from **113.7 persons/Feddan** in **1984** to **83.3 persons/Feddan** in **2007**, due to the large lands designated to new cities and dispersed unplanned urban growth.
     - ✓ The area of human settlements almost doubled and resulted in the absolute loss of about **300 thousand Feddan** of agricultural land. Most of the lands added to agricultural land during the **1984-2007** have been in land reclamation lands East and West of the Delta.

- ✓ Canals and drains are present within the built up area of **86.2 %** of villages.
- ✓ **71 %** of villages with canals & drains suffer from solid waste, Drains and canals in **44 %** of villages have dead animals, **44 %** of villages suffer from wrecked canal and drain embankments, **26.9 %** of villages suffer from damaged bridges, in **51 %** of villages, solid waste is collected from houses, HHs in **17.4 %** of villages dispose solid waste in streets, HHs in **12.5 %** of villages dispose solid waste in water ways, HHs in **12 %** of villages burn solid waste.

2. Urban characteristics of the built-up Area in Villages.
   - ✓ Densities vary from very low to very high with an average of **100 persons/ acre** (close to villages)
   - ✓ Average lot area is about **150 m^2.**
   - ✓ High buildings represent a very small percentage of buildings mostly on main village and roads.
   - ✓ **53.8 %** of villages have many local roads, and **25 %** of village have many dead end alleys, while **65 %** have some dead end alleys.
   - ✓ About **66 %** of village have narrow roads making it difficult for cars to pass.
   - ✓ **61%** of villages have narrow streets not allowing for adequate ventilation.
3. Housing Stock & Living Conditions.
   - ✓ **70 %** of residential buildings (**10.5 million**) are in Rural Egypt (**37.5 %** in Lower Egypt and **31.5 %** in Upper Egypt).

- ✓ Major progress has been achieved in access to potable water networks. In **2006**, a gap in % pop with tap in unit was observed between Lower and Upper Egypt (**87 %** and **70 %**).Very low access to tap in unit is evident in all upper Egypt except for Aswan and Luxor

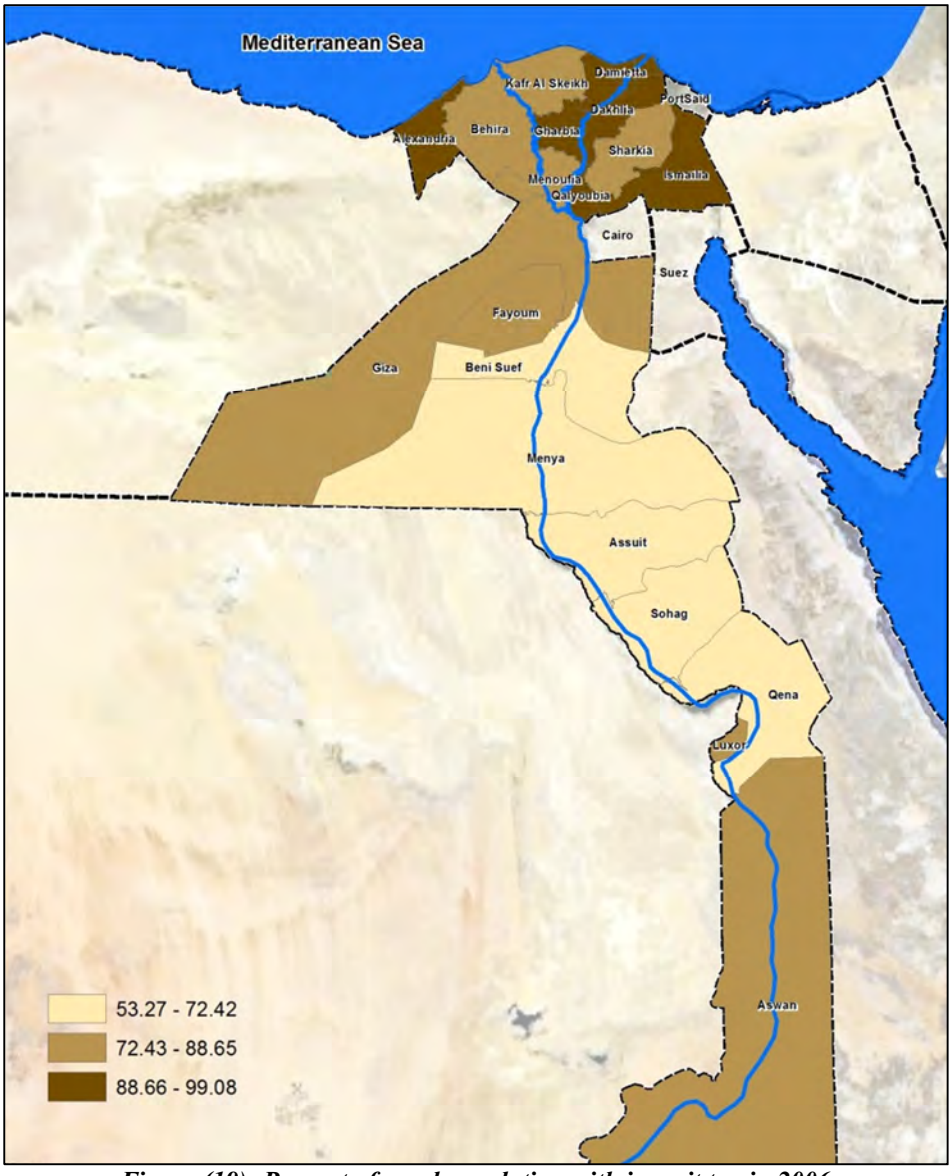

Figure (19): Percent of rural population with in-unit tap in 2006

- ✓ In **2006**, **65 %** of the rural population depended on vaults. In Upper Egypt, the rate reached **84 %**. Assuming the same

percentage in **2015**, then **32.4 million** population in Rural Egypt depend on vaults.

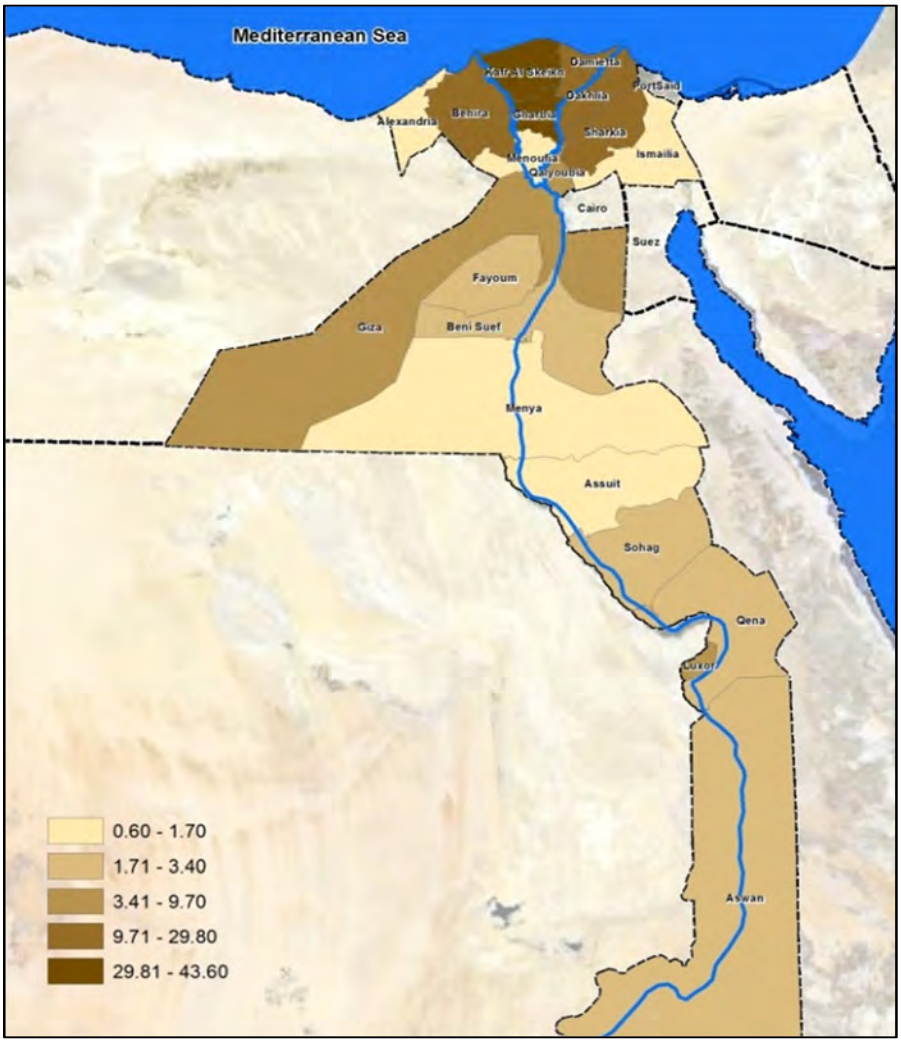

Figure (20): Percent of rural population connected to sewer networks in 2006

- Shifts in Industrial Mix.
  1. Declining Sectors shares: Manufacturing and agriculture, Insurance & Real estate.
  2. Growing sectors shares: Transportation, storage, communication, General services, Whole sale and Retail Trade.

3. Major Employers in **2014**: Agriculture (**27.6 %**), Retail Trade (**13.4 %**), Manufacturing (**11.3 %**) and Construction (**11.3 %**), Transportation, storage and communication (**8.0 %**).

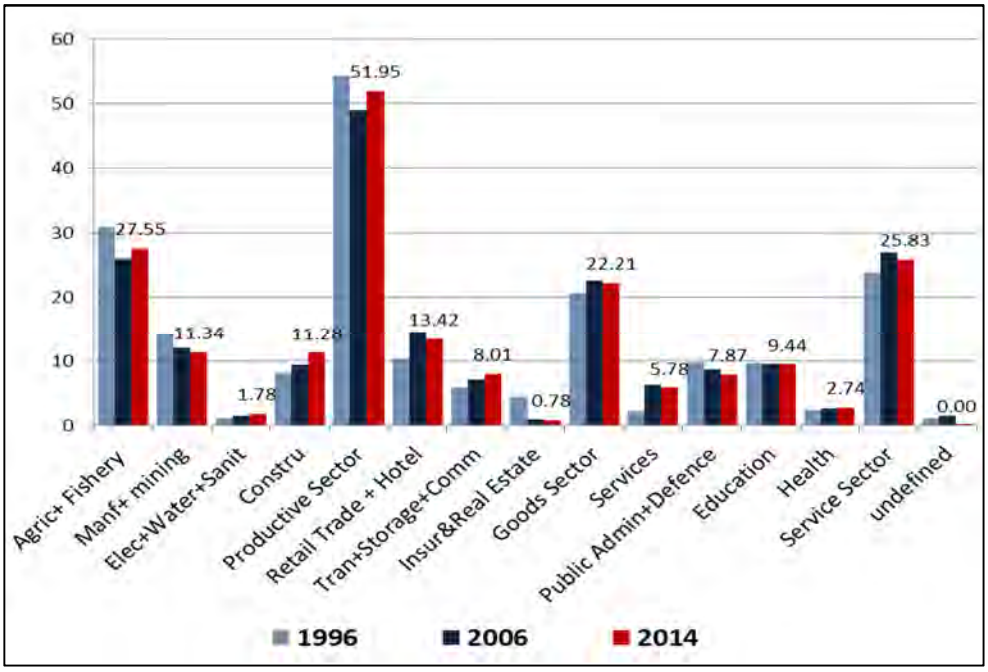

Figure (21): Shifts in industrial mix

6.6 PRESENTATION (RU-06):

"Egypt Rural Sanitation: Understanding Technology Mapping"

By Dr. Ahmed Gaber

(Professor of Sanitary And Environment Faculty Of Engineering Cairo University)

Main Points:

- Global Overview.
  1. **UNICEF/WHO 2015** Update and **MDG** Assessment.
  2. Urban Sanitation system Trends in the Developing World.

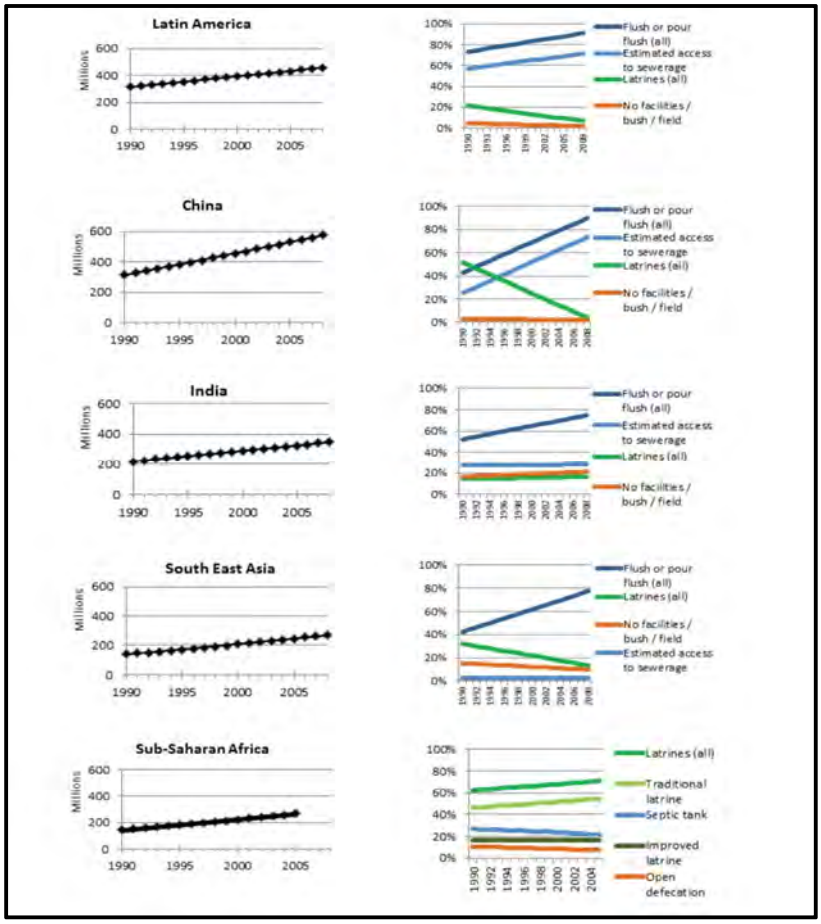

Figure (22): Urban population an sanitation system trends by region/country

3. Overview on the **UN HABITAT**, Global Atlas of Excreta, Wastewater, Sludge and Biosolids Management.
4. Primary treatment is still an option, secondary treatment in the most predominant and tertiary treatment is applied as a necessity to meet stringent requirements for disposal in sensitive areas.

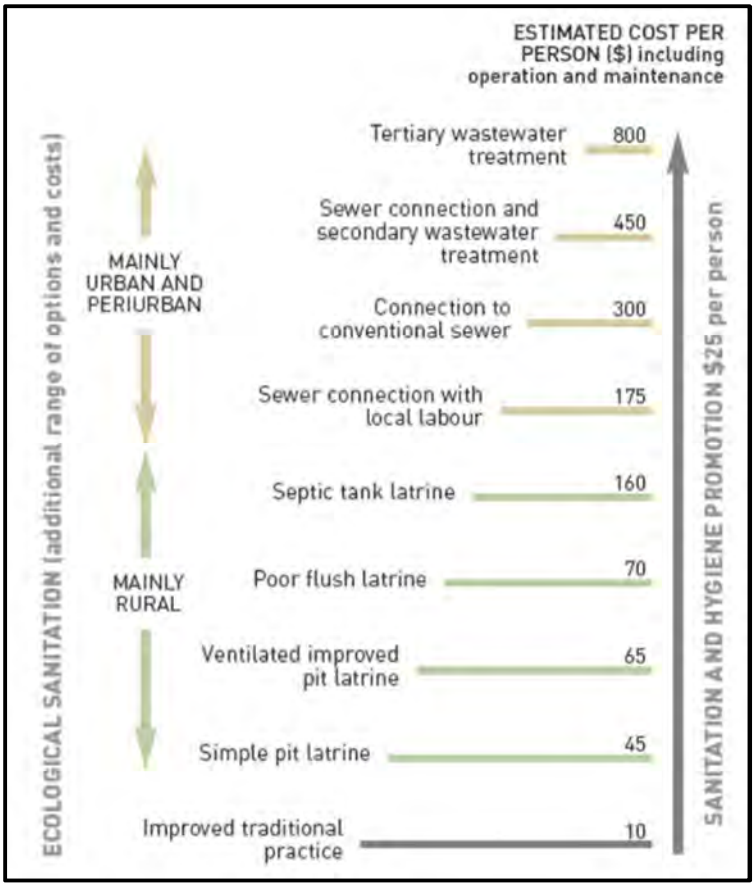

Figure (23): Options for different levels of sanitation services and their cost estimate

5. According to the fourth World Water Development Report, presently only **20%** of globally produced wastewater receives proper treatment. Treatment capacity depends on the income level of the country. Treatment capacity is **70%** of the generated wastewater in high-income countries, compared to only **8%** in low-income countries.

- Regional Overview.

1. Arab Countries Region.

✓ Through the past **50** years, many of Arab countries took a huge steps in the water and wastewater management field.

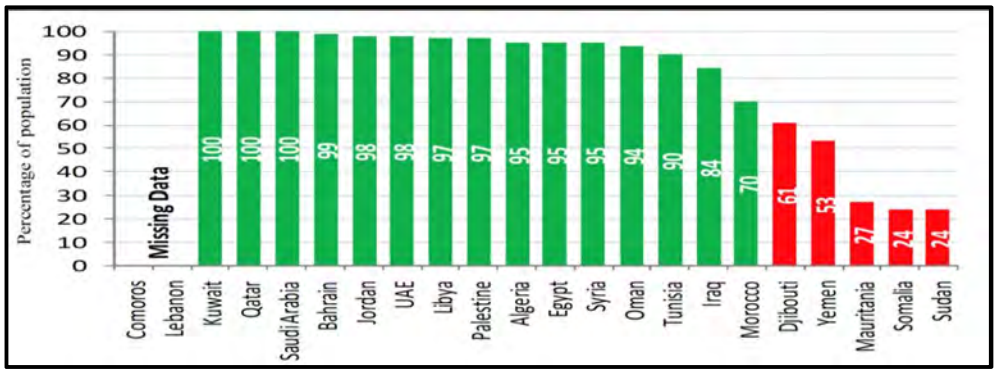

Figure (24): Sanitation coverage in Arab countries (2011)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Algeria	33.6	33.6	33.6	33.6	35.0	36.3	37.7	39.1	40.5	41.8	43.2	44.6	46.0	47.3	48.7	50.1	51.5	52.8	54.2	54.2	54.2	54.2
Bahrain																						
Comoros	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3		
Djibouti		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Egypt	3.0	3.8	4.5	5.3	6.1	6.8	7.6	8.4	9.1	9.9	10.7	11.4	12.2	13.0	13.7	14.5	15.3	16.1	16.8	17.6	18.4	18.4
Iraq					0.6	0.6	0.6	0.6	0.6	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.8	2.0	2.2	2.3	2.3	2.3
Jordan									2.8	2.8	2.8	2.8	2.8	3.1	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5
Kuwait																						
Lebanon																						
Libya																						
Mauritania						0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Morocco																						
Oman	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3
Palestine		3.8	3.8	3.8	3.8	3.8	4.2	4.7	5.1	5.5	6.0	6.4	6.9	7.3	7.8	8.2	8.7	9.1	9.6	9.6	9.6	9.6
Qatar																						
Saudi Arabia																						
Somalia				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2
The Sudan	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Syrian Arab Republic	28.9	28.9	28.9	28.9	28.9	30.2	31.5	32.8	34.1	35.4	36.7	38.0	39.4	40.7	42.0	43.3	44.6	45.9	47.2	47.2	47.2	
Tunisia							5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1		
United Arab Emirates														60.1								
Yemen	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0

Figure (25): Rural sanitation coverage in Arab countries (2011)

2. South Asia Region.

✓ Some countries in South Asia such as India & Malaysia suffered from the sanitation problems for decades. Recently, new technologies (such as faecal sludge management) helped these countries to improve the sanitation services.

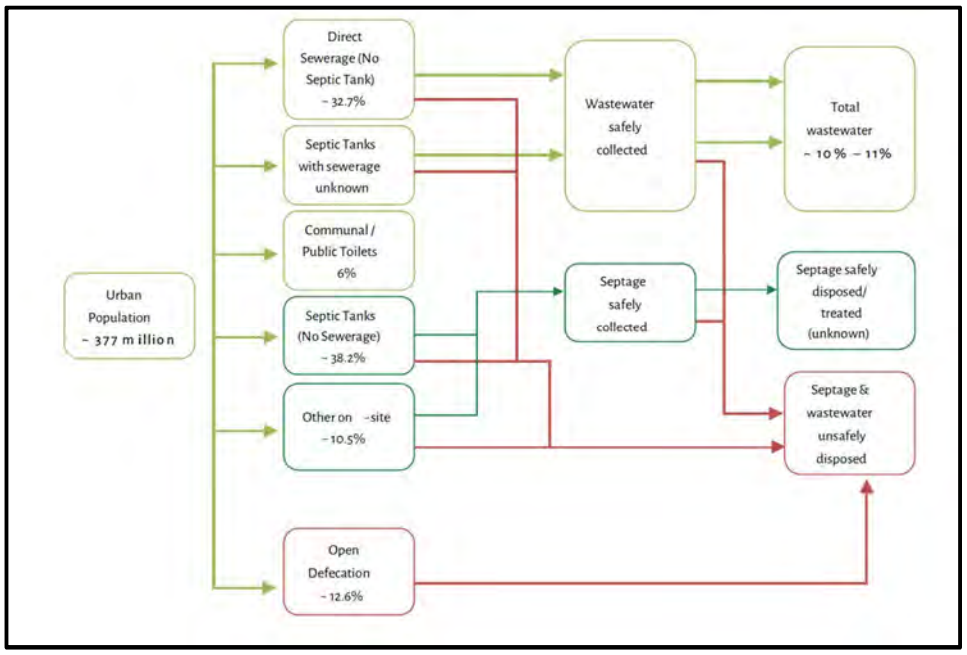

Figure (26): Outline wastewater flow diagram for all census urban areas in India

Figure (27): Malaysia faecal sludge management

3. **EU member states.**

- ✓ A study Had been applied to estimate the compliance costs related to the Urban Wastewater Treatment Directive (UWWTD) in **27** member states and to assess whether the estimated investment cost can be covered by available finance.
- ✓ The generic cost function for the collection system has been developed based on, Function of the total length of pipe with number of p.e, Distribution of pipe length on pipe diameters and Cost for each diameter size

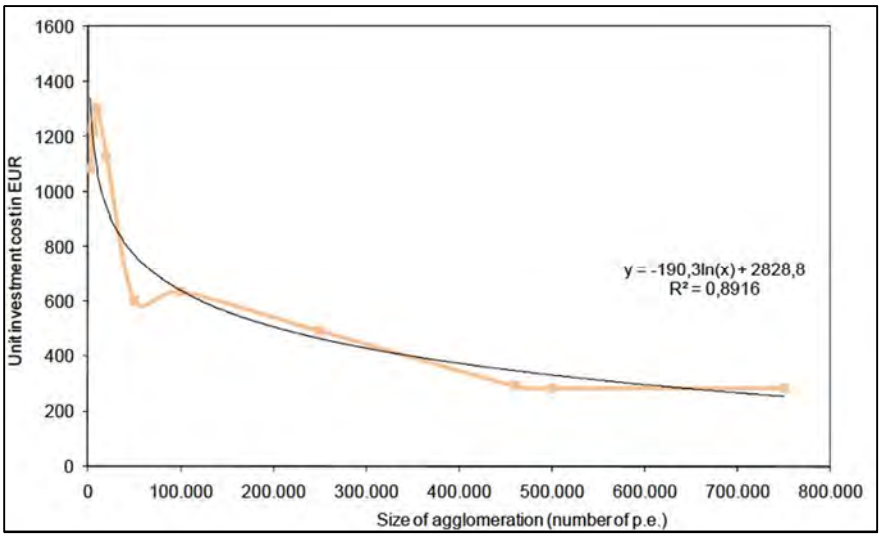

Figure (28): Replacement value function of wastewater collection works

- ✓ Wastewater treatment cost functions were developed based on the following combinations:
  - **1** Primary treatment (mechanical).
  - **2** Secondary treatment (Mechanical-Biological).
  - **3P** Advanced treatment with P removal (mechanical-Biological-Chemical).
  - **3N** Advanced treatment with N removal (Mechanical-Biological-Chemical-Nitrification).

- **3NP** Advanced treatment with removal of both N and P (Mechanical-Biological-Nitrification-DE nitrification-Organic P).

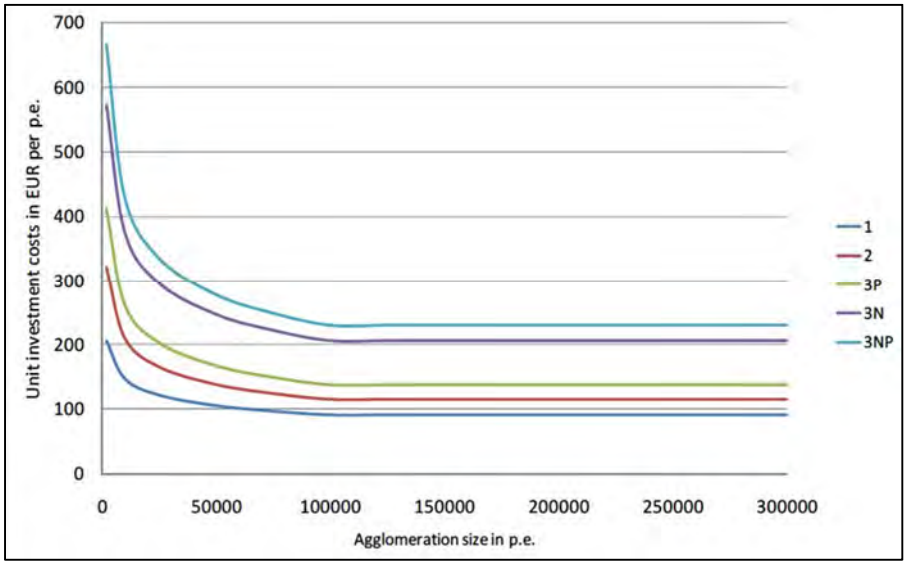

Figure (29): Investment expenditure functions for wastewater treatment

- The study addressed Supply of finance & Financing gap.

	Article 3	Article 4	Article 5	Total
Austria	0	0	0	0
Belgium	223	107	832	1,161
Bulgaria	4,208	126	790	5,125
Cyprus	295	50	18	363
Czech Republic	845	244	435	1,524
Denmark	0	0	13	13
Estonia	117	4	58	178
Finland	0	0	243	243
France	0	198	1,424	1,623
Greece	599	279	12	890
Germany	1	4	0	4
Hungary	0	2	8	10
Ireland	0	53	195	248
Italy	2,040	714	650	3,404

Figure (30): overview of investment compliance cost estimate

4. Danube watershed Countries.

- ✓ Almost **80%** of the population in Danube watershed countries report using flush toilet in their dwelling, yet only **66%** are connected to public sewer networks.
- ✓ Although progress has been made in the region since **2000**, but the rate of progress is indicative to the capacity of countries to increase the coverage level with public sewer networks.

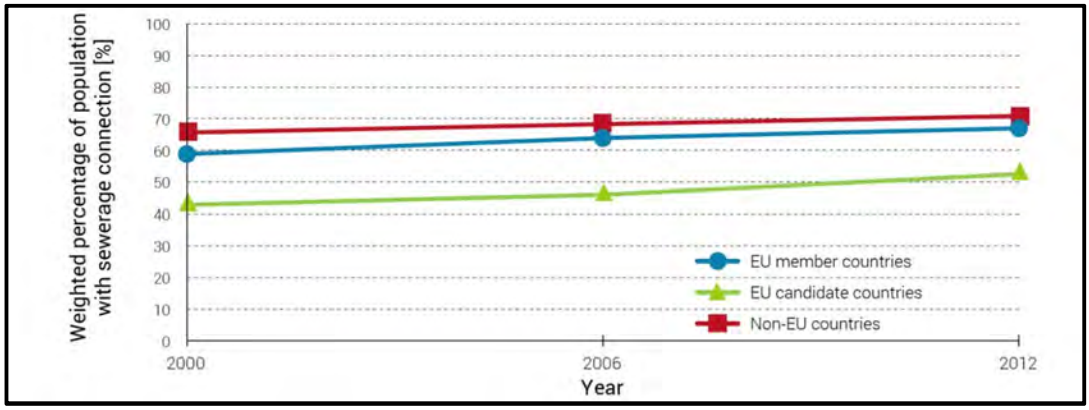

Figure (31): Sewerage coverage in Danube watershed countries (2000-2012)

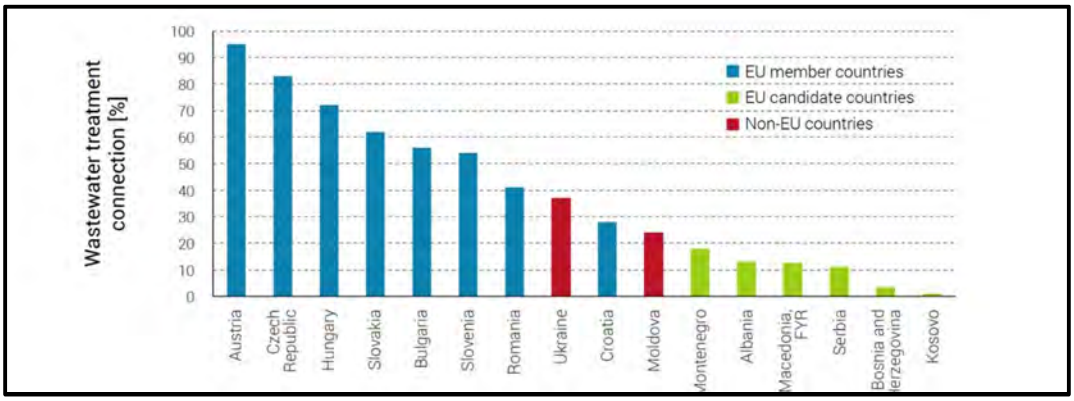

Figure (32): Wastewater treatment coverage in Danube watershed countries (2000-2012)

- ✓ The Danube region study applies an excellent conceptual model for sector analysis and assessment. The model focuses on:
  - Access.
  - Quality.
  - Efficiency.
  - Financing.

Figure (33): Assessing the sector's progress in providing sustainable services

- Faecal Sludge Treatment **(FSM)** Technologies.
    1. Developing solutions for FSM is a serious global problem that has limited attention over the past twenty years. Compared to wastewater management practices, there is a hundred year gap in knowledge of FSM in urban areas. Over the last **15** years, the thinking of engineers worldwide has started to shift words designing integrated FSM systems.
    2. FSM projects are faster to implement than wastewater management projects. In some cases, it is an interim solution tells the community is covered with sewerage. In other communities it is a final sustainable solution. It has been demonstrated that, depending on local conditions, the cost of FSM technologies are five times less expensive than conventional sewer-based solutions.
    3. Many countries are struggling to cover rural and urban populations with basic sanitation(WHO/UNICEF) sanitation ladder. FSM objective is to stop unsafe discharge of waste by completing the sanitation service chain. the expansion and development of functioning conventional sewer networks is not likely to keep pace with the rapid urban expansion typical of low and middle-income countries.
    4. About **2.7** billion people worldwide are served by sanitation methods that need faecal sludge

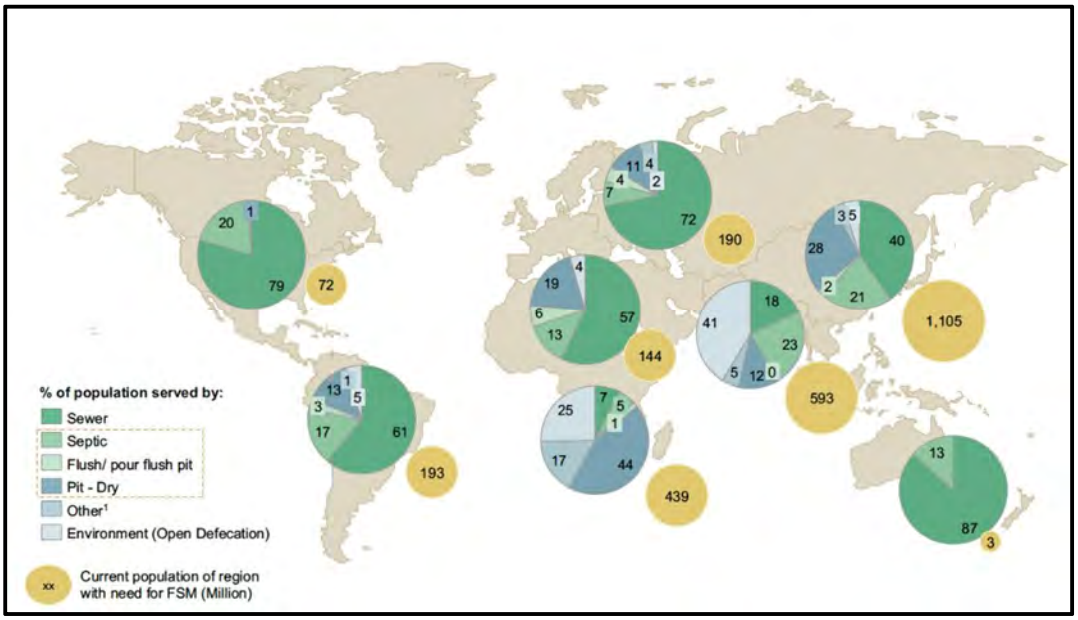

Figure (34): Percentage of population served by onsite sanitation technologies

- Wastewater Treatment Technologies.

  1. Stages and evolution of wastewater treatment.

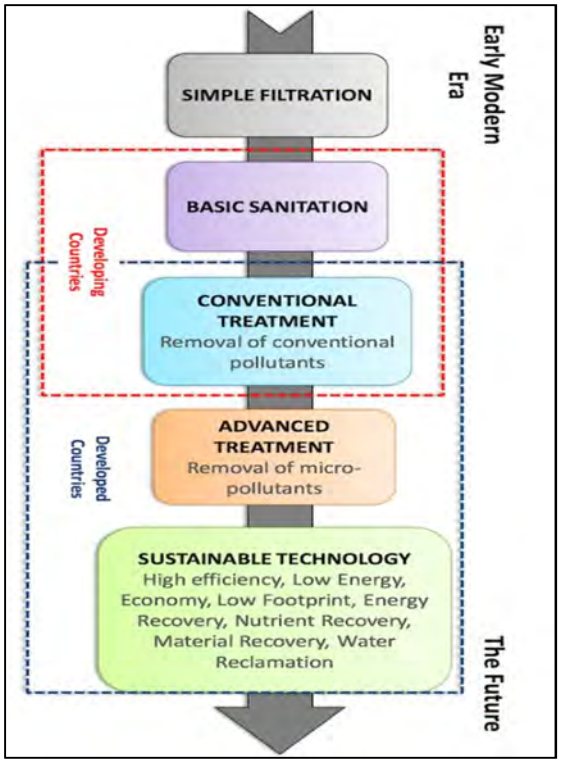

Figure (35): Stages and evolution of wastewater treatment

2. Examples of a treatment matrix for reuse.
3. Economic considerations for different wastewater treatment systems.
4. Energy Requirements, Efficiency and Recovery.

- Innovation Directions.
  1. Theme-Scape Map of Water Patent Collection.
     - ✓ Wonderful work published **2013**, strategic review of scientific papers and patents in **15** technology areas. The output is valuable and the applied process and tools are as valuable.

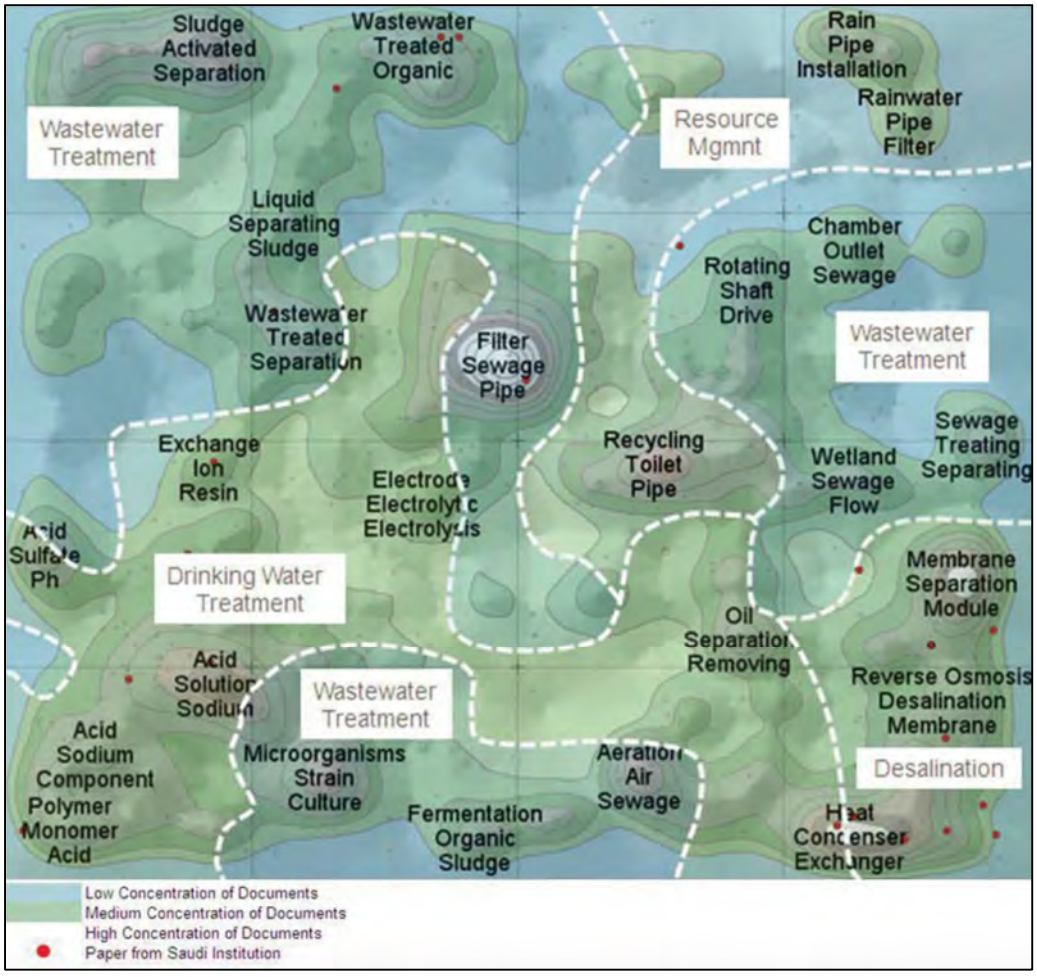

Figure (36): ThemeScape map of water patent collection

2. Soil Aquifer Treatment **(SAT)**.

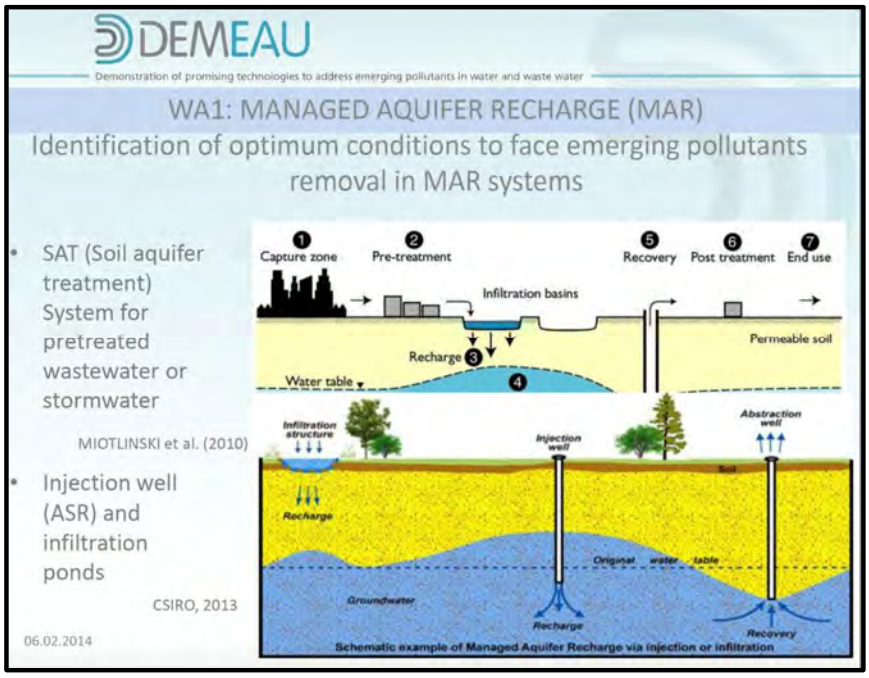

Figure (37): Soil Aquifer Treatment

3. The Dutch Waterharmonica Innovation.
   - ✓ Conceptual idea developed in order to use constructed wetland systems for polishing treated wastewater and provide simultaneous nature enhancement. The main goals are:
   - ✓ Water treatment/effluent polishing-EU WDF compliance.
   - ✓ Ecosystem recreation and restoration/biodiversity enhancement.

Figure (38): Waterharmonica

4. Floating wetland innovation.

Figure (39): Floating wetland installed on the river Kshipra-India

5. **UN HABITAT** Vacutug.

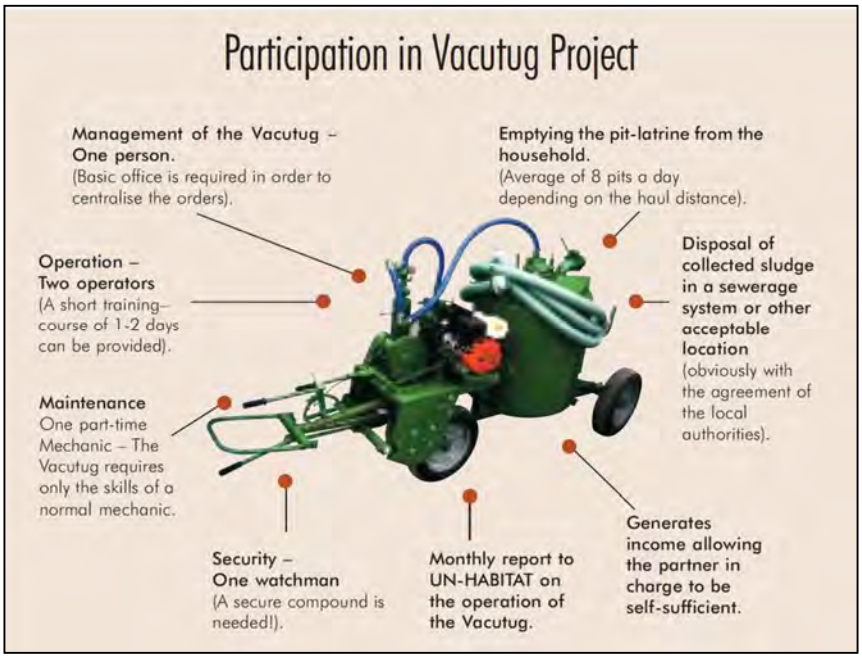

Figure (40): UN HAPITAT Vautug

6. Use of geo-synthetic materials for sludge and faecal sludge dewatering.

Figure (41): Geobag usage in sludge dewatering

- Outcomes & recommendations.
  1. It is a tremendous fascinating amount of knowledge, experience and lessons learned on country, regional and global levels. Part of it "is a must-to-study" and some of it "is a must-to-translate" and disseminate
  2. Faecal sludge management is new technologies shall be studied and adopted.
  3. Integrating rural sanitation in watershed management is recommended for Egypt.
  4. Maximize the benefits from the upcoming **CAPMAS 2016** census by collecting data about the current sanitary conditions.

7. FOURTH SESSION: TREATED WASTEWATER REUSE

1.7 PRESENTATION (TR-01):

"Human resource development in Water and Wastewater sector"

By Dr. Yehia Kamal

(Professor of Irrigation And Hydraulics Faculty Of Engineering Ain Shams University)

Main Points:

- The Human resource is the key player in the water & the wastewater sector success.
- The sector suffers from an acute shortage in the qualified human resources.
- The previous plan for the holding company for the human resources adopted the following aspects:
  1. Qualifications framework.
  2. Competence standards.
  3. Assigning specific learning areas.
  4. Competences based curricula.
- Incapabilities in the holding company plan:
  1. Lack of logistic & physical potentials at the training centers.
  2. Absence of **ISO** applications in the human resources sector.
  3. Disorientation of the human resources.
  4. Lack of Arabic software.
  5. Depression of the moral spirit & loyalty to the organization.

2.7 PRESENTATION (TR-02):

"Advanced technologies for water/wastewater treatment"

By Dr. Amer El-Kalliny

(Water Pollution Research Department, National Research Centre)

Main Points:

- Problem definition.
  1. According to the **WHO**, more than **3.4 million** people die each year from water pollution, lack of sanitation, and hygiene-related causes.
  2. The problem of water pollution negatively affects economic growth as well as the physical and environmental health and quality of life for billions of people.
  3. Due to the polar nature of some water pollutants (such as pesticides, hormones, pharmaceuticals, and industrial chemicals), they are not completely removed by traditional water treatment barriers.
  4. There is no "one-size-fits-all" solution.
- Group definition & adopting strategy.
- Homogeneous photo-oxidation.
- Heterogeneous photo-oxidation.
- Fixed-bed solar reactor for water purification based on a stainless steel woven mesh.
- Magnetically separable photocatalyst.
- Membrane technologies.

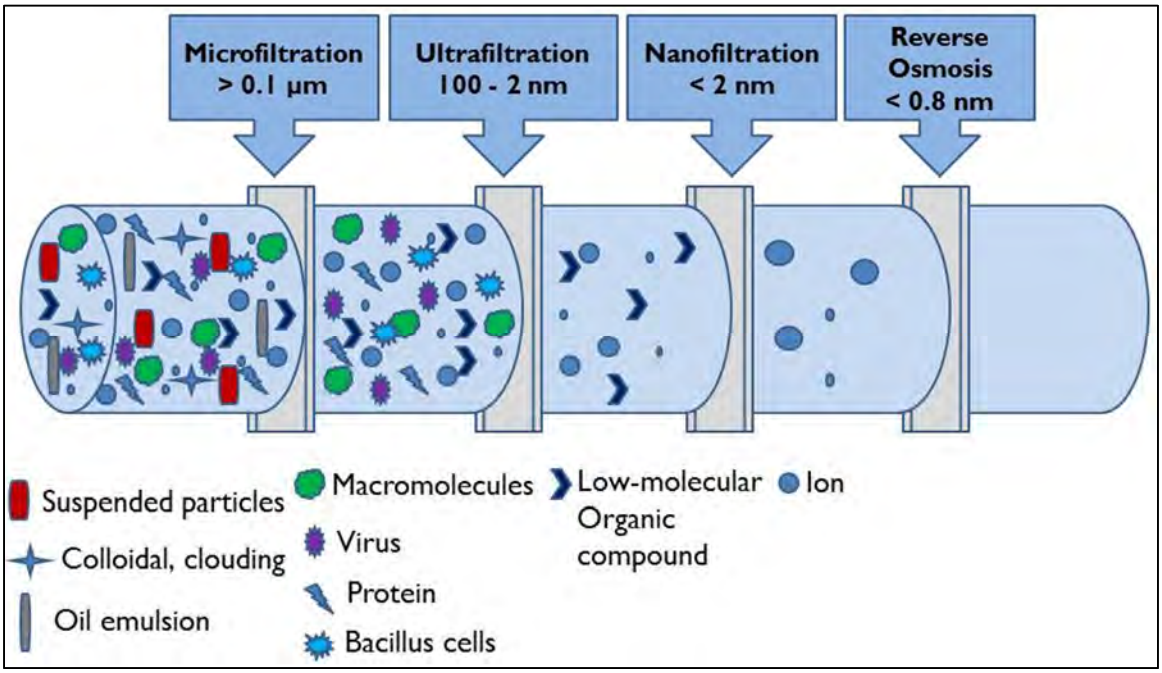

Figure (42): Membrane application in treatment

- MBR vs. conventional wastewater treatment.

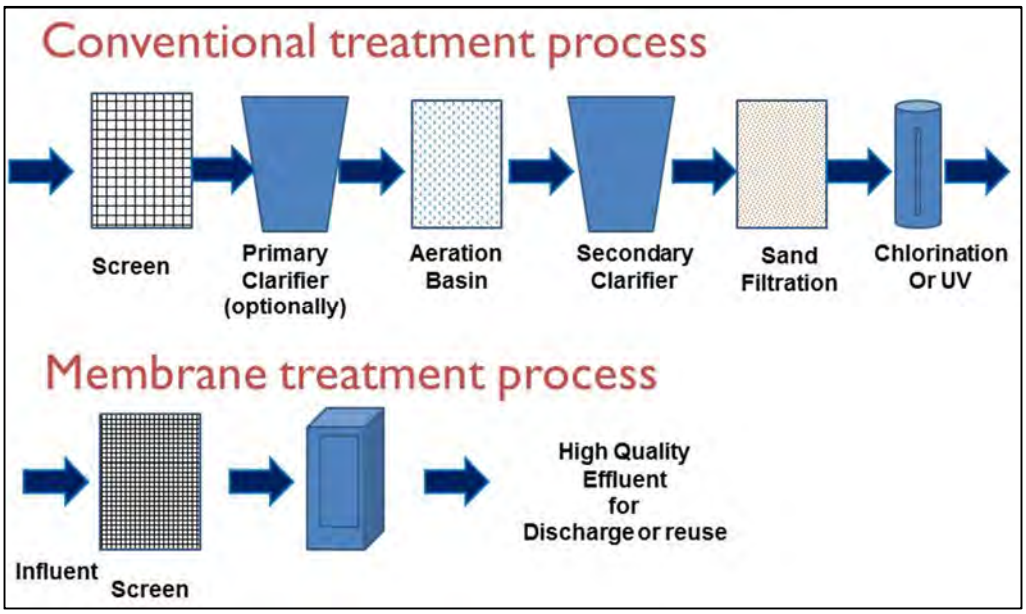

Figure (43): MBR vs. conventional wastewater treatment

- Membrane technology will lead the treatment trial in Egypt (desalination and MBR).

8. CONCLUSION & RECOMMENDATIONS

The eventual conclusions & recommendations of the workshop categorized under **2** main topics as follows:

1.8 EXECUTIVE RECOMMENDATIONS

1. Orientation towards the concept of integrated strategic planning in the water sector and sanitation among all concerned ministries and sectors (Housing, Irrigation, Agriculture, Environment, Health... etc.), creating a mechanism to coordinate all strategies under the common goals and under the umbrella of the governmental plan of sustainable development **2030**.
2. Establish a mechanism to link all the previous strategies with clear executive plans that allow the executive authorities to achieve their purpose in an orderly and sustainable way.
3. Achieve integration in connecting the information systems of the water & wastewater sector located in different ministries under one umbrella, to enable decision makers and executives to see the full picture and identifying the sector's priorities clearly.
4. Creating a clear mechanism through ministerial committees / Top Water Council with specific authorities\power, to achieve common executive decisions regarding development, investments and institutional reform, through the application of the concept **(shared-decision)** between the concerned ministries, enabling the implementation of a common developmental vision without obstacles.

5. Study the integration between the local manufacturers to develop unconventional solutions, that can be manufactured locally (Treatment systems, desalination plants,… etc.).
6. Focusing on un-served villages and developing the investment priorities considering the degree of contamination, the environmental impact, public health and other clear aspects.
7. Considering the community participation in projects concerning the funding issues for the existing un-served areas and not the newly developed ones. (Al Monoufia un-served villages could be taken as a successful role model).
8. For the desalination plants, a proper disposal of the outcome shall be studied to avoid any harm to the marine life.
9. Preparing an economical plan for the wastewater collection and treatment upon number of five-year plans, including the determination of the optimum funding procedures for the plan implementation.
10. Completion of water & wastewater projects according to the strategic master plan prepared for the sector.
11. Increase the governmental financial support directed to the maintenance, replacement and renovation of the water & wastewater projects, taking into account the achievement of financial balance between costs and revenues to ensure the sustainability of the national investments in the sector.
12. Increase the attention to the young employees in the sector through: continuous training (internal and abroad), creating appropriate mechanisms to improve their positions and linking their salaries to the incentive performance.

13. Increase the attention to the technical schools and specialized trainings.
14. Encourage the customers to rationalize water consumption by intensive awareness campaigns.
15. Applying an executive plans to reduce the leakage in the distribution networks.
16. Speeding up the issuing of the unified water law.

2.8 RESEARCH RECOMMENDATIONS

1. Speeding up the issuing of the Egyptian code for the desalination works.
2. Environmental impact assessment of the effect of the desalination plants outcome on the marine life.
3. Study of the solar desalination plants considering the financial aspects.
4. Environmental impact assessment for applying decentralization of wastewater treatment in rural areas.
5. Developing a study for an integrated plan between the concerned ministries (Housing, Irrigation, Agriculture and Environment) to control the expected water supply shortage during the upcoming years.
6. Study the possibility of increasing the service cost to: cover the operation & maintenance cost, increase the quality of the service and ensure the service sustainability.
7. Environmental impact assessment for the treated wastewater effluent reuse in agriculture.

8. Study the modern techniques for energy reduction\recovery in the desalination plants.
9. Study the possibility of reusing the water used in the cooling process of the nuclear plants as one of the desalination techniques.
10. Study of allotment the service management according to the water borders instead the governmental borders.
11. Inventory of manpower in the sector to study the required training programs and redistribution of existing competencies considering their specialties and the administrative aspects.
12. Developing an applicable strategy for the separation between the domestic and the industrial wastewater.
13. Spreading the Faecal sludge management knowledge.
14. Study the successful experiences in wastewater management all over the world (Arab countries, South Asia region, Danube watershed countries, EU states,….etc.).
15. Study the modern techniques for wastewater treatment (Soil Aquifer Treatment **(SAT)**, Floating wetland,**UN HABITAT** Vacutug, geo- synthetic materials for sludge and faecal sludge dewatering….. etc..).
16. Translating and publishing the modern researches, studies and innovations related to the water and wastewater field.