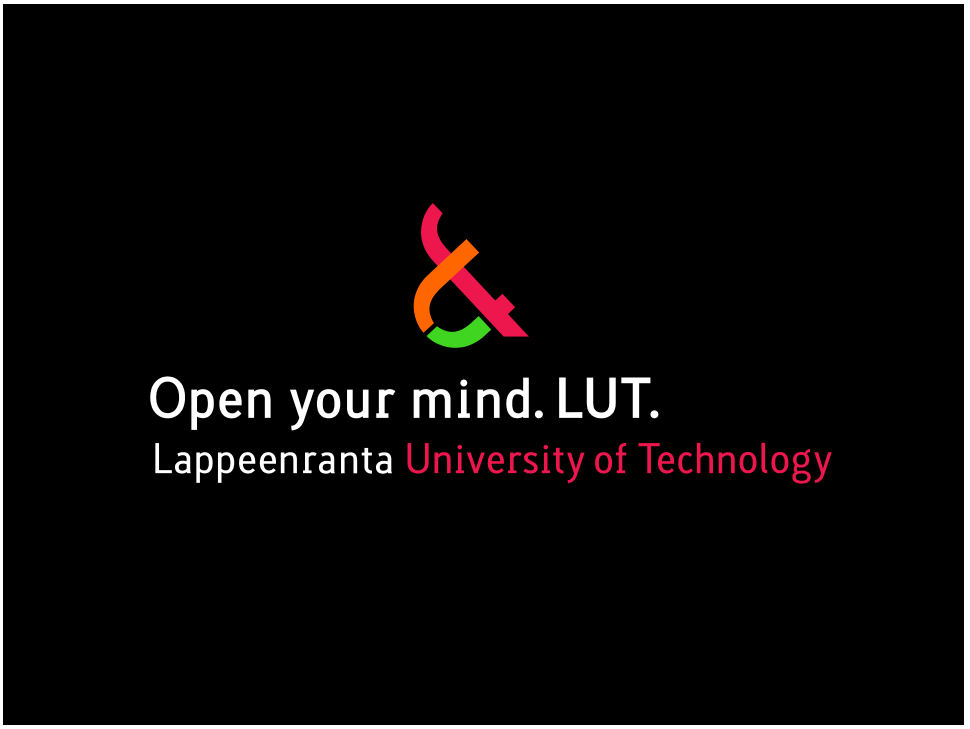

Deltas in Times of Climate Change II, Rotterdam, the Netherlands, 24-26 Sept. 2014

Water Quality of Fayoum Surface Water, Fayoum Province, Egypt

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Climate Change and its Potential Consequences on Water Resources in Egypt

Sea level rise

↓

Inundation of low lands and salt water intrusions in the Nile Delta

↓

Contamination of groundwater resources
+
Soil degredation by salinization

↓

People leave their lands and homes

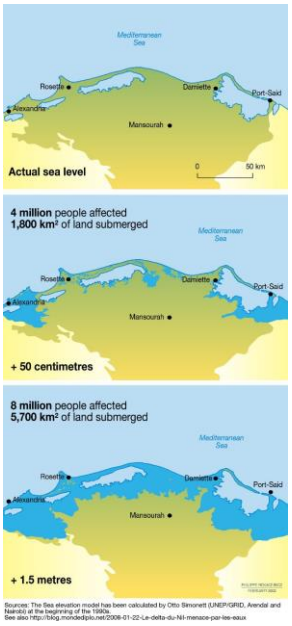
↓

New lands reclamation

→ Increasing stresses on water resources

Population growth
+
Competition on water from the upper Nile basin countries

→ Increasing stresses on water resources



Sources: The Sea elevation model has been calculated by Otto Simonett (UNEP/GRID, Arendal and Nairobi) at the beginning of the 1990s.
See also http://blog.mondediplo.net/2008-01-22-Le-delta-du-Nil-menace-par-les-eaux

Major challenges facing water security in Egypt

Population Growth	• 104 million in 2025. • 237 million in 2100. • The per capita share of water will decrease to 500 m^3/capita/year in the year 2025. • Water poverty limit is 1000 m^3/capita/year.
Reduction of Nile Flow	• Rapid implementation plans of the Ethiopian Dams.
Climate Change and Sea Level Rise	• Inundation the coastal zones and the Nile delta. • Seawater intrusion. • Salinization of fresh water aquifers.
Water Quality	• Agricultural returns, industrial effluents and municipal sewage are being irresponsibly dumped into the Nile River, gradually making its water not suitable for drinking or irrigation.

Water quality assessment, Why?

Polluted water = No useable water

- Poor water quality has a direct impact on water quantity in a number of ways. Polluted water that cannot be used for drinking, bathing, industry or agriculture effectively reduces the amount of useable water within a given area.

Water Quality of Fayoum Surface Water, Fayoum Province, Egypt

Sites 1–17

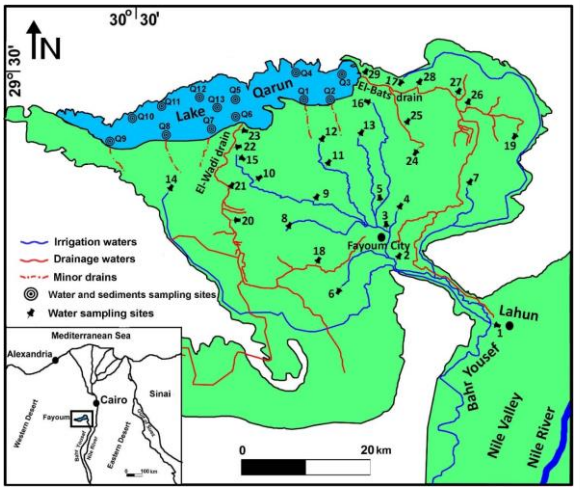
Irrigation waters

Sites 18–29

Drainage waters

Sites Q1–Q13

Lake Qarun

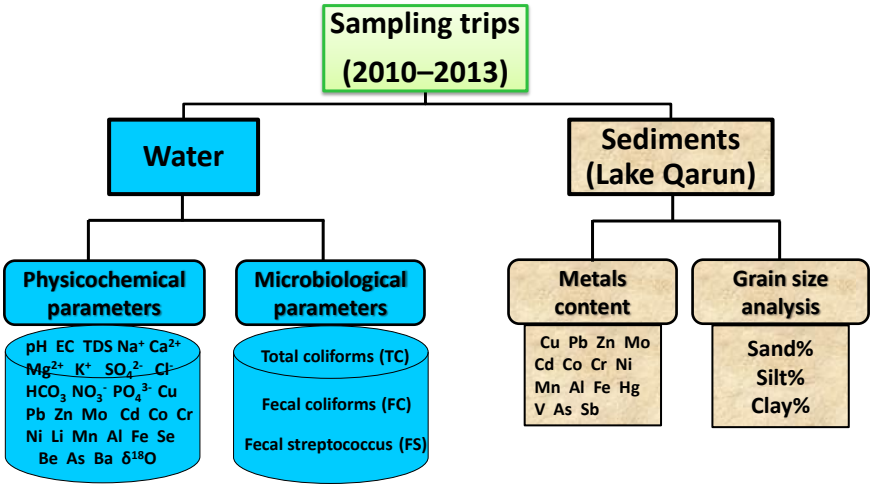


Location map of the studied area showing sampling sites

Objectives

- Evaluation the water quality of Fayoum surface water against the criteria of the World Health Organization (WHO) guidelines for drinking-water Quality.
- Assessment the surface water quality for agricultural purposes in Fayoum Province.
- Study the environmental significance of Lake Qarun in Fayoum Province.
- Study the fate of contaminants through sources–sink pathway.
- Assess metal pollution in Lake Qarun sediments

Methods

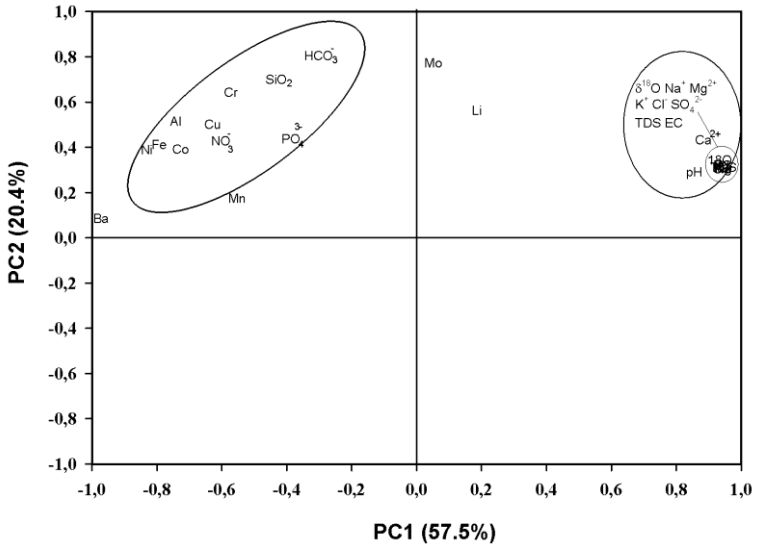


TDS (Total dissolved solids)
EC (Electrical conductivity)

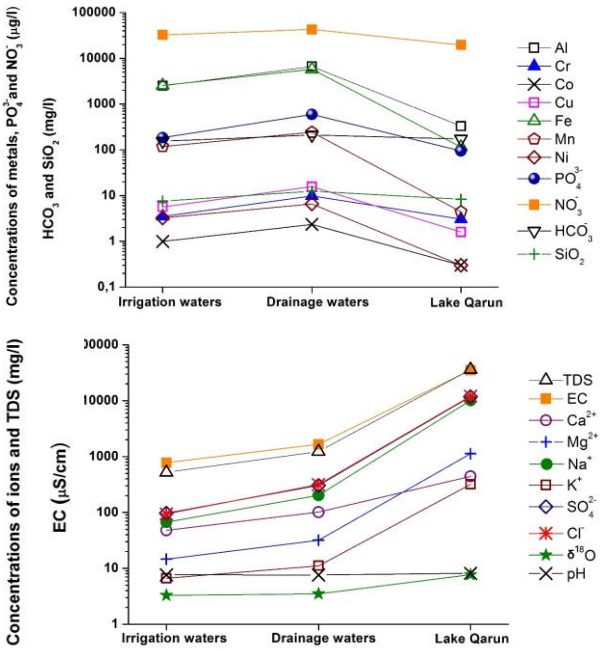
Lappeenranta University of Technology | Laboratory of Green Chemistry
LUT Lappeenranta University of Technology

Results and Discussion

Physicochemical Parameters

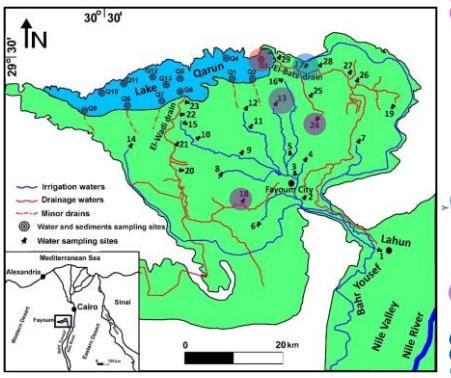


Principal Component Analysis (PCA)

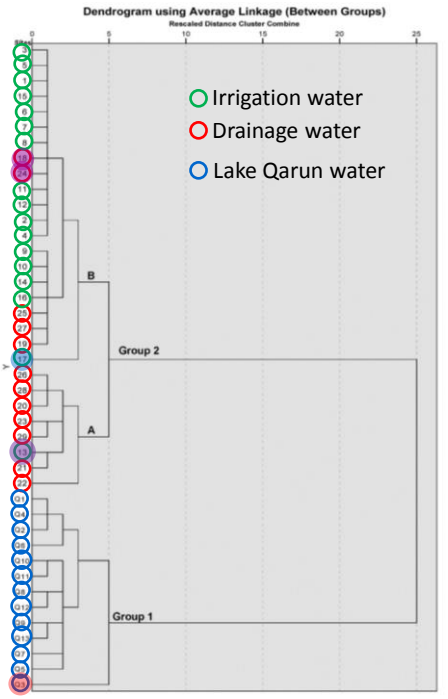


Means plot

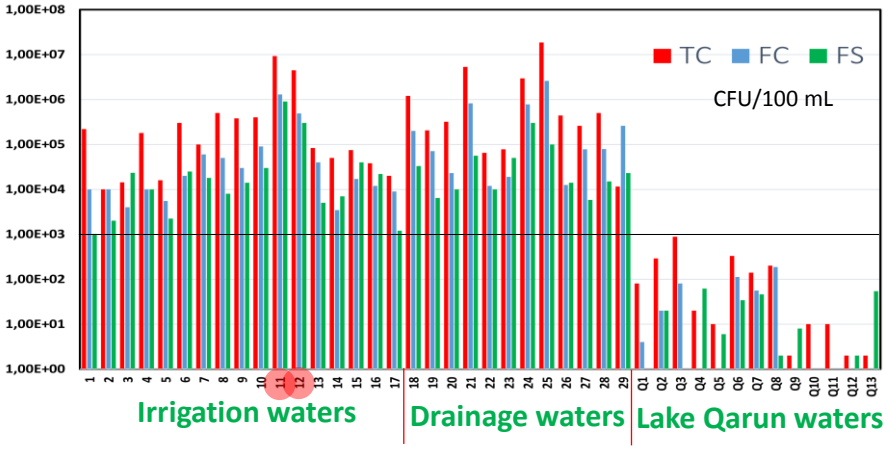
Cluster Analysis



Sampling map

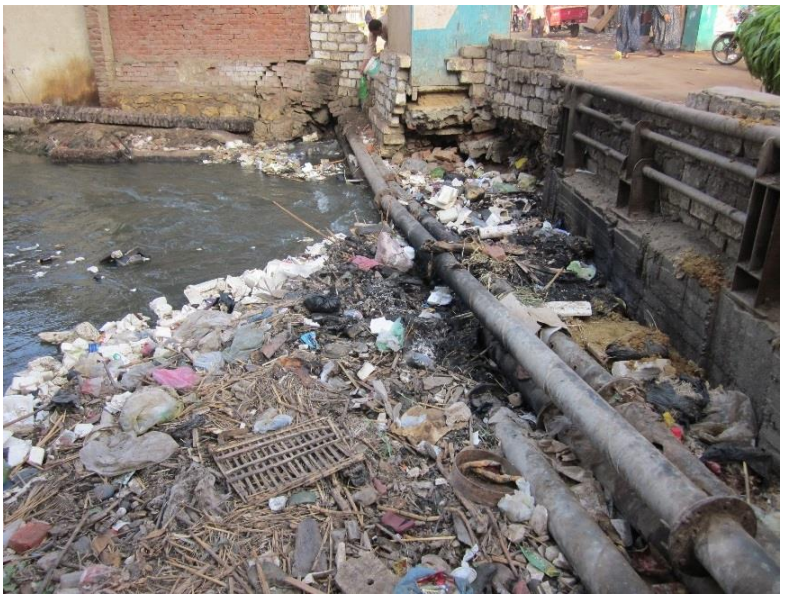


Microbiological Results of water



TC (Total coliforms) **FC (Fecal coliforms)** **FS (Fecal streptococcus)**

Photographs taken at some sampling sites show the anthropogenic pollution inputs into the running waters and demonstrate the high level of microbiological contaminations.



Evaluation of water quality against the criteria of the World Health Organization (WHO) guidelines for drinking-water quality

In the following Table, waters from irrigation canal, which are using as water supply for drinking water in Fayoum Province, are examined against the available WHO (2008) guidelines for drinking-water quality

	Al µg/L	Cr µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Mo µg/L	TC CFU/100mL	FC CFU/100mL	FS CFU/100mL
This study	2503	3.5	5.6	117.1	3.2	ND	9.46×10^5	1.27×10^5	8.29×10^4
WHO (2008)	200	50	2000	400	70	70	0	0	0

[a] mean values (N = 17)
ND (not detected)
TC (Total coliforms)
FC (Fecal coliforms)
FS (Fecal streptococcus)
values > WHO guideline value

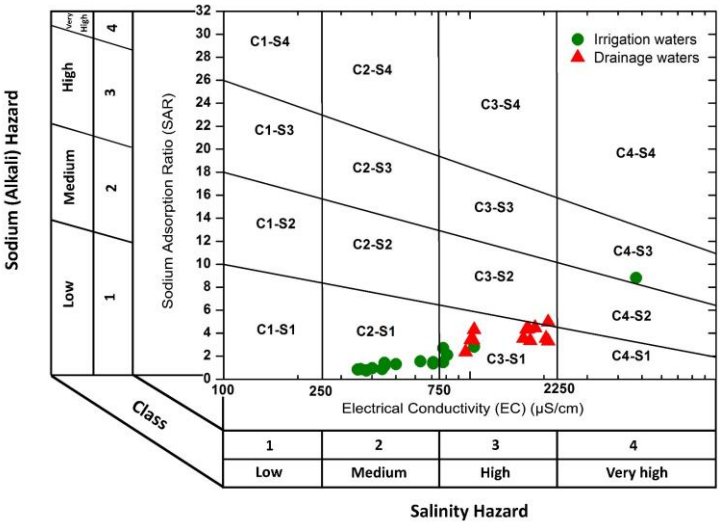
Evaluation of water quality of irrigation waters and drainage waters for agricultural purposes

Element	Recommended max. Conc. (µg/L) (FAO, 1992)	Irrigation waters	Drainage[a] waters	Remarks (FAO, 1992)
Al	5000	2503	6625.8	Causes non-productivity in acid soils (pH<5.5)
Co	50	1	2.3	
Cr	100	3.5	9.8	
Cu	200	5.6	15.6	
Fe	5000	2547.1	5746.7	Causes soil acidification and loss of availability of P and Mo
Li	2500	3.3	7	
Mn	200	117.1	241.7	
Mo	10	ND	2.7	
Ni	200	3.2	6.5	
FC	1000 (CFU/100 mL)	1.27×10^5	4.13×10^5	Pathogenes transfer through crops that are eaten uncooked

[a]Drainage waters are using as secondary sources for irrigation in Fayoum Province.

Note: Pb, Zn, Cd, Be and As were not detected in irrigation waters or drainage waters.

Water quality for agriculture (salinity and alkalinity hazards)



Salinity and alkalinity hazards in US salinity diagram applied for evaluation the studied irrigation waters and drainage waters and their suitability for agricultural purposes.

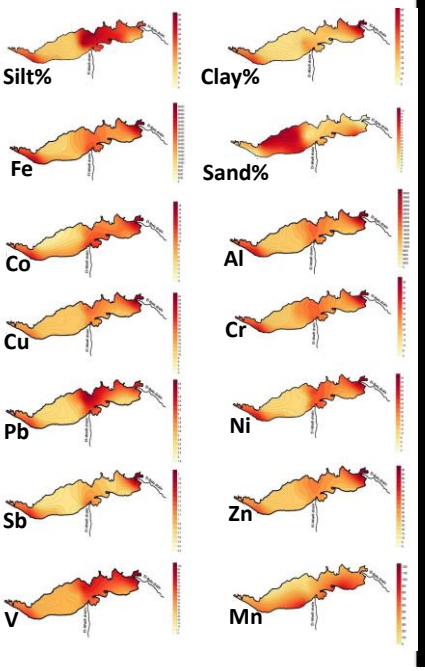
Salinity problem in Fayoum

- **Water of high salinity cannot be used on soils with poor drainage, and plants with good salt tolerance should be selected.**
- **Most of Fayoum soils are characterized by poor drainage.**
- **Using of high salinity waters in irrigation can cause soil salinization especially under the hot and arid climate of Fayoum (see the following image).**
- **Degradation of soil productivity as a result of soil salinization is common in Fayoum Province.**

An image shows soil salinization feature in Fayoum

Spatial distribution of grain size fractions and metals content in Lake Qarun's sediments

- The metals content in sediments is distributed similary to clay and silt frations.
- Mn has a different distribution than other metals, which indicates different sources and/or different precipitation mechanism.
- Sites with higher sand% have lower concentration of metals.
- Lake Qarun is the main sink for metals transported with drainage water.
- The concentrations of metals in sediments reflect the concentrations of the same metals in the inflowing drainage waters.
- Metals which were found in higher concentrations in the drainage water inflow present also in higher concentrations in sediments and vice versa.



Conclusion

Assessment of water quality of surface waters in Fayoum Province was invistigated and the main findings can be summurized as follow:

- The water in irrigation canals which are using as water supply for drinking is highly polluted with microbiological contaminants (TC, FC and FS) and also Al which makes it unsuitable for human consumption when used directly without sufficient treatment. This kind of water has a high risk on human health and can cause serious illness for people who are drinking it directly.
- The high levels of FC and FS in the studied waters indicate sources from human and animal wastes.
- Water in irrigation canals and drains have high significance levels of FC (> 1000 CFU/100 mL) making it unsuitable for irrigation specially in the case of crops which are eaten uncooked.
- There is a potential threat to soil salinization when drainage waters of high salinity are using in irrigation. This affects negatively on the soil productivity.

- **The possible sources of the different dissolved constituents in irrigation waters and drainage waters in the studied area are:**

1. ***Natural sources (soil weathering).***
2. ***Anthropogenic sources which includes <u>point sources</u> such as sewage water treatment plants which are distributed in Fayoum and <u>non-point</u> sources such as households sewage pipes that are connected directly to the irrigation canals or drains, on-site sanitation tanks overflow, seepage from unconfined septic tanks and the agricultural drainage which includes sediments, plant remains, crop residues, inorganic salts and minerals, chemical fertilizers and pesticides.***

- **Lake Qarun plays an important environmental role. It is the main sink for all pollutants and metals coming with drainage water inflow. It has a self cleaning capacity where all metals are adsorbed on its sediments surface.**

- **The concentrations of metals in Lake Qarun sediments reflects the concentrations of the same metals in the inflowing drainage waters. This means that surface drainage waters are the main inlets to the lake.**

Recommendations

- **Online water quality monitoring of surface water is an obligated task to follow up the contaminations levels in Fayoum surface waters and also to decide the most suitable treatment processes.**

- **There is a necessity for the activation of the environmental protection laws in Egypt that deal with protection of water resources and running waters.**

- **Authorities must work on public awareness rising through the environmental protection agencies or via media especially in rural areas.**

- **Sanitation network should extend over all regions to minimize the pollution coming from unconfined septic tanks and their impact on the water quality of groundwater and surface water as well.**

- **Egypt is suffering from water scarcity and it needs every drop of clean water.**

References

- Abdel Wahed, M.S.M., Mohamed, E.A., El-Sayed, M.I., M'nif, A., Sillanpää, M., 2014. Hydrogeochemical processes controlling the water chemistry of an inland closed lake, Lake Qarun, Egypt. Submitted for publication.
- Abdel Wahed, M.S.M., Mohamed, E.A., El-Sayed, M.I., M'nif, A., Sillanpää, M., 2014. Geochemical modeling of evaporation process in Lake Qarun, Egypt. J. Afr. Earth Sci. 97, 322-330.
- FAO, 1992. FAO Irrigation and Drainage paper 47. FAO (Food and Agriculture Organization of the United Nations), Rome.
- WHO, 2008. Volume 1, Recommendations, in Guidelines for Drinking-Water Quality, 3 ed. World Health Organization, Geneva.

THANK YOU