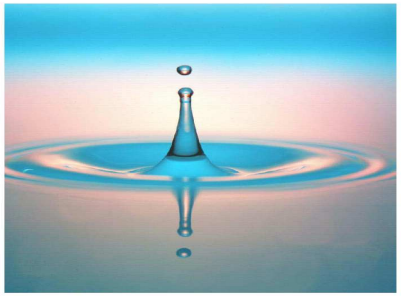


Wastewater, challenges and Opportunities, An Egyptian Perspective

INNOVA – MED
Innovative Processes and Practices for Wastewater
Treatment and Re –Use

Agadir, Morocco, April 2008

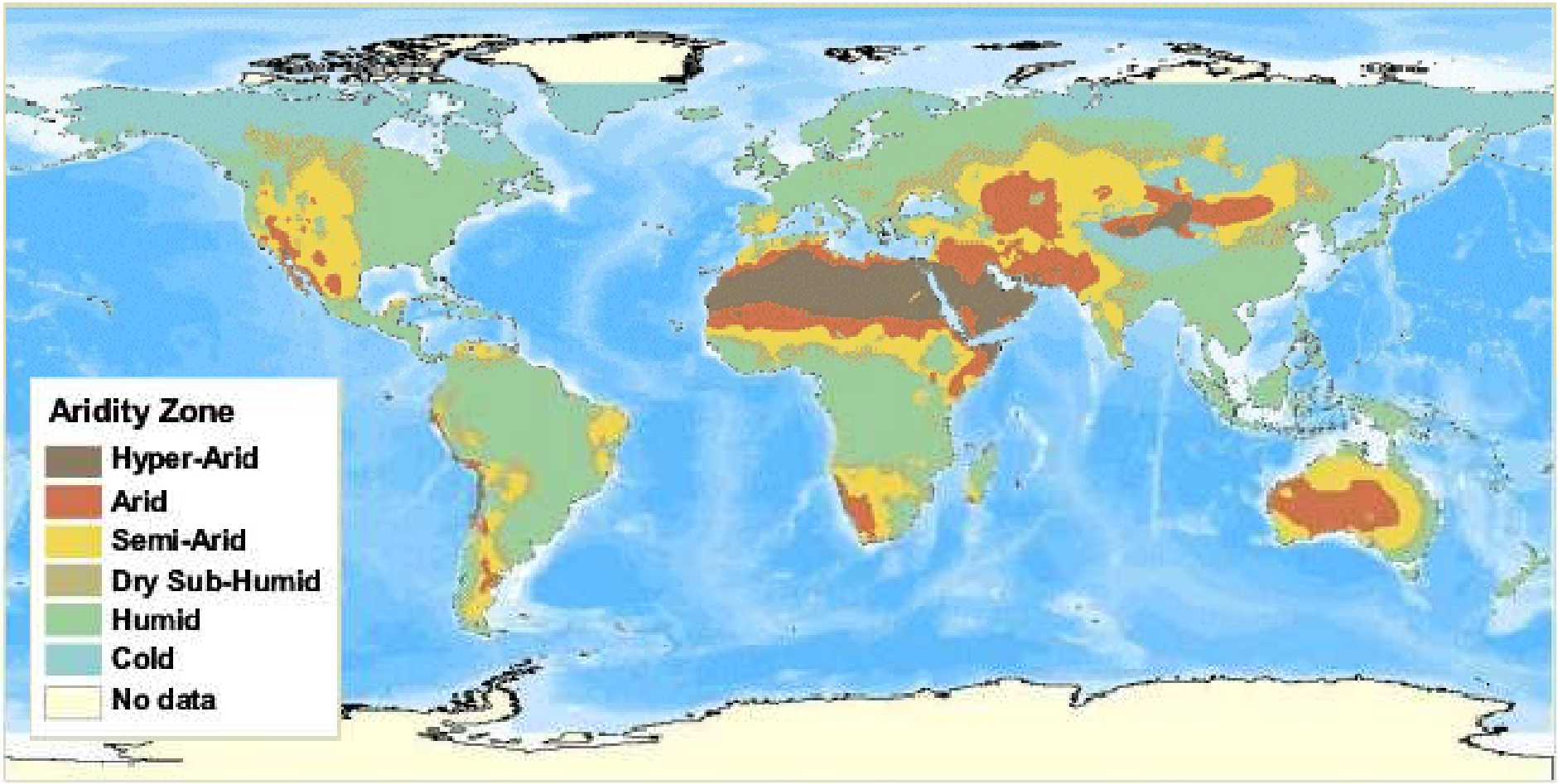
Mohamed Tawfic Ahmed
Suez Canal University, Ismailia, Egypt

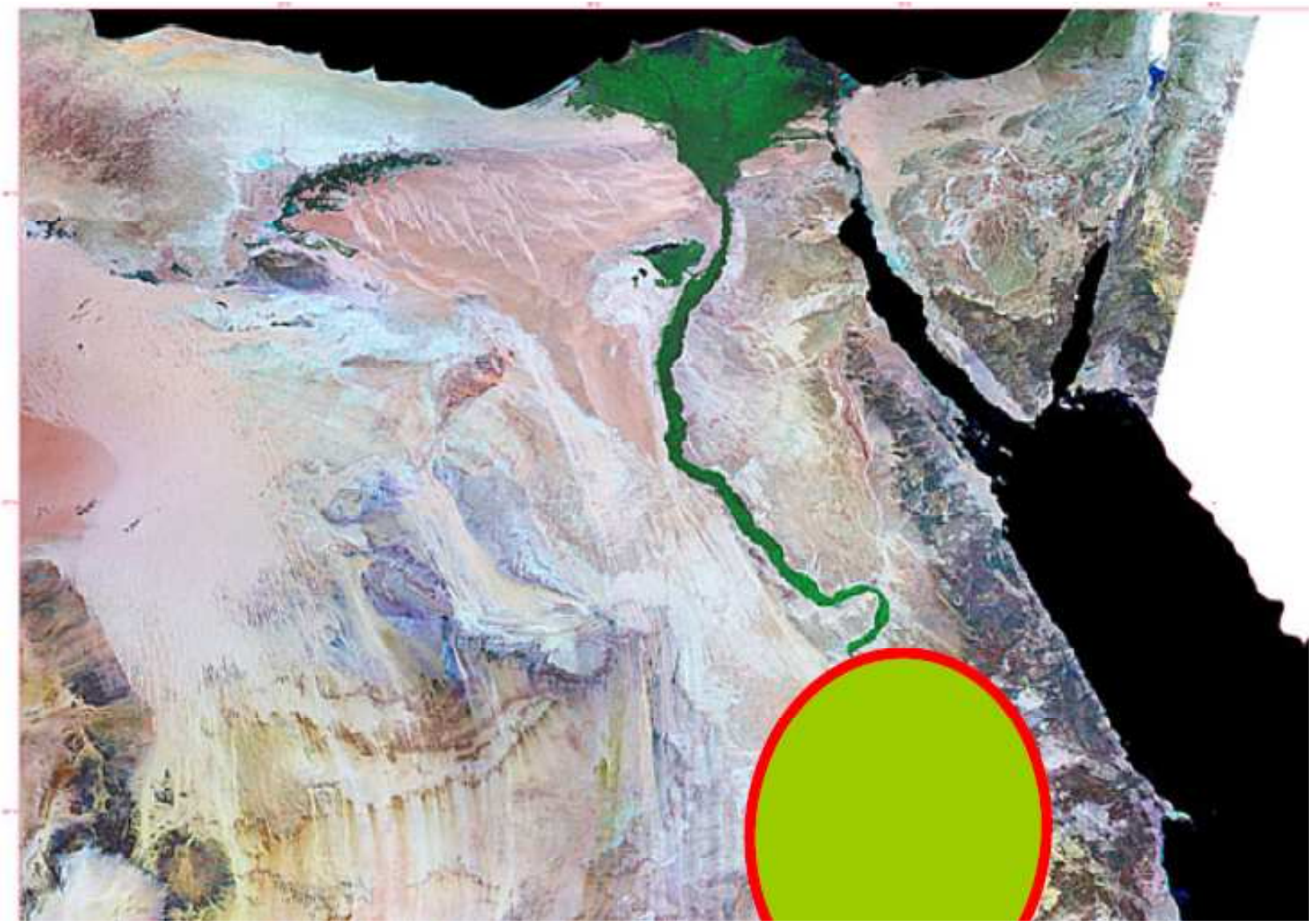
Presentation Highlights

- Egypt, water issues
- Wastewater in Egypt, Generic view, Urban and Rural
- Wastewater in Small Communities,
- Treated Wastewater Use
- District – Based Water Quality Environmental Action Plan


174
5 17 120
Canada

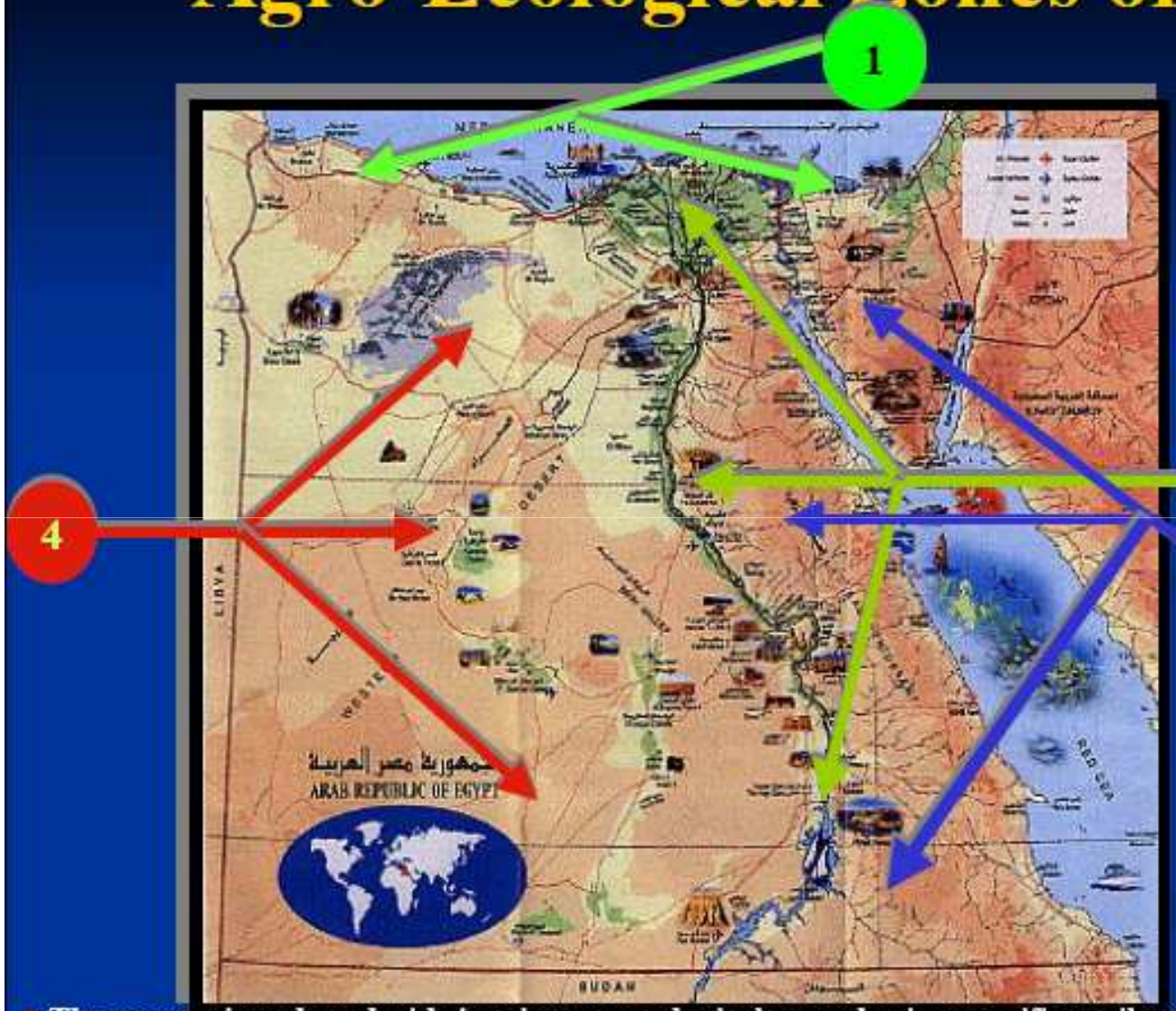
Egypt is Not An Arid Country





Egypt is a Hyper arid Country. It Occupies 1 million square km, 86% lies Entirely in hyper arid and 14% in arid climatic conditions

Agro-Ecological Zones of Egypt



NAP has classified the country into :

- **North costal area**
- **Nile valley**
- **Eastern desert**
- **Western desert**

- **The country is endowed with 4 main agro-ecological zones having specific attributes of resources base, climatic features, terrain and geographic characteristics, land use patterns and socio-economic implications. Since significant variations in the environmental characteristics are apparent in each agro-ecological zone, the active factors and processes of desertification, and their impacts are necessarily variable.**

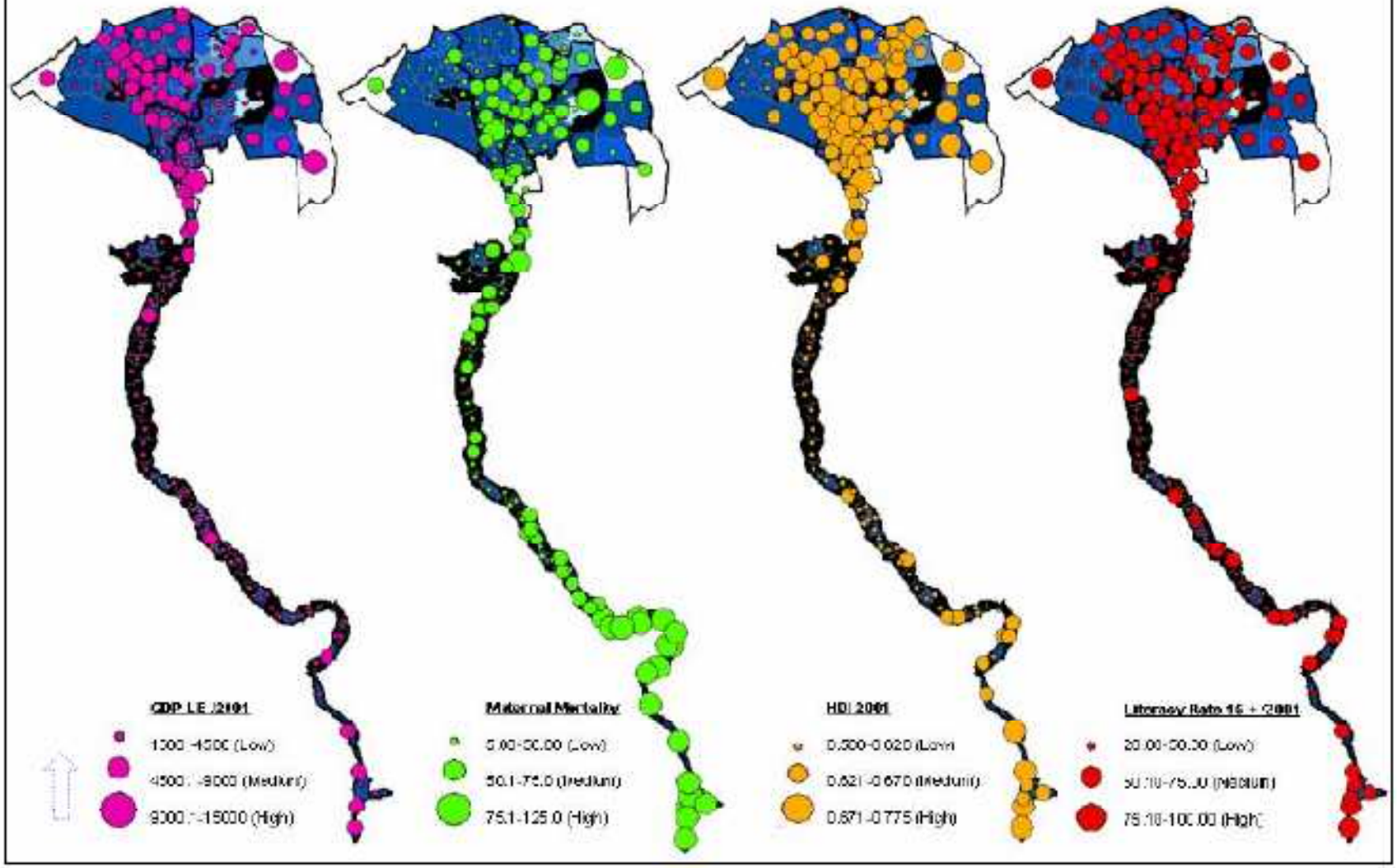
Egypt

key figures

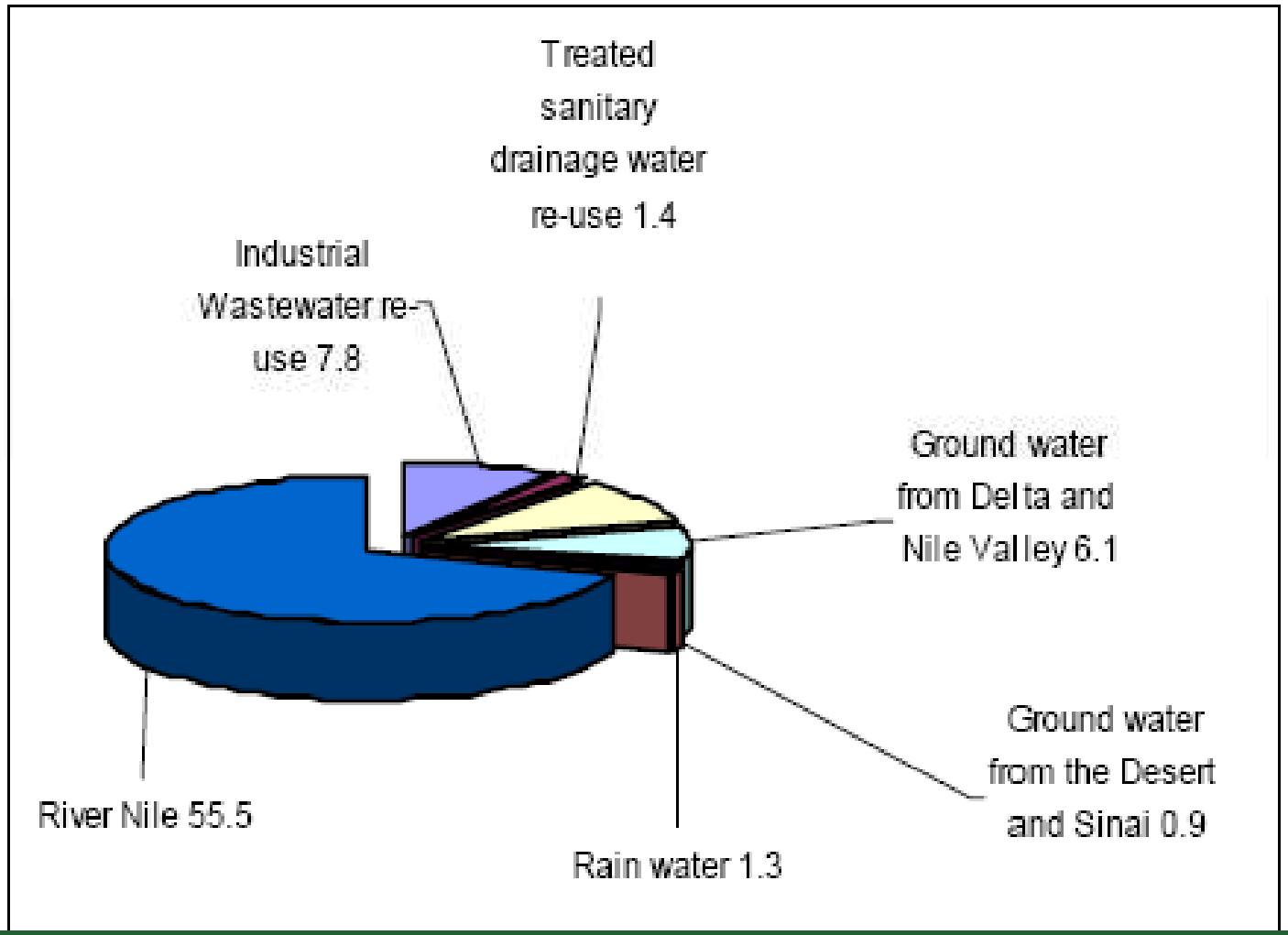
- 1 Mio. km² Land area
- 79 Mio. Population (2007)
- 1.9% Population growth
- 97% of Egyptians live on 4% of total land
- 1600 inhabitants per km² in Nile Delta

Figure 11: overlaying the base map with separate layers of development indices

N.E: Each Index is categorized into three categories (low, medium & high) and each category differ in figures according to its value



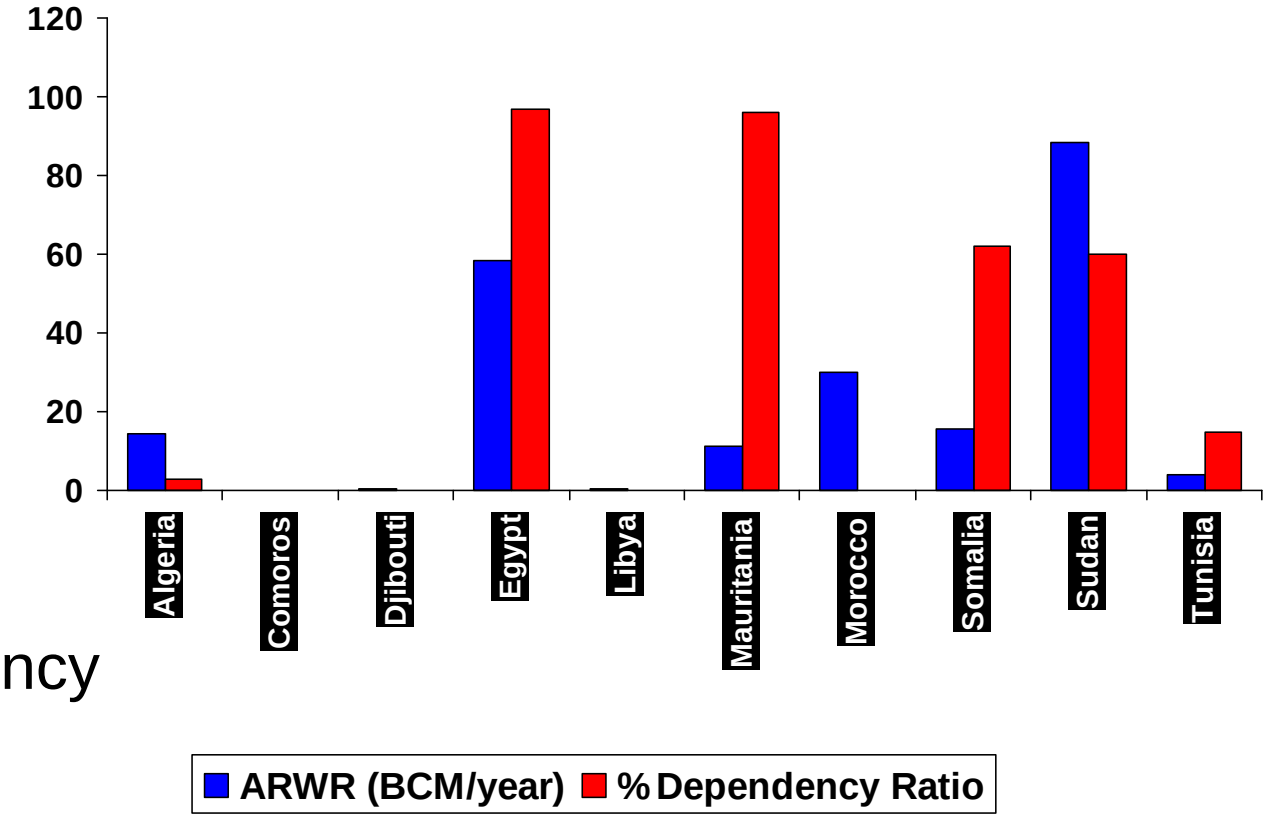
Billion cm/year		Source
2017	**2000**	
57.50	55.50	**River Nile**
1.50	1.00	**Rain**
8.40	5.06	**Agricultural Drainage**
7.50	4.80	**Groundwater, Nile Valley and Delta**
3.50	0.57	**Groundwater, Sinai and W Desert**
2.50	0.70	**Treated Municipal Wastewater**
7.00	0.00	**Irrigation improvement programme**
87.90	**67.63**	**Total**



Direct and Indirect Use of Water

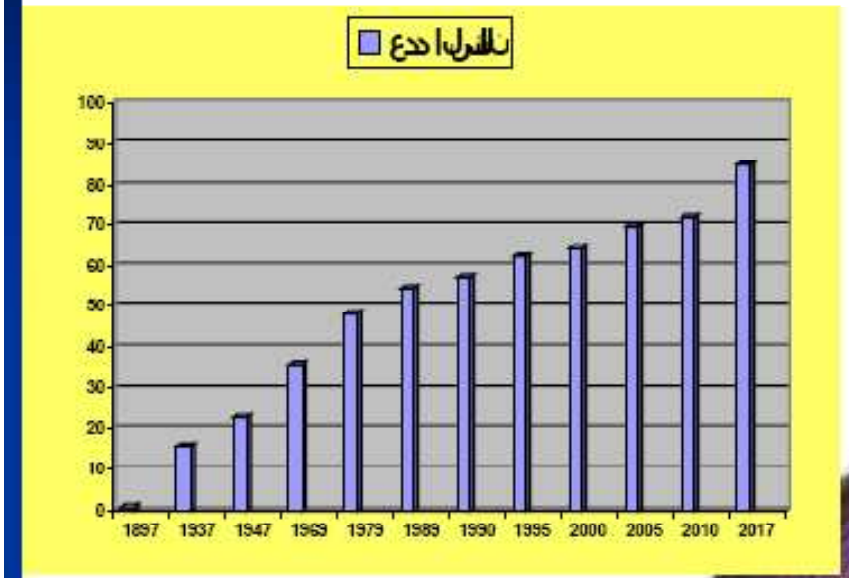
Source: Ministry of Water Resources and Irrigation (MWRI)

Actual Renewable Water Resources & Dependency Ratio On Neighbors



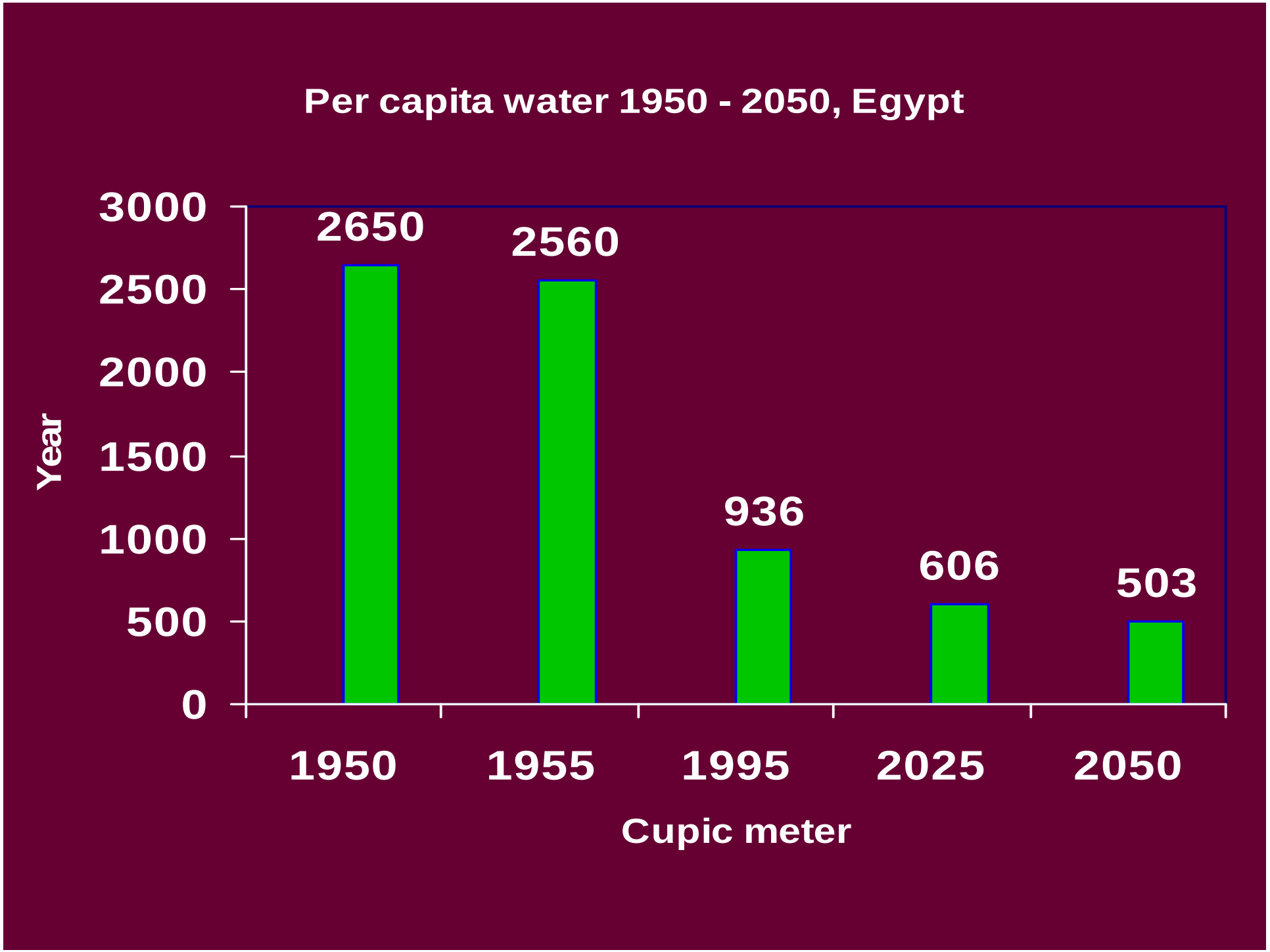
Average Dependency Ratio of 60%

Population Growth Rate

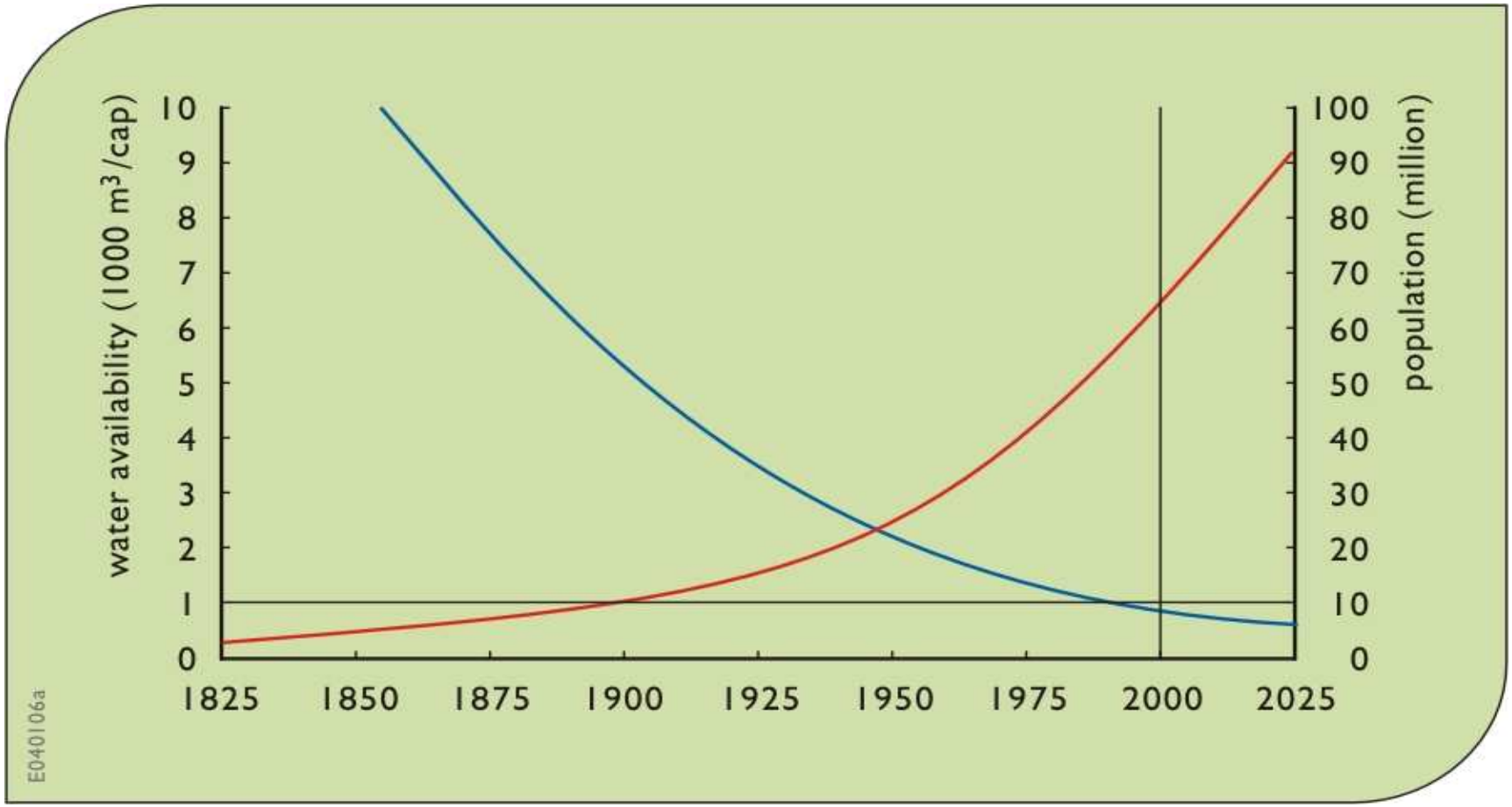


Criticality Ratio, 1995 and 2025, BAU

	Criticality Ratio (ratio of water withdrawal to total renewable water)	
	1995	2025
Egypt	0.89	**1.08**


Per capita water 1950 - 2050, Egypt
3000
2500
2000
1500
1000
500
0
Year
2650
2560
936
606
503
1950
1955
1995
2025
2050
Cupic meter

Egypt Water Per Capita
More than one sign



National water availability (m3/capita/year)

- China – 2,140
- France – 3,370
- Germany – 1,870
- India – 1,750
- Kenya – 930
- Egypt – 790
- South Africa – 1,110
- USA – 10,270

Sector Use of Water in Behira
(total volume 3508 mcm/year,2002)

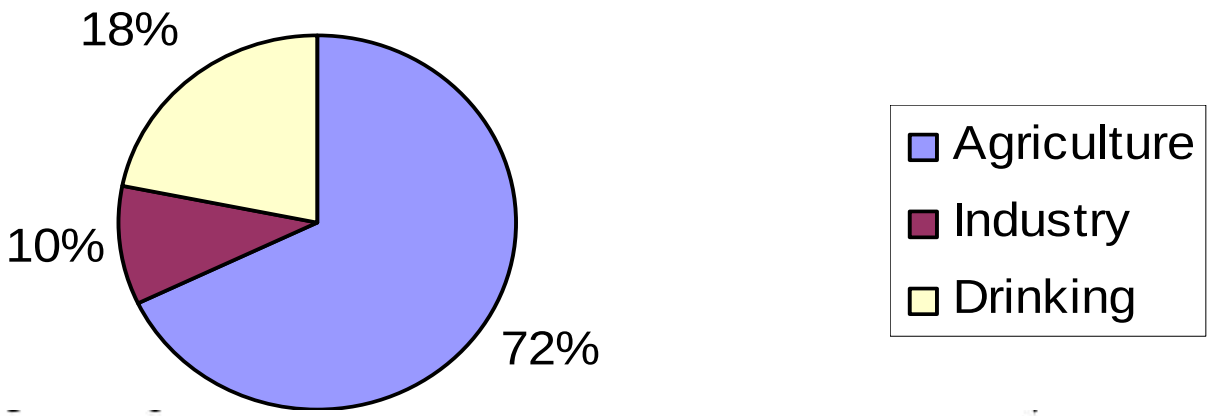
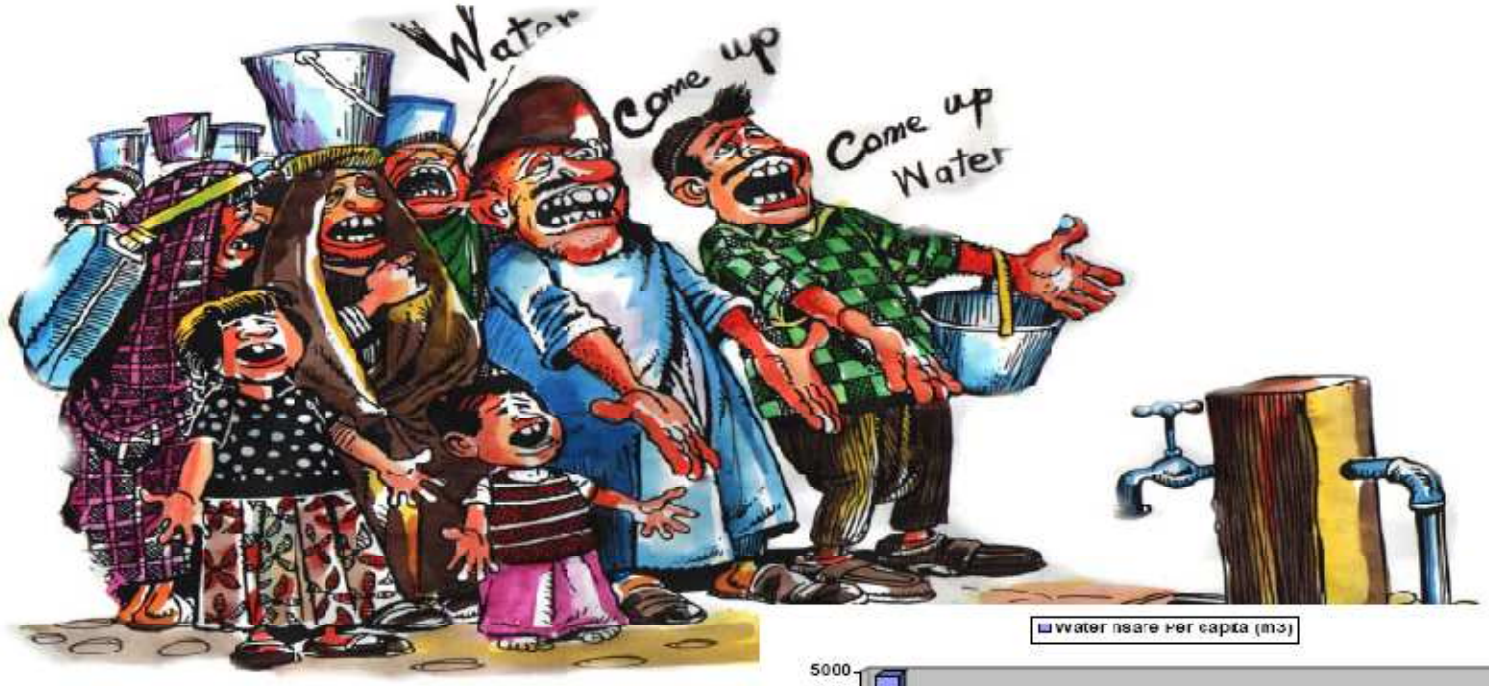
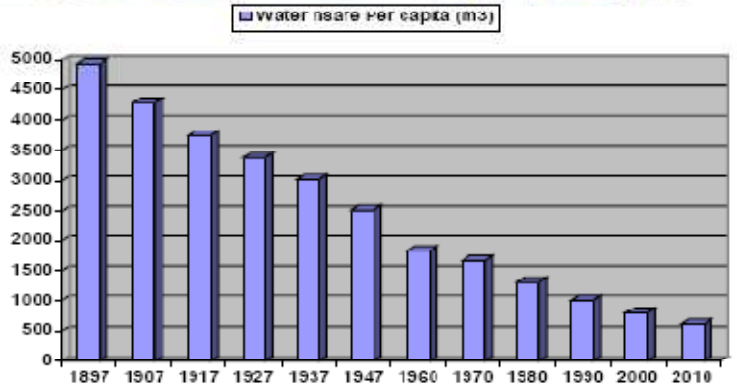



Figure 7


Figure 8

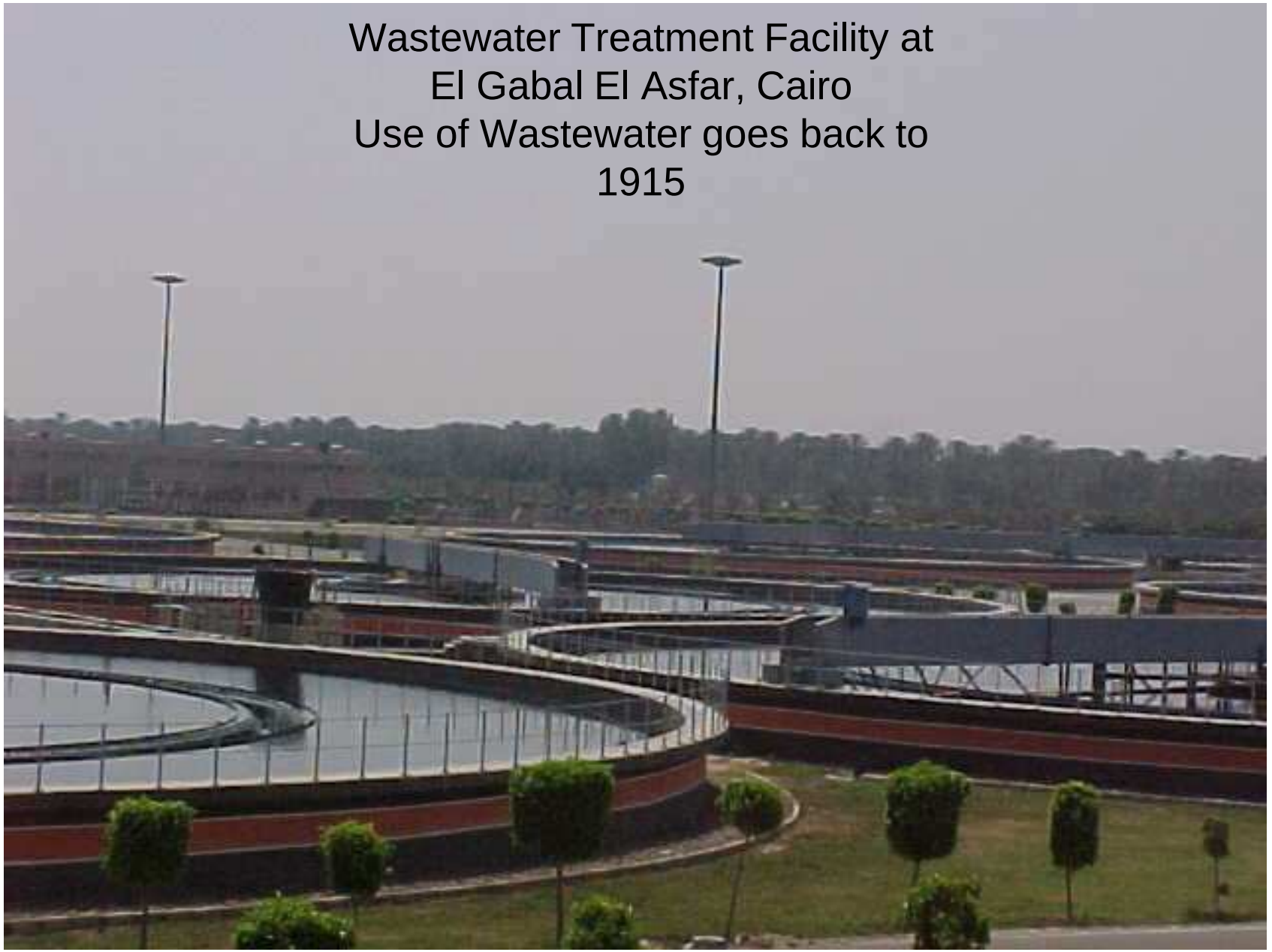
Water Shortage





Waste water Reuse

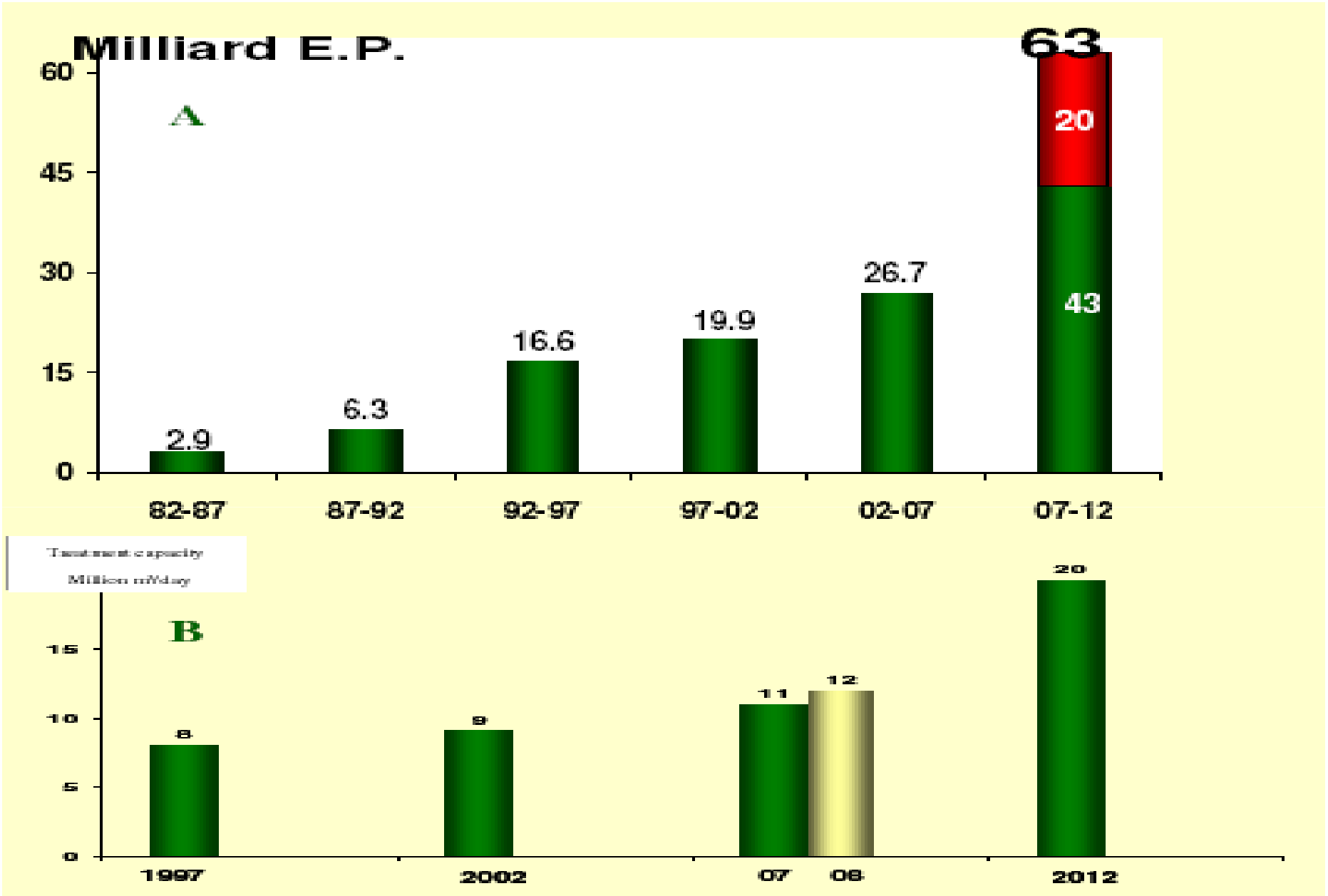
- In Egypt since 1915 the sewage water was utilized in cultivation orchards in sandy soil areas (El gabal el Asfar, Abu Rawash and different small areas such as Tibbin and Assiut).
- The present water management system strongly depends on the reuse of drainage water.
- Drainage water of upper Egypt is discharged into the Nile (about 2,6 billion m3 / year). Drainage water in the Delta is recycled for irrigation by mixing part of the flow of the main drainage system with water in the main irrigation canals.


Wastewater Treatment Facility at
El Gabal El Asfar, Cairo
Use of Wastewater goes back to
1915

The Gabal El Asfar WWTP. The picture is taken from one end of the area and the two purple biogas towers in the middle of the picture is about 2 kilometres away! The plant is getting even bigger by further construction work and 2007 it will serve 12 million people.

Wastewater Treatment Facilities in Egypt some Figures

- In Egypt, 217 urban city, 24% of them are covered by WWTF
- About 5000 village, 4% of them are covered by WWTF
- Investment in providing clean water have superseded investment in wastewater treatment facilities



A: The developments of drinking water production
B: The developments of treated wastewater

Municipal Wastewater Treatment

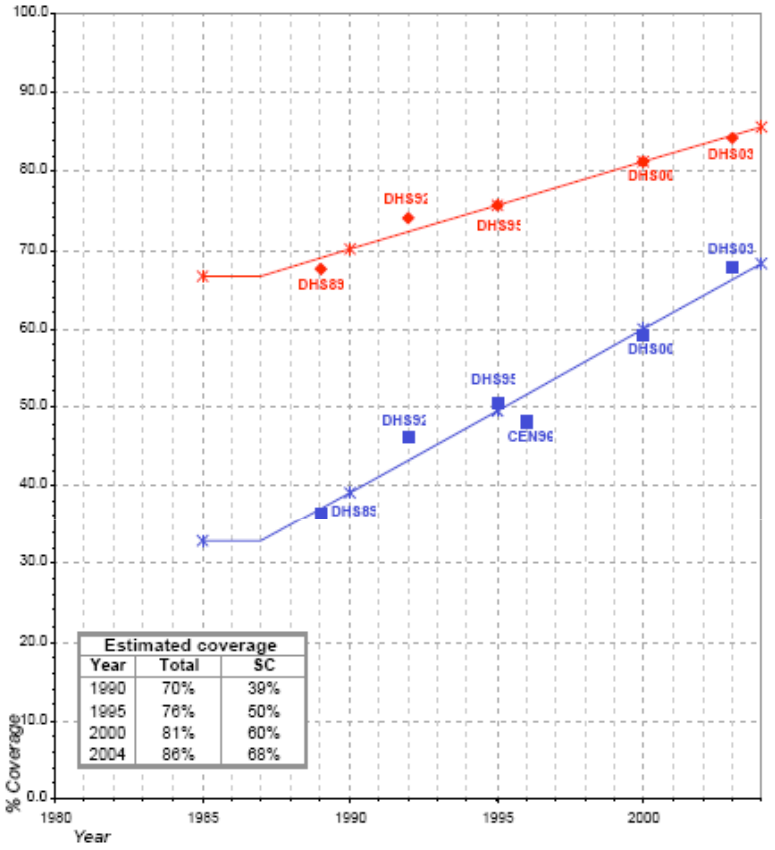
- **Wastewater generated by all governorates = 3.5 BCM/year**
- **50% of the urban population has access to sewerage services**
- **5% of rural areas has access to sewerage services.**
- **75% of rural population uses septic tanks, cesspits and latrines**
- **More than 15% of rural areas have no access to sanitation at all**
- **Current treatment capacity = 1.6 BCM/year.**
- **An additional treatment capacity of 1.7 BCM targeted by 2017**

Table 2. NOPWASD Investments in Wastewater Treatment

Year	Actual Investments (million LE)
1992-1993	392
1993-1994	684
1994-1995	960
1995-1996	1,300
1996-1997	2,428
1997-1998	1,559
1998-1999	1,616
1999-2000	1,524
Total	**10,464**
Average Annual	**1,308**

Source: National organization for wastewater and sanitary drainage

Egypt - urban -
Access to improved sanitation coverage



Estimated coverage		
Year	Total	SC
1990	70%	39%
1995	76%	50%
2000	81%	60%
2004	86%	68%

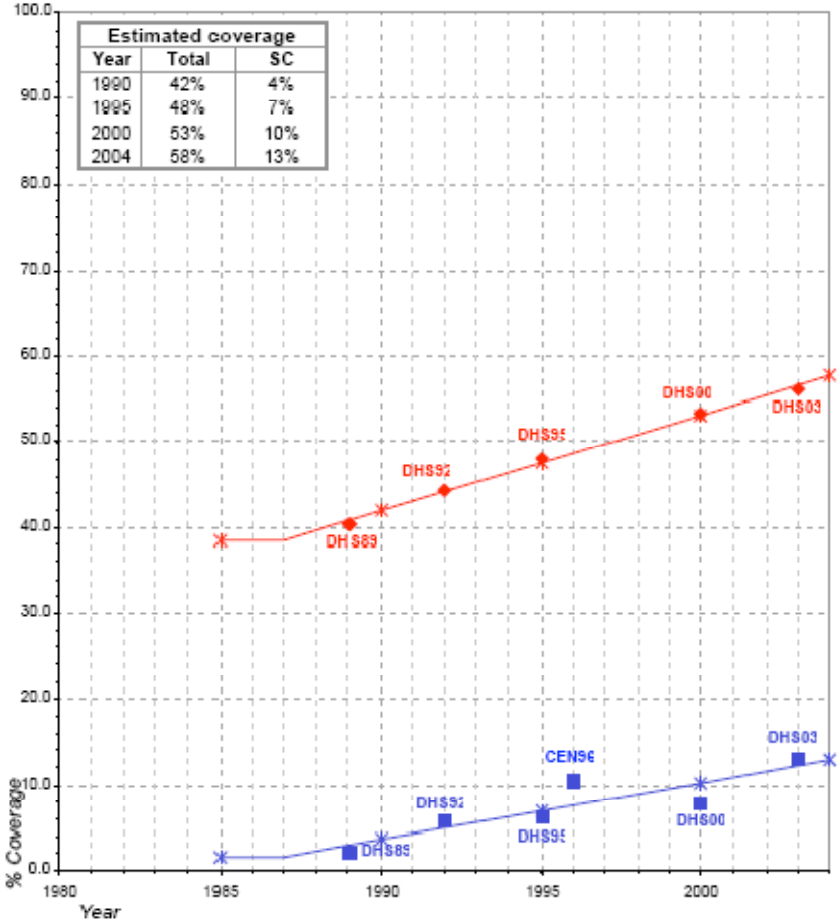
Total improved access
- Used for estimates
- Estimates

Sewerage connections (SC)
- Used for estimates
- Estimates

Total access :

Sewerage connections :

Egypt - rural -
Access to improved sanitation coverage



Estimated coverage		
Year	Total	SC
1990	42%	4%
1995	48%	7%
2000	53%	10%
2004	58%	13%

Total improved access
- Used for estimates
- Estimates

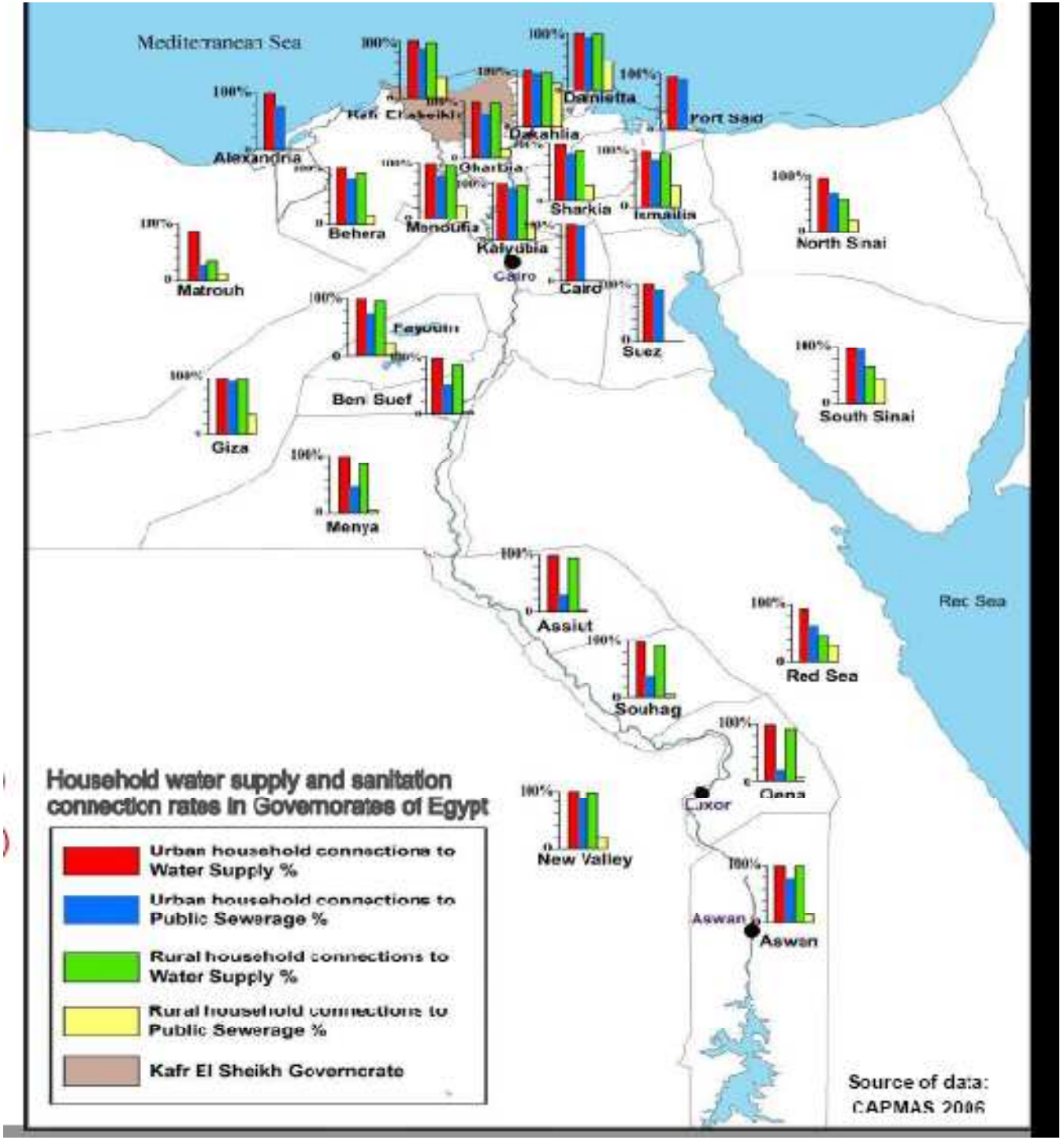
Sewerage connections (SC)
- Used for estimates
- Estimates

Total access :

Sewerage connections :

Projections of Sanitation Coverage
In Egypt

Year	Population	People served	People not served
1997	60 Million	18 Million 30%	42 Million 70%
2017	83 Million	39 Million 47%	44 Million 53%


Mediterranean Sea
Alexandria
Kafr El Sheikh
Damietta
Port Said
Dakahlia
Gharbia
Sharkia
Ismailia
Behera
Menoufia
Kalyubia
Cairo
Caird
Matrouh
Fayoum
Suez
North Sinai
South Sinai
Ben Suef
Giza
Menya
Assiut
Souhag
Red Sea
Qena
Luxor
New Valley
Aswan
Aswen
Red Sea
Household water supply and sanitation connection rates in Governorates of Egypt
Urban household connections to Water Supply %
Urban household connections to Public Sewerage %
Rural household connections to Water Supply %
Rural household connections to Public Sewerage %
Kafr El Sheikh Governorate
Source of data: CAPMAS 2006

Water Reuse in MENA I: Sewerage Generated and Reused, Wastewater Treatment Plants and other Quantitative Parameters

		Unit	Algeria	Egypt	Jordan	Morocco [1]	Syria	Tunisia	Yemen	West Bank Gaza
Total Water Resources		MCM/year	11,000	67,800	900	21,000	14,000	4,700	3,600	276
Total Sewage Collected [2]		MCM/year	n.a.	3,300	72	292	260	240	33 *	~15 *
Total Sewage Treated [3]		MCM/year	Limited	1,640	72	~ 6	260 *	156	33 *	~13 *
Total Sewage Discharged to the Sea		MCM/year	Substantial	1,000	0	Most	Limited	100	~8 *	~7 [4]
Total Sewage Reused	Planned or Semi-Planned	MCM/year	Very small share	Yes	Large share	Very small share	Yes	> 28 [5]	Small share	Negligible
	Unplanned	MCM/year	Yes	Yes	Very small share	~ 70	Yes	Officially none	Large share	Limited
Share of Treated Sewage Reused		%	n.a.	Large share	All, minus evaporation losses	n.a.	All, minus evaporation losses	18 %	~75 %	< 25 %
Municipal Wastewater Treatment Plants		Number (Extensive / Intensive)	44 (including 16 to be scrapped)	121	18 (9 ext + 9 int)	19 (7 ext + 12 int) + 27 out of order	4 (4 int.)	61 (14 ext + 47 int)	9 (6 ext + 3 int)	8 (7 ext +1 int)
Total Area Irrigated with Treated Wastewater or Blended Water		Hectare	n.a.	42,000	10,600	7,000	36,370	7,100	n.a.	n.a.

* World Bank Estimate. For Syria, Yemen and West Bank Gaza: Calculated as the sum of the daily sewage load of individual treatment plants, converted to an annual basis.

n.a. = not available

Projected wastewater flow in Cairo and the Delta (Abdel-Gawad 2001)

Year	Population	Sewage flow
	Delta + Cairo (million)	Total (c/d)
Current	44.619	6.016
Urban	22.913	4.350
Rural	21.706	1.666
Year 2002	49.407	6.662
Urban	25.372	4.817
Rural	24.035	1.845
Year 2007	54.709	7.376
Urban	28.094	5.334
Rural	26.615	2.043
Year 2012	60.580	8.168
Urban	31.109	5.906
Rural	29.471	2.262
Year 2017	67.081	9.045
Urban	34.448	6.540
Rural	32.633	2.505

Treated Urban Sewage in Egypt

Locations	**(mcm/day)**
Greater Cairo	4,130
Alexandria	317
Upper Egypt	99
Lower Egypt	955
Middle Egypt	170
Suez Canal	410
Sinai	81
New Valley & Matroh	47
Total	**6,209** (2.3 bcm/year)

Source: NOPWASD, "Appendix 1, Wastewater Treatment in Egypt," in "National Policy for Urban Wastewater Discharge and Reuse," MWRI/EPIQ water policy benchmark C2 report, July 2000.

Urban Wastewater, Some Figures

It is reported that 74 % of the urban population are connected to public sewers but in rural areas only 5 % of the population are connected to sewers.

The treatment technologies used in the different plants are:

- **Activated Sludge by surface aeration or compressed air.**
- **Oxidation Ponds**
- **Trickling / Coarse filters are still used in some old treatment plants.**

Helmet Eggs removal from wastewater depends on the efficiency and capacity of the treatment plants. Generally speaking, present technologies used in treatment is not sufficient for efficient removal of helmet eggs Which considered as one of the most important water borne diseases in Egypt .

Sludge

The existing wastewater treatment plants in Egypt produce an estimated quantity of dry sludge of *950 000* tons per year and are expected to increase to 2 million tons by 2020.

Various treatment techniques are employed for sludge. Presently in Cairo, at a wastewater treatment plant in the east bank area, produced sludge is treated in temporary drying beds. Later it is pumped to new treatment utilities in Al Gabal Al Asfar where thickeners, digesters and mechanical dewatering are employed.

Sludge analysis has shown that its moisture content is in the range of 94 %- 96% and heavy metals content is below allowable limits. It contains relatively high concentrations of iron and small quantities of copper and manganese. More importantly, perhaps, is the microbiological quality of the sludge and its parasite infestation .

محطة الجبل الأصفر

توسعات المرحلة النهائية لمحطة معالجة مياه الصرف الصحي بالجبل الأصفر

لزيادة طاقة المعالجة الكلية المستهدفة بالمحطة لتصل إلى 3 مليون م3/يوم يتم تنفيذها على مراحل ، هذا وقد تم افتتاح المرحلة الأولى من المحطة بطاقة معالجة متوسطة 1.2 مليون م3/يوم في أكتوبر عام 1998 ، كما تم افتتاح المرحلة الثانية بطاقة معالجة متوسطة 500 ألف م3/يوم في أكتوبر 2004 .

أبو رواش

Abu Rawash

Small Rural communities

Sewerage service rates in smaller (rural) towns average at less than 10%.

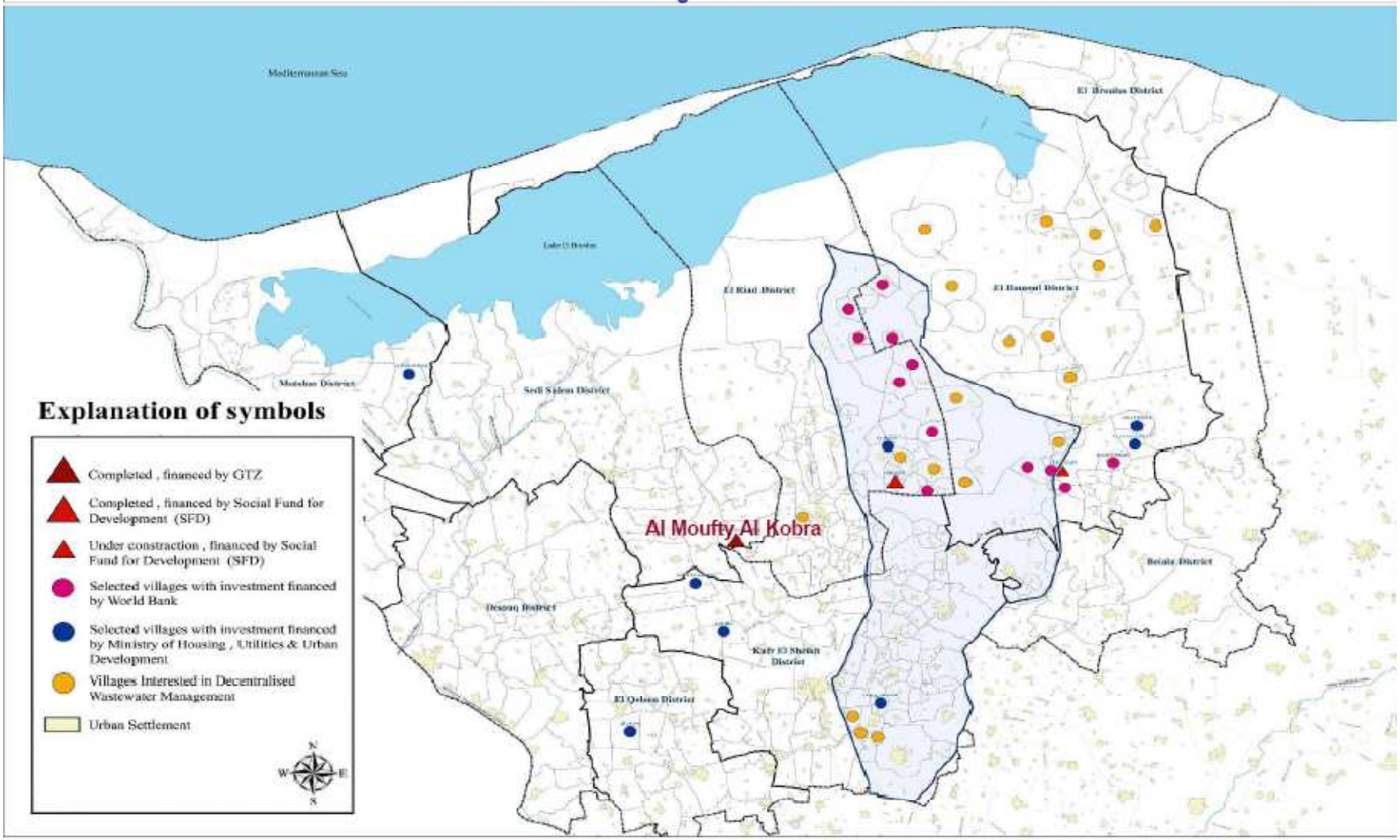
The population not connected to a sewer system relies on individual means for the disposal of excreta and wastewater (latrines, septic tanks, …etc.).

The Government of Egypt is allocating a budget of 20 billion LE for providing villages with wastewater facilities within the next five years

Decentralised Wastewater Management Project
Kafr El Sheikh Governorate

Villages planned for implementation of Decentralised Wastewater Management and sources of finance

gtz



Village Selection Matrix for WWTP
A Decision Making Matrix
(مصفوفة إختيار نظم المعالجة)

Village	Municipality	Population	Water Supply	Sewerage System	Water Boards	NGO	Partners	Land availability	Drain	Technology
المنشاة										
المنايف										
منشاة ناصر										

How to build a consensus and take a community - based decision
Stakeholders views,
opinions, capabilities,
village conditions

Limiting Factors for WWTP at Small Community Level

- Land
- Cost
- Operation and Maintenance
- Environment
- Compliance with Egyptian standards

Septic Tank Efficacy
BOD 50%
COD 30%
TSS 70%

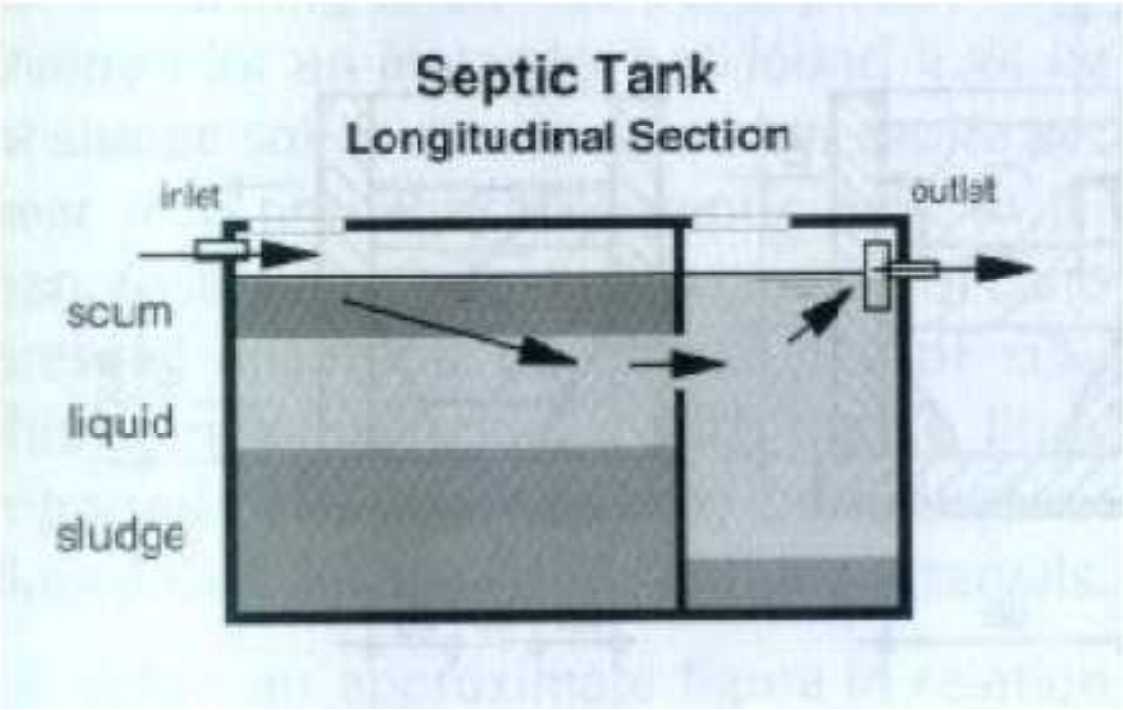
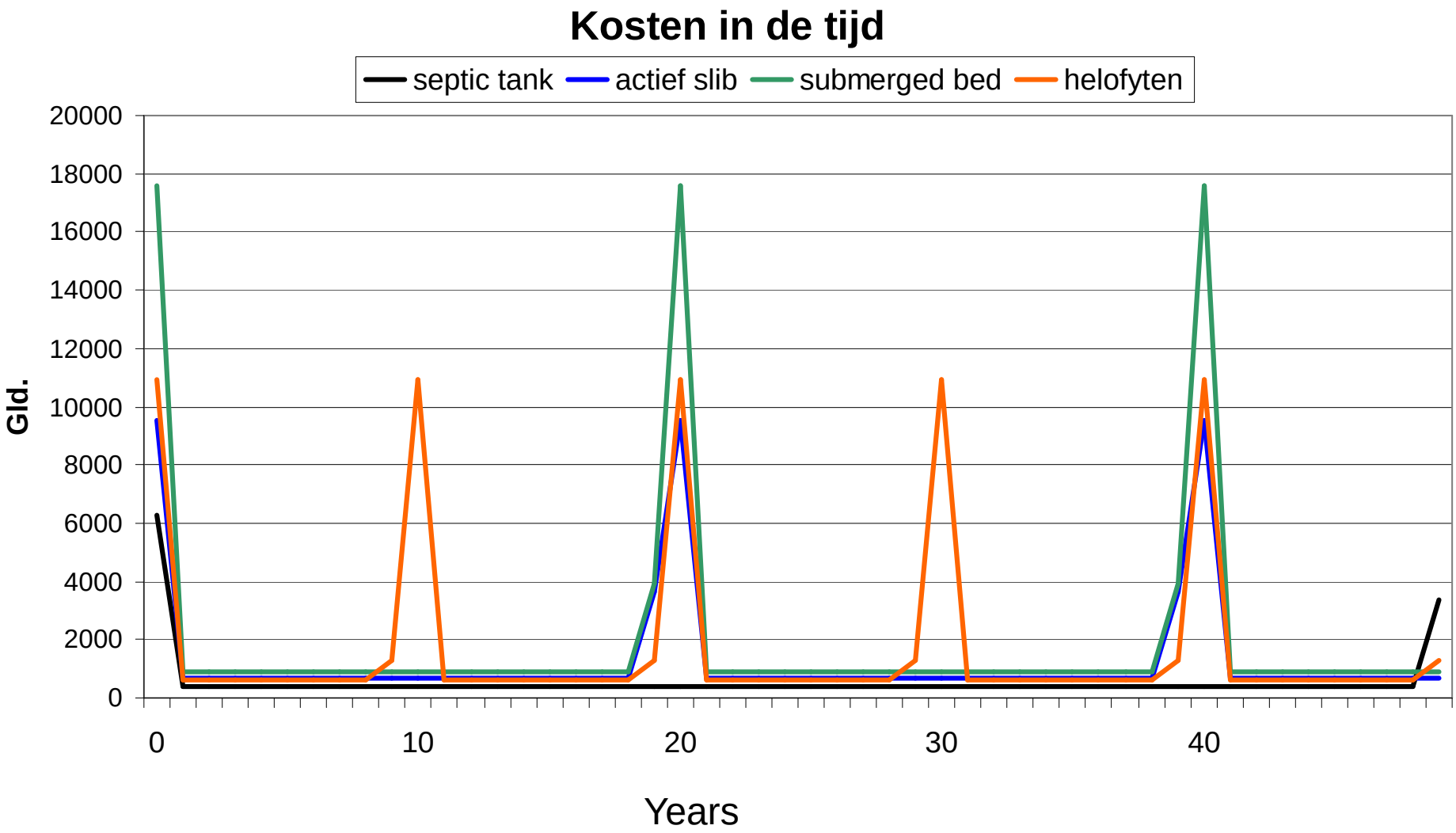


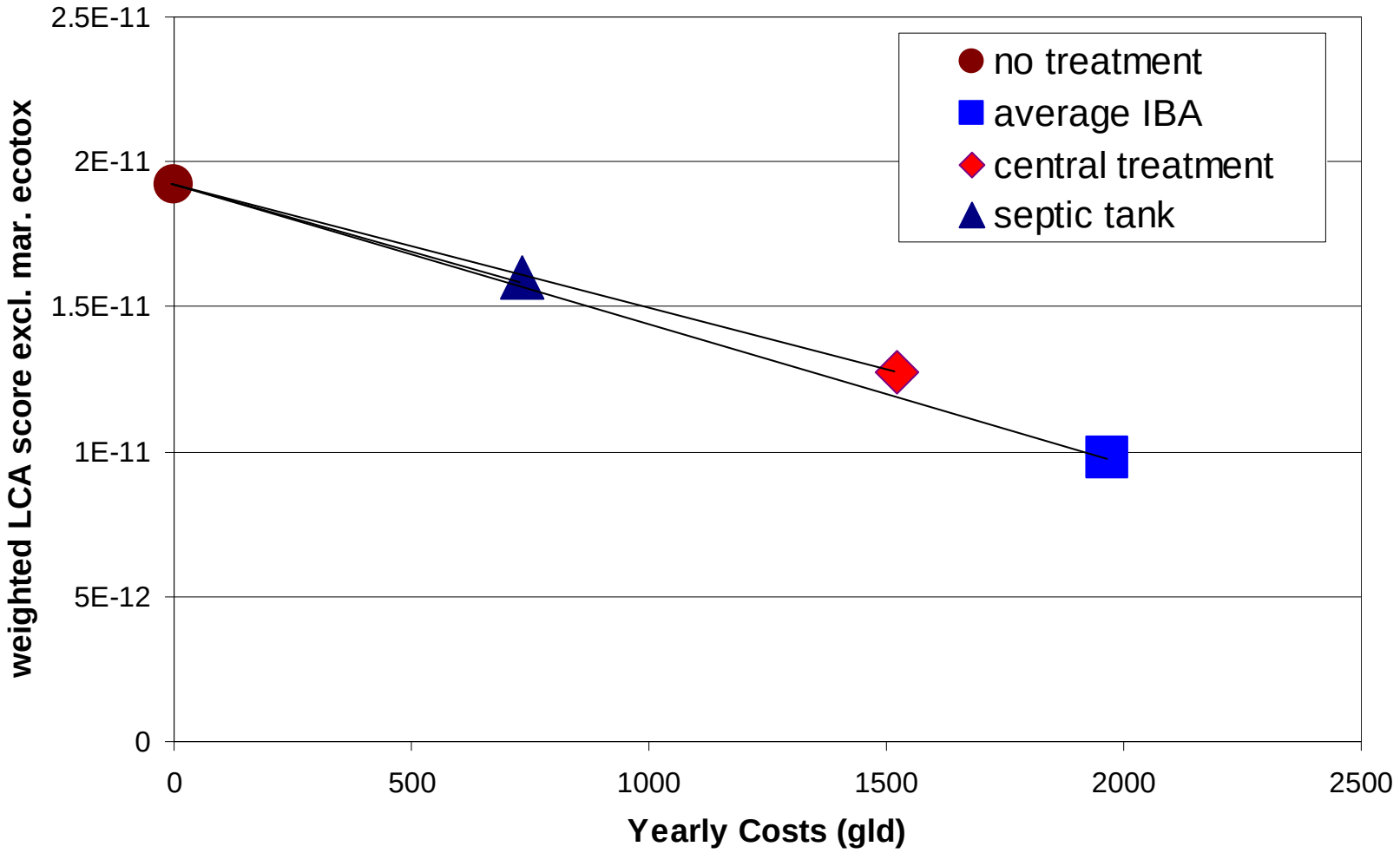
Fig. 6: Principle design features of septic tank (Source: [9])

- Easy to operate
- Minimal maintenance
- Low cost
- Groundwater problems
- Not good when water table is high

Cost over time, A Dutch Study



Eco-efficiency waste water treatment options



Anaerobic Sludge Blanket Reactor (UASB)

Anaerobic Treatment Using UASP is newly emerging method in Egypt, usually followed by another treatment . Primary results showed the ability of UASB to remove up to 60 % of helminthes eggs

The First UASB WWTP Sanhour, Fayoum Governorate

The First UASB WWTP Sanhour

The wastewater treatment plant of Sanhour in Egypt has been rehabilitated and extended with a UASB (Upflow Anaerobic Sludge Blanket) plant..

The UASB is removing over 80% of the BOD and 75% of the COD. Suspended solids removal is even better: up to 95%. The produced biogas is collected with the possibility of energy recovery, although at this stage the biogas is (still) flared. The UASB effluent is polished in trickling filters followed by final settling tanks, and resulting in an effluent with a very low BOD of around 30 mg/l.

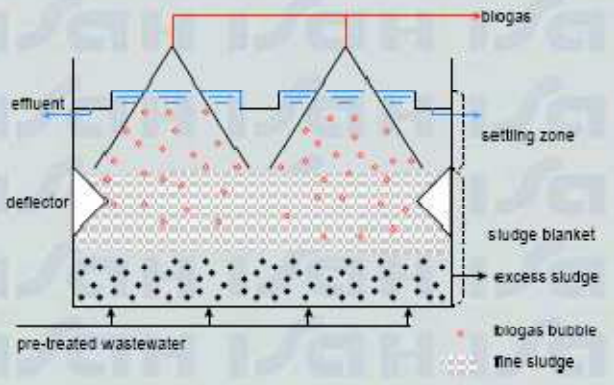
معالجة بعد UASB

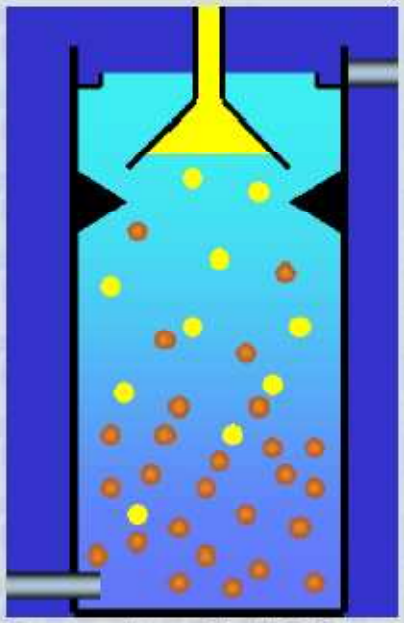
Demonstration of anaerobic technology for MWWT

Upflow Anaerobic Sludge Blanket " UASB-Reactor"

- **Upflow Anaerobic Sludge Blanket "UASB" reactor** still is the most frequency used reactor in full-scale installation and has proven to be effective even in the treatment of low strength municipal wastewater at tropical conditions *(Lettinga et al 1993).*

- **In the UASB reactor's process,** wastewater flows through a sludge bed "Granular or Digested", where different physical and biochemical mechanisms act in order to retain and biodegrade the organic substances in the wastewater.





Source: *Jams Field, 2001*

ISAH HBRC CUFOE

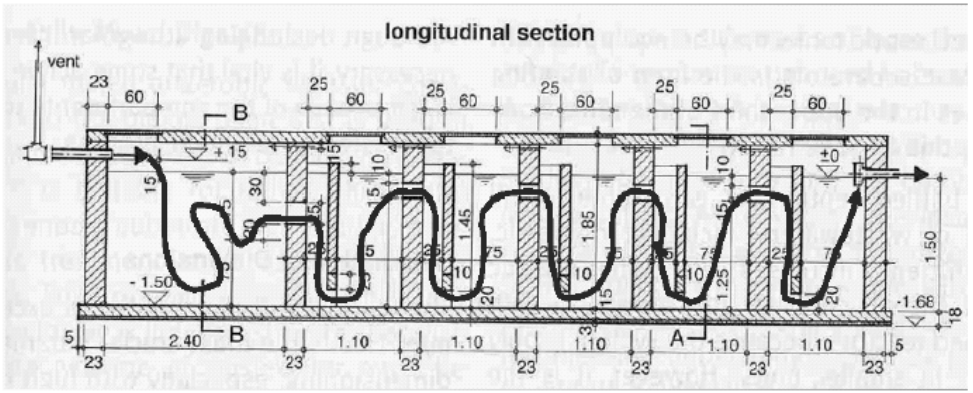
Anaerobic Digester

Raw Sewage Treatment
Anaerobic Digestion
People's Own Initiative
Joint Initiative of Ministry of Water Resources

- Septic tank to collect raw sewage, sedimentation, liquid waste is allowed through a number of chambers
- Each chamber is furnished with gravel of plastics cups (matrix), to increase surface area.
- Chlorination process, using sodium hypochlorite
- No sludge problems

Anaerobic Treatment Process

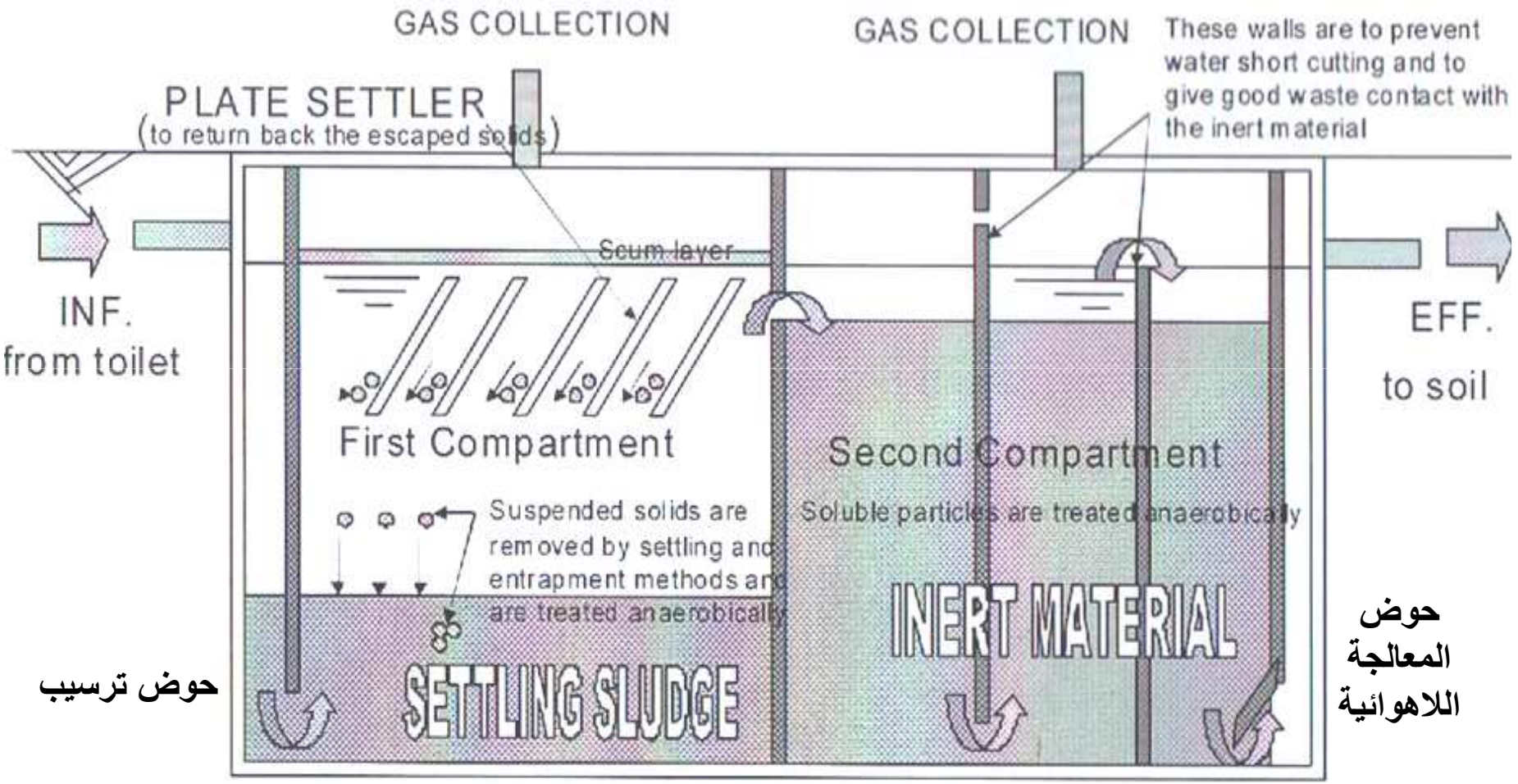
Anaerobic Baffled Reactor



Advantages: Small footprint, no electricity required, relatively low cost and easy to operate and maintain.

The Anaerobic Baffled Reactor system in Abdel Kariem Easa village, Snores, Fayoum governorate

Anaerobic baffled Reactor



Septic Tank **Anaerobic Baffled Reactor**

المعالجة اللاهوائية

Natural Oxidation Ponds
Stabilization Ponds

Three ponds in a raw, with decreasing Depth
Solar exposure in the final pond to eliminate pathogens

Land constraints
only if the village is in the vicinity of desert

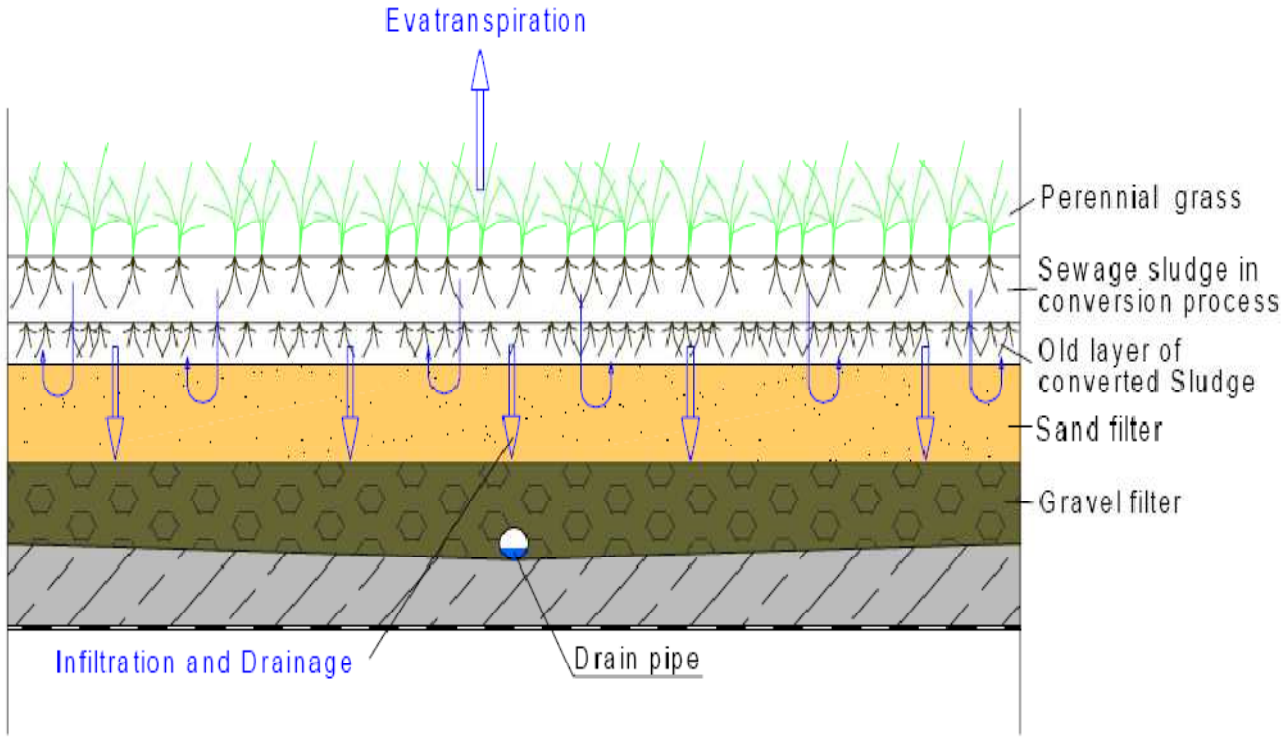
municipalities in Egypt already have or plan their own sewage treatment plants. One aspect often neglected is the amount of sewage sludge produced and to be disposed or reused respectively. There is an annual amount of 12–15 kg of solid matter in the sewage sludge per inhabitant in Egypt, which corresponds to a daily production of 35–40 g.

Sludge Management At Municipalities Level

Figure 2: Large lumps in overfilled drying beds *(source: ipp consult)*

A local survey was conducted at six treatment plants in the Mansoura and Damietta Governorates in order to assess the related problems of sludge treatment and handling. The method of treatment adopted in all of the treatment plants is thickening followed by drying.

Egypt the use of sewage sludge is legally restricted by very complicate regulations that can hardly be observed under the local conditions. Nevertheless its use is common in Egypt and the demand is increasing.

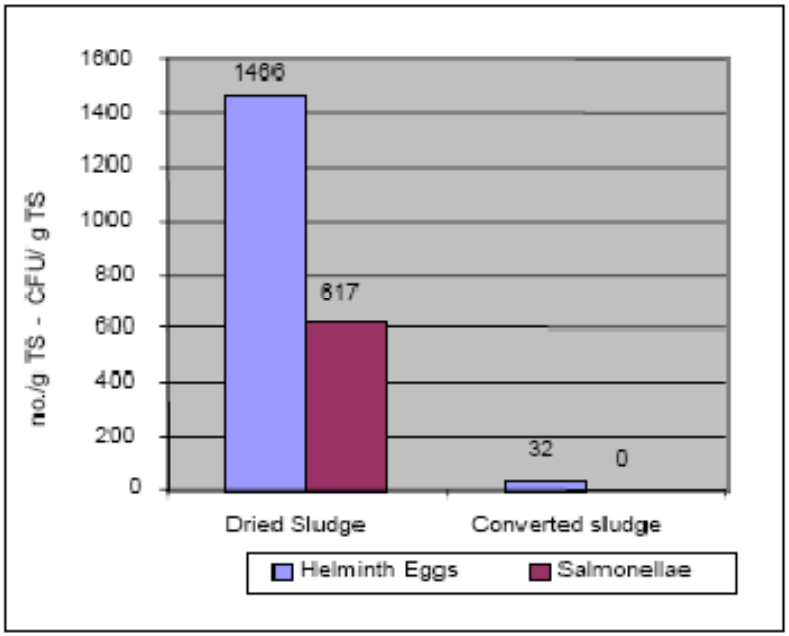


Scheme of a sludge conversion plant *(source: ipp Consult)*

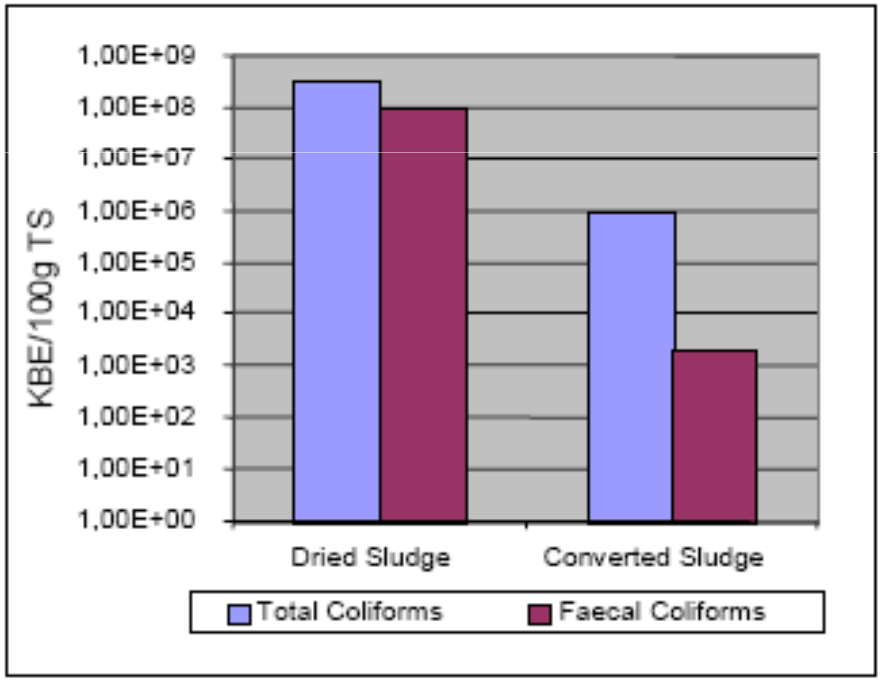
Figure 3: Converted sludge
(source: ipp Consult)

Figure 7: Development of Ladyfinger on sand (from left to right: with 30l dried sludge, 10l dried sludge, 30l converted sludge, 10l converted sludge and without any soil conditioners) *(source: IppConsult)*

Sludge Processing
Effect of Pathogenic Organisms



Graphic 2: Contents of Helminths and Salmonellae *(source: ipp Consult)*



Graphic 3: Contents of total coliforms and faecal coliforms (Navaq)

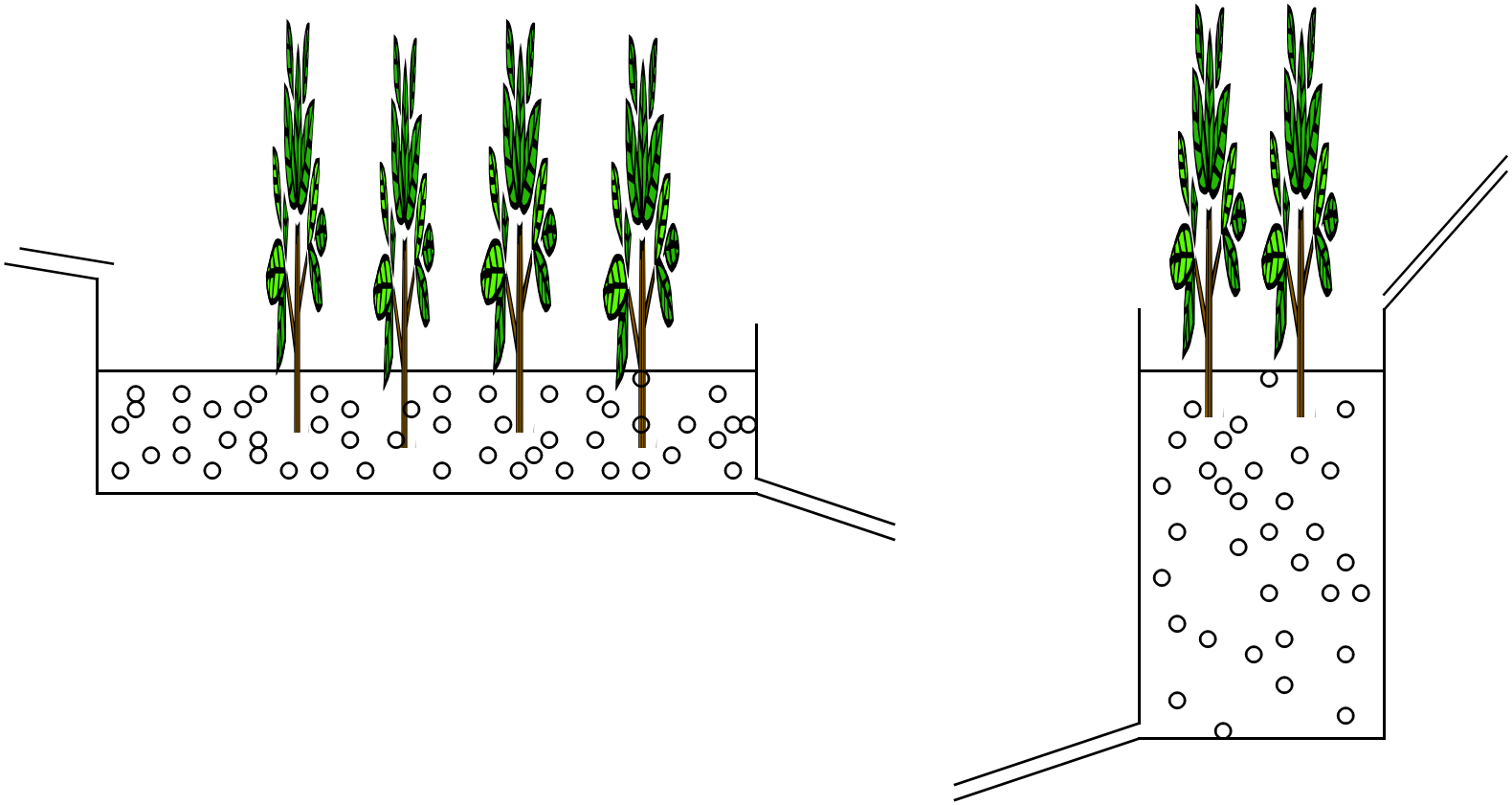
Grey Water

Main Environmental Problems
Nasseria Village, Menia Governorate
Egypt

Problem Description	Priority List
Grey water Animal farm houses Solid waste Home ovens problems Poultry houses	1 2 3 4 5

Villagers indicated that their most urgent problems is grey water. They cannot dispose it in their septic tanks because this would fill the tanks much too soon

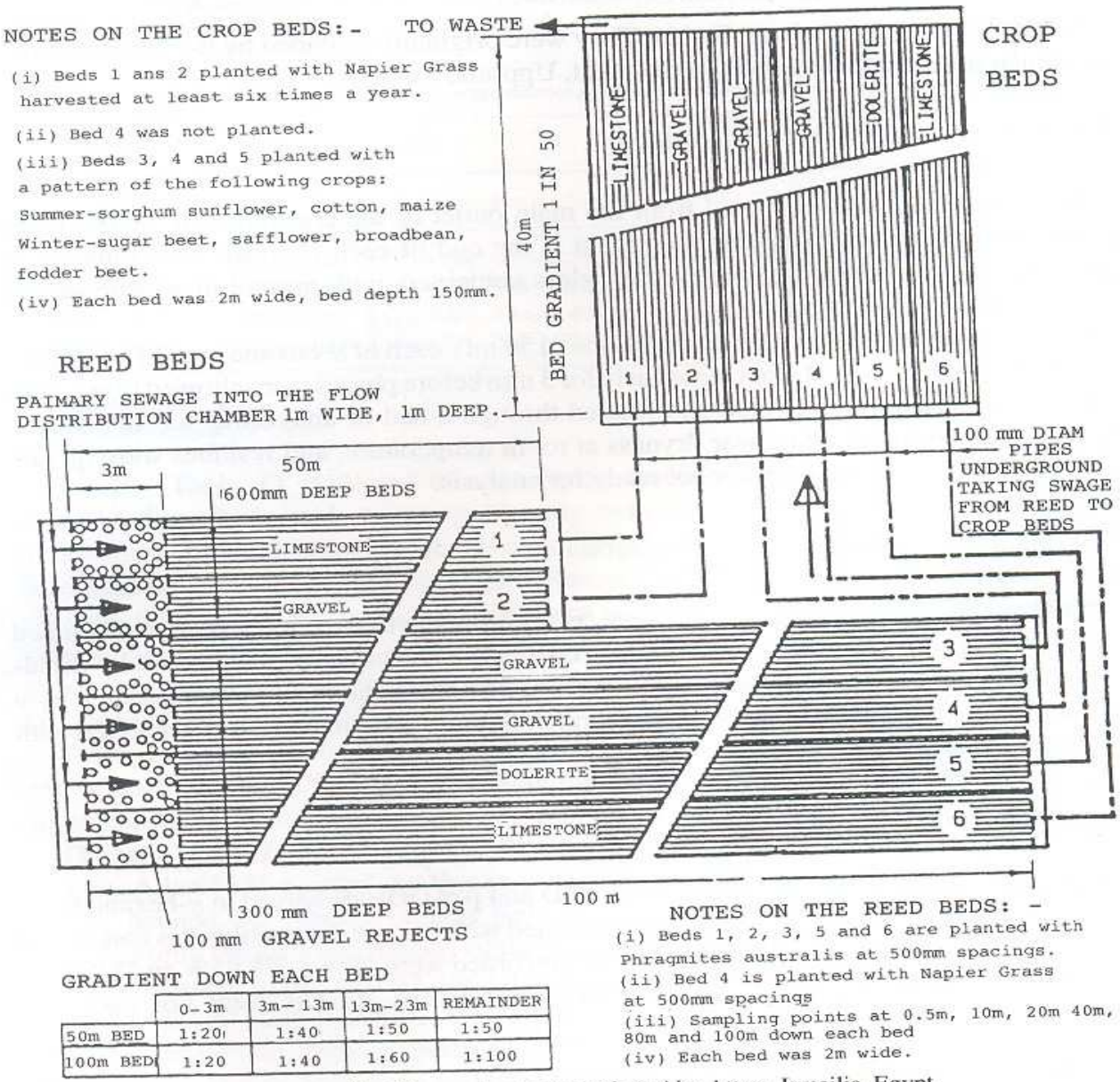
2. Sub-surface Flow



Examples of Subsurface Flow, Ismailia, Egypt

The GBH System
System Highlights

•Gravel Bed Hydroponic (GBH) reed bed systems, consist of channels sealed with geomembrane.
•The channels are filled with gravel, and wastewater is percolated horizontally below the surface of the gravel.
•This subsurface flow reduces the potential for breeding sites of insects, especially mosquitoes and aquatic snails.
• Reeds, predominantly Phragmites australis, are planted in the gravel and grow hydroponically using nutrients in the sewage.
•The reeds maintain the hydraulic pathways and their rhizospheres support intense microbial activity which ensures sewage treatment.



GRADIENT DOWN EACH BED

	0-3m	3m- 13m	13m-23m	REMAINDER
50m BED	1:20	1:40	1:50	1:50
100m BED	1:20	1:40	1:60	1:100

Fig. 1. Details of the reed and crop beds at Abu Attwa, Ismailia, Egypt.

Advantages of GBH

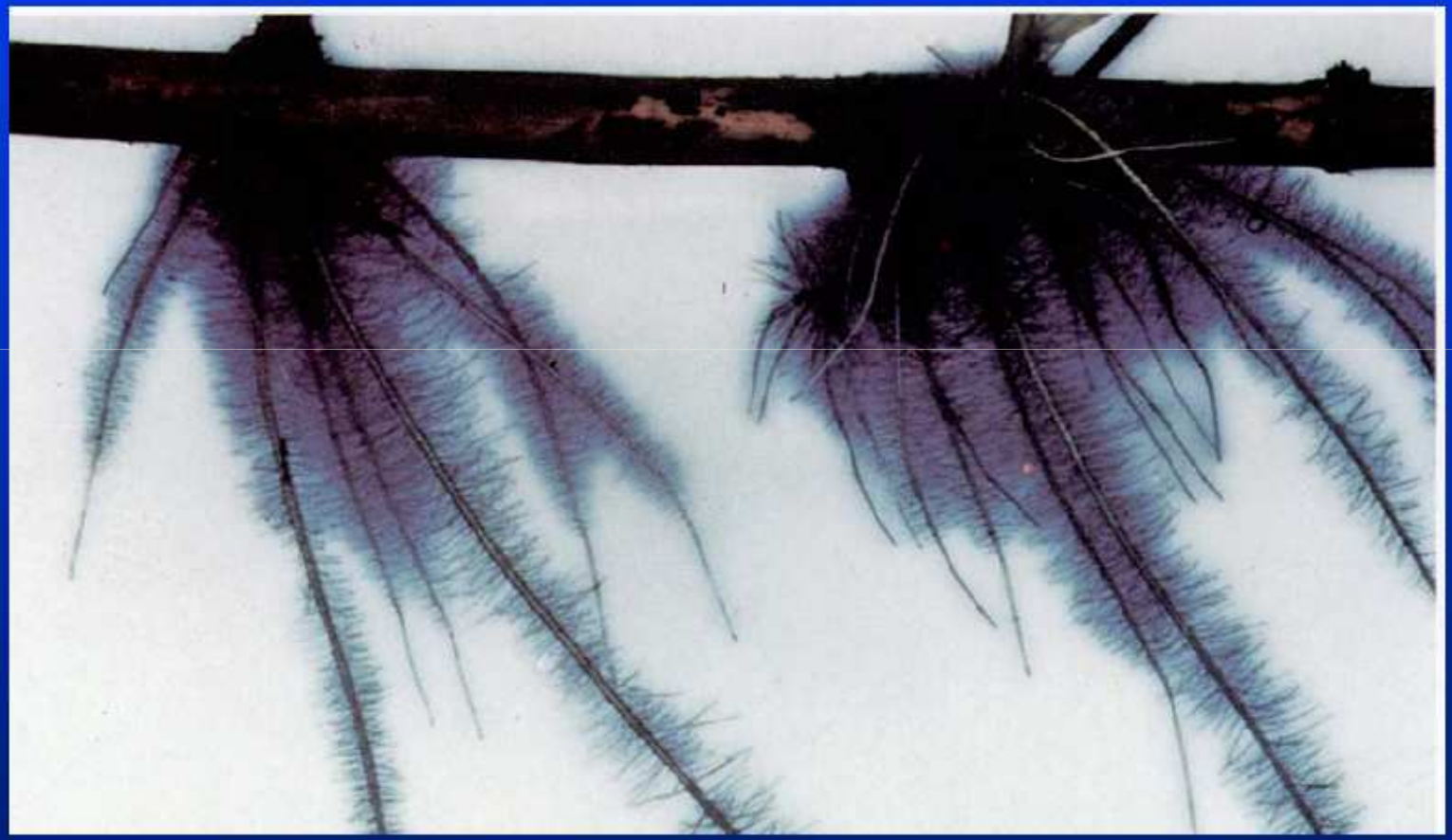
- Easy to operate and capital cost is reasonable
- Excellent efficiency of removing pathogens at a level almost similar to WHO standard.
- High efficiency of removing nutrients, many organics
- Effluent comply with Egyptian regulation
- Land requirements are not ideal but could be afforded at village level
- Effluent could be used straight for agriculture
- Bed length, wastewater retention time, and gravel size have significant bearing on the performance of the system

Industrial wastewater treatment

The GBH beds at 10th Ramadan City received a complex mixture of wastewater from a wide range of industries with BOD:COD ratios fluctuating between 0 and I (values below 0.2 indicate a toxic wastewater with poor prospects for biological treatment). The GBH beds were able to remove long chain hydrocarbons and fatty acids, but more recalcitrant compounds, including aromatics such as phthalates, remained. This suggests that GBH beds have applications for industrial wastes but may require a longer residence times or further treatment stages.

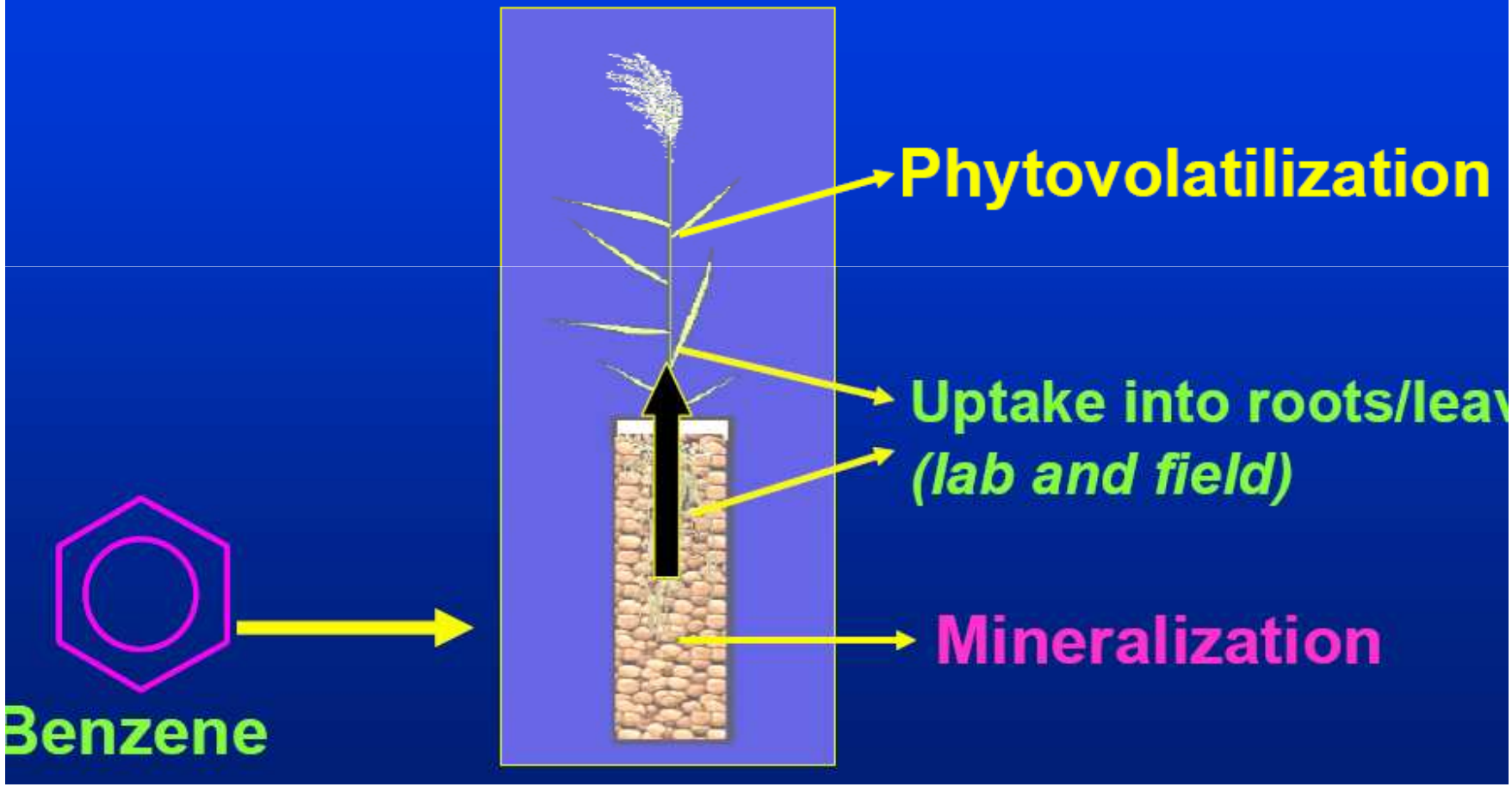
Community Initiative
Nasseria Women NGO

Preferred Treatment:
Aerobic Biodegradation in Root Zone



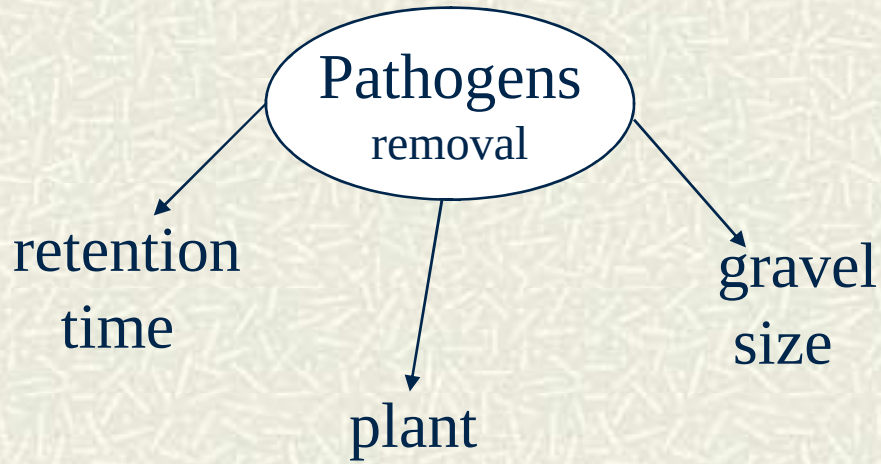
Oxidation "halo" around roots creates aerobic zone

Fate of Benzene in Plants

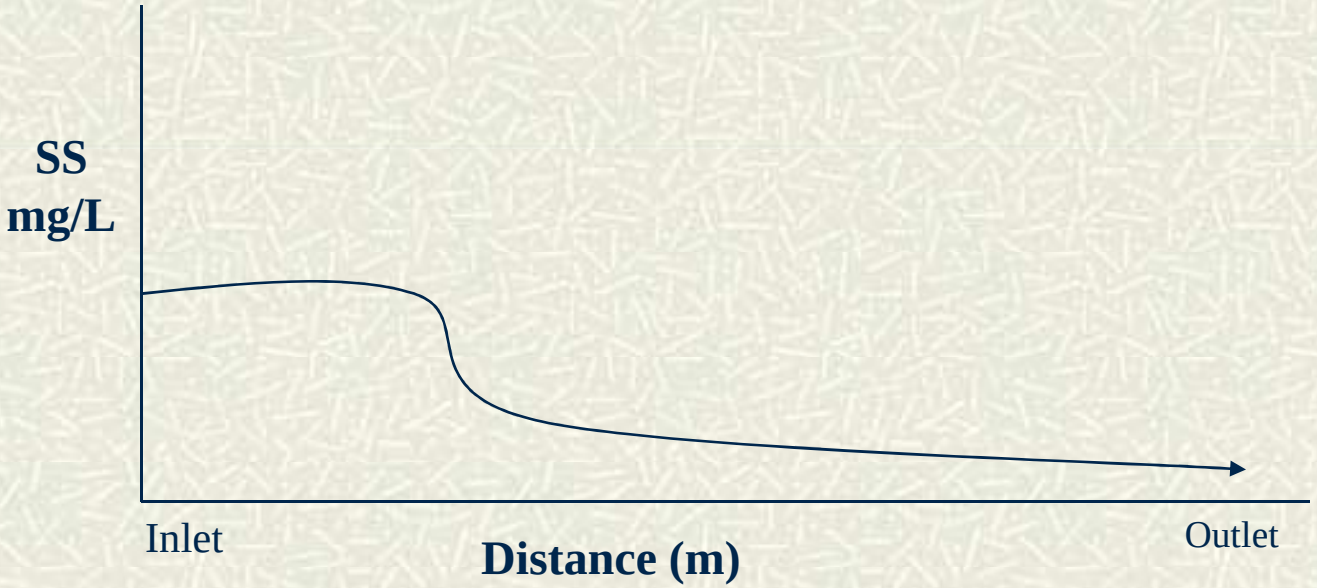


Removal of Pathogens

Adsorption – sedimentation – inactivation - predation



Removal of Suspended Solids



Treatment Indicators

- BOD & COD
- Suspended solids
- Nitrogen, phosphorus & sulphur
- Hydrocarbons, heavy metals
- Pathogens

Reuse of Wastewater

El Salaam mixes fresh Nile water with drain water harvested from three major drain systems in the Eastern Nile Delta. Water is conveyed under the Suez Canal through.

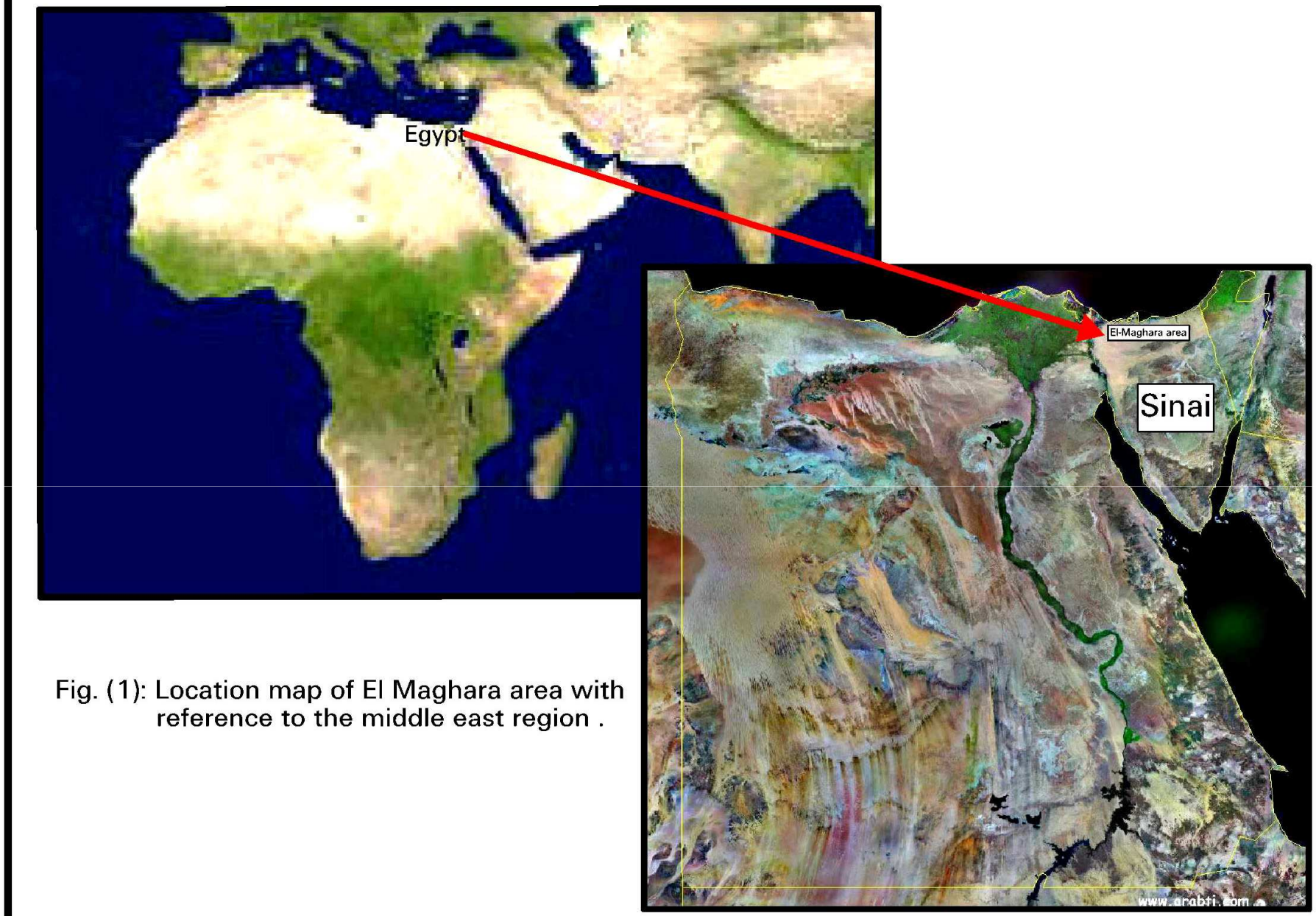


Fig. (1): Location map of El Maghara area with reference to the middle east region .

Physical Layout of El Salaam Canal

By design, El Salaam mixes fresh Nile water with drain water harvested from three major drain systems in the Eastern Nile Delta.

Water is conveyed under the Suez Canal through “The Great Siphon” , located some 28 kilometers south of Port Said, to the North Sinai Peninsula. Water emerges from the siphon on the Sinai Peninsula as El Sheikh Gaber El Sabah Canal; bringing water to El Areesh Valley..

Drain water supplied to El Salaam Canal will be 2 BCM/year. Moreover 2 BCM fresh water are withdrawn from Damietta Branch of the River Nile annually. Together, this water (4 BCM) will supply irrigation water to 200,000 feddan on the western side of the Suez Canal region, and 440,000 feddan in the East, north of Sinai Governorate

Canal Infrastructure

Forest-trees cultivation using wastewater

List of established Afforestation Areas Irrigated by Treated Sewage Water

Sr.	Governorate	Forest	Area (Feddan)	Plant Discharge Capacity (m^3)/day	Irrigation System	Cultivated Plant Varieties
1	Ismailia	Sarabioum	1000	90000	Drip irrigation	Cupressus sp. – Pinus sp. – Khaya senegalensis – Casuarina sp. – Eucalyptus sp. – Morus sp. – Concarpus sp. – Agava sisalana – Dendrocalamus strictus
2	Mounefia	El Sadat*	500	18000	Drip irrigation	Cupressus sp. – Pinus sp. – Acacia saligna – Casuarina sp. – Eucalyptus sp. – Agava sisalana – Morus sp. – Khaya senegalensis – Ornamental trees and plants
3	Luxor	Luxor	1700	30000	Modified Flood and Drip Irrigation	Khaya senegalensis – Eucalyptus sp. – Acacia saligna – Morus sp. – Jatropha curcas
4	Kena	Kena	500	23000	Modified Flood Irrigation	Eucalyptus sp. – Khaya senegalensis
5	South Sinai	Tur Sinai	200	3500	Modified Flood and Drip Irrigation	Casuarinas sp. – Eucalyptus sp. – Morus sp. – Popular sp.
6	Aswan	Edfu	300	8000	Modified Flood Irrigation	Khaya senegalensis
7	New Valley	El Kharja	400	13000	Modified Flood Irrigation	Khaya senegalensis – Casuarina sp. – Eucalyptus sp. – Terminalia sp. – Tamarix sp.
8	New Valley	Paris	200	18000	Drip Irrigation	Cupressus sp. – Pinus sp. – Acacia saligna – Casuarina sp. – Eucalyptus sp.
9	Giza	El Saf	500	65000	Drip Irrigation	Khaya senegalensis – Casuarina sp.
10	Dakahleya	Gamasa	150	1500	Drip Irrigation	Cupressus sp. – Pinus sp.
11	South Sinai	Sharm El Sheikh	60	3000	Drip Irrigation	Casuarina sp. – Eucalyptus sp. – Ornamental trees and plants
	Total		**5510**			

* Egyptian-Chinese Friendship Forest

Afforestation Using Wastewater

List of Under Establishment Afforestation Areas Irrigated by Treated Sewage Water						
Sr.	**Gover-norate**	**Forest**	**Area (Feddan)**	**Plant Dis-charge Capacity (m^3/Day)**	**Irrigation System**	**Cultivated Plant Varie-ties**
12	Aswan	Aswan	500	8000	Drip Irriga-tion	Khaya senegalensis – Acacia saligna – Euca-lyptus sp. – Terminalia sp.
13	Aswan	Nasr El Nouba	100	1400	Drip Irriga-tion	Khaya senegalensis – Acacia saligna – Euca-lyptus sp. – Terminalia sp.
14	Beni Sueif	El Wasta	500	10000	Drip Irriga-tion	Khaya senegalensis – Jatropha curcas
15	New Val-ley	Moot	700	10000	Drip Irriga-tion	Terminalia sp.
16	North Sinai	El Ar-ish	200	15000	Drip Irriga-tion	Khaya senegalensis – Jatropha curcas
17	Assiout	Assiout	40	50000	Drip Irriga-tion	Khaya senegalensis – Jatropha curcas
18	Sohag	West of Sohag	1000	28000	Drip Irriga-tion and Modified Flood Irriga-tion	Khaya senegalensis
19	Sohag	East of Sohag	1000	28000	Drip Irriga-tion and Modified Flood Irriga-tion	Khaya senegalensis
20	Red Sea	Hurgh-ada	200	10000	Drip Irriga-tion	Casuarina sp. – Khaya senegalensis
21	South Sinai	Nouei-ba	200	4000	Drip Irriga-tion	Casuarina sp. – Khaya senegalensis
22	Suez	Attakah	400	30000	Drip Irriga-tion	Jatropha curcas – Euca-lyptus sp. – Cupressus sp. – Casuarina sp.
	Total		**4840**			

Water Reuse in MENA III: Types of Reuse, Crop Restrictions, Participation and Project Examples

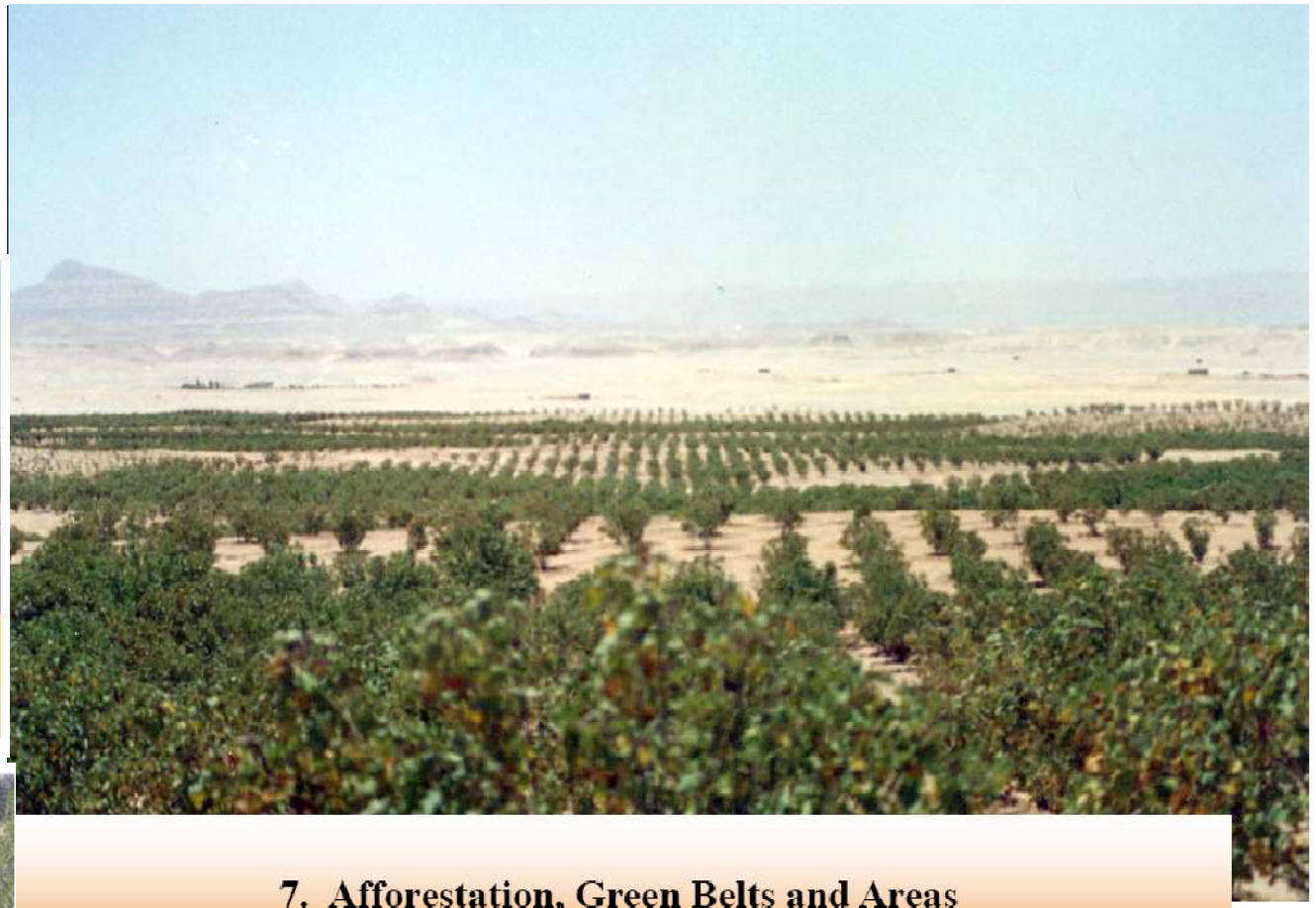
		Algeria	Egypt	Jordan	Morocco	Syria	Tunisia	Yemen	West Bank Gaza
Type of Reuse	Current	Ag	Ag, LS, Trees	Ag, Trees	Golf	Ag	Ag, Golf, LS	Ag, Trees	Ag
	Future (on top of current)	LS, Ind, Trees	Timber Trees, Industrial Crops	LS, Ind, GR	Ag	n.a.	GR, Ind, unrestricted agricultural reuse	--	LS, Ind, GR
Crop Restrictions for Irrigation with Treated WW		Yes, applied in at least some schemes	Yes, applied in at least some schemes	No (in Jordan Valley) Yes (in other schemes)	Yes (planned)	Yes, applied in at least some schemes	Yes	No (under discussion)	Planned (WB) No (Gaza)
Participation by WUAs		Yes, in some schemes	n.a.	Planned	n.a.	n.a.	Yes	Yes, in some schemes	Planned
Reuse of Untreated WW		n.a.	No	No	Yes	Yes	No	Yes	Yes
Pre-Treatment of Industrial Wastewater		Yes, but often not functioning	Yes, has recently been enforced more vigorously	Yes	n.a.	n.a.	Yes	n.a.	n.a.
Current Projects		Setif	Gebel Asfar (Cairo) Ismailia	Samra, Mafraq, Aqaba Madaba etc.	Benslimane (Pilot)	Damascus	Numerous	Sana'a Others	--
Planned Projects		n.a.	2.5 BCM/year from Cairo and Alexandria to irrigate 115,000 ha of trees and industrial crops	Upgrading of existing schemes, Northern Jordan Valley	Agadir	n.a.	Tunis-West and many others	Upgrading of existing schemes (e.g. in Sana'a)	Al Bireh, Gaza (3 WWTPs) as part of IAMP

Ag = Agriculture; LS = Landscaping; Ind = Industrial; GR = Groundwater Recharge; WUA = Water User Association
IAMP = Integrated Aquifer Management Program

Decree 44/2000 :Reusing Treated Wastewater in Agriculture; Degree of Treatment, Kind of Plant & Soil, and Method of Irrigation

Group	Degree of Treatment	Plants	Environmental & Health Precautions	Suitable Irrigation Methods	Proposed Kind of Soils
First	Primary	Trees for Timber	Fencing farms No direct contact with water and entrance of farm workers only Prohibit from entering farms Take health measures required for the protection from infection with pathogenic organisms and treatments	Furrow	Light texture authorized for use in desert land 5 km away from dwelling communities while complying with periodical assessment of the environment
Second	Secondary	Palm trees, cotton, flax, linen, jute Fodder crops & dried cereals Husky fruits & crops Cooking vegetables Heat processed fruits Flower nurseries Raw edible plants Husky plants	Cattle not yielding milk, and producing met could be used Food should be cooked prior to eating	Furrow & sprinkling	Light medium texture
Third	Advanced	All kinds of horticulture crops Fodder & green grasses	None	All methods except spraying	All kinds for soil

Photo (7-5) Ismailia–Cairo Desert Road



7. Afforestation, Green Belts and Areas

Photo (7-7) Jojoba watered by treated wastewater in Luxor

Afforestation works Using WW, Egypt

Thank you for your attention