Brackish Water Definition

According to the Commonwealth of Australia (2011), brackish water is defined as the water that has more saline than fresh water, but not as much as seawater.

It may result from mixing of seawater with fresh water (rivers ends), land drainage water, or it may occur in brackish aquifers.

Brackish Water Limits

Water type	Limits
Mildly brackish	1,000- 5,000 mg/l
Moderately brackish	5,000 - 15,000 mg/l
Heavily brackish	15,000 - 35,000 mg/l
Seawater and Brine	> 35,000 mg/l

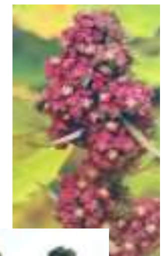
USBOR, 2003

Saline Water Limits

Water class	Electrical conductivity dS/m	Salt concentration mg/l
Non-saline	<0.7	<500
Slightly saline	0.7 - 2	500-1500
Moderately saline	2 - 10	1500-7000
Highly saline	10-25	7000-15 000
Very highly saline	25 - 45	15 000-35 000
Brine	>45	>45 000

FAO No.48, 1992

Use of Brackish Water for Agriculture Opportunities and Challenges



Prepared by:
Dr. Samia El-Guindy
MWRI/ Egypt

Impact of Irrigation with Brackish Water on Soil and Plants

The use of saline water can negatively affect soil quality, plant growth, yield, soil fertility as well as soil physical properties. Crops can suffer large yield reduction in salinized soils and in severe condition might leave the land abandoned.

I. Stress and toxicity effects on plants

How can Salinity be expressed

- Salinity is defined as the total concentration of dissolved mineral salts presented in water and soil. Some times it is expressed as milligrams per liter mg/L (ppm).
- The total salt content is generally measured by the Electrical Conductivity (EC) which increases as the total salt content increases. The EC is expressed as mmho cm^{-1} or $dscm^{-1}$

II. Physico-chemical effects of slats on soil

- Sodium has a detrimental influence on soil structure and hydraulic properties. Soils containing high levels of sodium (as opposed to calcium or other divalent cations) are most at risk of damage when water is applied.
- Sodium risk is to look at the sodium adsorption ratio (SAR) of the soil. The SAR equation is given as:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

- The clay fraction in soils is susceptible to long-term damage as it is subject to physico- chemical interactions with salt ions, which alter the soil's structure and its hydraulic properties, sometimes irreversibly.

Classification of soil infiltration rate according to the United States national cooperative soil survey

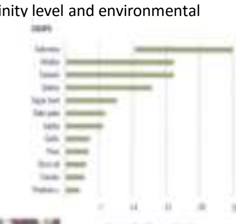
Infiltration	Classification	Soil Type
< 2.5 mm/hr	Very low	Clays
2.5 – 12.5 mm/hr	Low	Clay loams
12.5 – 25 mm/hr	Medium	Loams/silts
>25 mm/hr	High	Sands/silt loams

Natural mechanisms of tolerance

Plant do not only differ in their salt tolerance but often also in their bandwidth to withstand saline conditions. This allows farmers to select the most adequate crops for the actual salinity level and environmental conditions of their fields

Introduction of salt tolerance crop species like quinoa or sugar beet may result in more resilient crop rotations and high value cash crop products.

Improvement of the production positional may arise from breeding for deep roots and increased transpiration efficiency



Salinity tolerance of different cash crops and their bandwidth

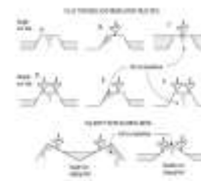
Salt crystals on salt grass

2) Crop Selection and Management
- Selection of crops tolerant to salinity and specific ions
- Identification of critical growing stage
- Development of salt tolerant varieties
- Adequate fertilizers application, type of fertilizers preferably be acid
- Increased fertilizers with K (decrease in Na content in plant tissue)
- Plants spraying with P/K application increase these nutrients in the leaves
- Timing and placement of mineral fertilizers
- Introduce high salinity tolerant crops


Agriculture Management Under Saline Conditions:

The following management practices are required for optimum crop growth conditions:

1) Water Management
- Irrigation practices
- Applications system, method, schedule
- Monitoring of irrigation water quality
- Leaching requirements
- Land drainage



Typical salt accumulation pattern in ridges and beds cross section in soils irrigated by furrows.

Example of low elevation sprinkler irrigation provided by new centre Pivot system

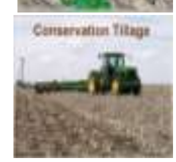

Surface drip irrigation left , Subsurface (10-12 cm below surface) drip irrigation, righ

5) Multiple Use of Brackish Water
- Integration with fish farms: first ponds then irrigation of field crops
- Intercropping : irrigating the least salt-tolerant crop first, then salt using drainage water to irrigate another crop which is relatively more salt tolerant and son

Increase water use efficiency (maximize the benefit of the same amount of water) and increase the income

3) Land Management
- Leveling, tillage, ploughing, mulching
  - **tillage**: is a mechanical operation for seedbed preparation, to break up surface crust, increase O.M (nutrient availability)
  - **ploughing**: beneficial on stratified soils having impermeable layers laying between permeable layers
  - **mulching**: reduces soil evaporation and temperature

4) Soil Improvement
- Application of chemical or organic amendments ($CaSo_4$, OM) to neutralize soil reaction and replace exchangeable Sodium by Calcium
- Mixing with sands to increase the permeability of a fire textured surface soil s
- Regular monitoring of soil salinity

Reuse of Brackish Water in Agriculture in Egypt

1) Reuse of Drainage Water

A- Irrigation practices:

- Official reuse

* Gravity reuse

Upstream from Cairo all drainage water return to the Nile. There are 72 drains on both sides of the river discharge water into Nile by gravity, or in the lower reaches through pumping.

* Mixing reuse

In the Delta, some drainage water is pumped into irrigation canals where it mixes with fresh water for further down - stream use.

Classification of Ruse Drainage Water in the Nile Delta during 2007/2008

Salinity Class	Eastern Delta Billion m^3/y	Middle Delta Billion m^3/y	Western Delta Billion m^3/y	Total Delta Billion m^3/y
< 750	0.466	0.000	0.499	0.964
750-1000	0.976	0.642	0.053	1.674
1000-1500	1.101	2.346	2.271	4.017
1500-2000	0.000	0.204	0.000	0.204
2000-3000	0.000	0.000	0.001	0.001
Total	2.845	3.192	0.823	6.860

Egyptian Experiences

Irrigation & Drainage Systems



- Water distribution through the Nile system (55.5 BC M/yr)
- Irrigation Canal length: 33000 Km (most of these canals are major sources for drinking water)
- Drains length: 18000 Km
- Open or subsurface drainage systems is covering the whole Agr. Land
- Water shortage :

Water Supply 2017	Water Demand 2017
66.8	86.8

B) Land Reclamation & Irrigation

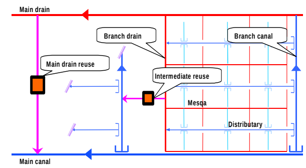
El-Salam Canal Project :
400,000 feddan (~170,000 Hectar) at North Sinai has been reclaimed, using
drainage water from Hadous & El-Serw drains mixed with fresh water from Rashid Branch

Principals:

- Continuous leaching as long as salt concentration in water is less than that of the soil
  * Land drainage : Surface and subsurface
- Policies for water quality protections have been considered
- Environmental impact assessment and socio-economic aspects are studied

* Intermediate reuse

Mixing of drainage and fresh water take place at lower level with a drainage catchment coinciding with a number of secondary canals



Typical reuse scheme in the Nile Delta

- Non-offical reuse: is practiced by individual farmers who decide, when and how drainage water will be used for supplementary their irrigation water

Water Quality Deterioration

- The high population destines and insufficient sewerage facilities
- Industrial activities and developments

Drainage Catchments with health risk due to pollution

Technical Measure
National Water Quality Monitoring Program

Water quality data is collected through:

- Intensive monitoring program which is currently comprises of 245 locations for surface water and 188 locations for groundwater
- more than 34 variables are regularly analyzed in the Central Laboratory for Environmental Quality Monitoring (CLEQM)
- Data Analysis, interpretation, coordination are presented in yearly book

Water Quality Monitoring Program

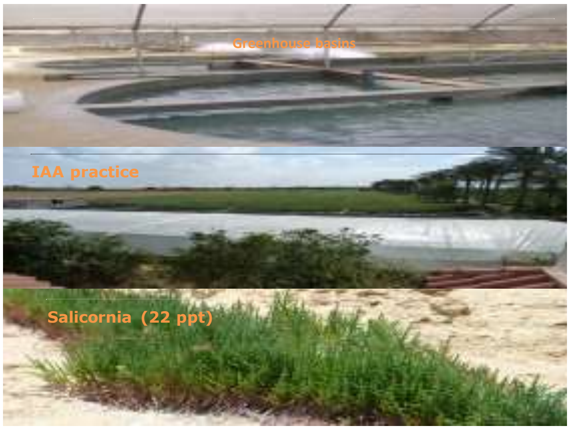
2- Use of Brackish Groundwater

Potential & Salinity

Brackish Groundwater

The major considerations for farm management applied by farmers

- Night irrigation is practiced daily to avoid the effect of the high soil temperature
- Farmers have made a field drainage network at intervals of 20-25 m
- Uniform crop relations include salt tolerant crops are followed
- Surface leaching is made from time to time through flooding the land
- Fertilizers, specially nitrogenous compounds, are applied at higher rates
- Gypsum is applied to the soil to overcome the presence of sodium ion
- Legume cultivation is suitable in soil degraded by Sodic water
- Plating techniques that minimize salt accumulation
- Use fresh water irrigation during seeding time
- Land drainage is essential

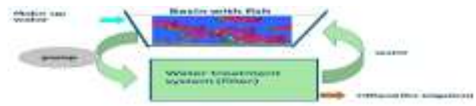


Using brackish groundwater for integrated Aquaculture and Agriculture/IAA in Egypt

IAA principles•

- More crop per drop - Fertigation of the water to increase crop yield

The basic design of Recirculating Aquaculture System (RAS)•



Our assignment•

IAA potential		
	fresh	brackish
surface water		
groundwater		Our focus

Brackish water Standards and Guidelines

•In most countries of the Near East and North Africa (NENA) region, the necessity to use non-conventional water resources, including brackish water, is well recognized.

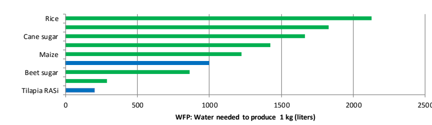
•When brackish water is to be used at a large scale for irrigation, the interaction of the water, soil and crop must be well understood beforehand.

•The success of brackish water use for irrigation requires the development of new technologies, new guidelines suitable for the prevailing local conditions, and new strategies that facilitate its use at a relatively large scale.

•Collecting Good Agricultural Practices (GAPs) and research results on brackish water use from sites in the NENA region, with the aim of developing guidelines for the safe use of this water is therefore highly recommended.

•The guidelines are very important to assist the stakeholders and farmers in using brackish water for irrigation while safeguarding the environment, conserving natural resources, increasing crop productivity/quality and enhancing farm income.

More crop per drop

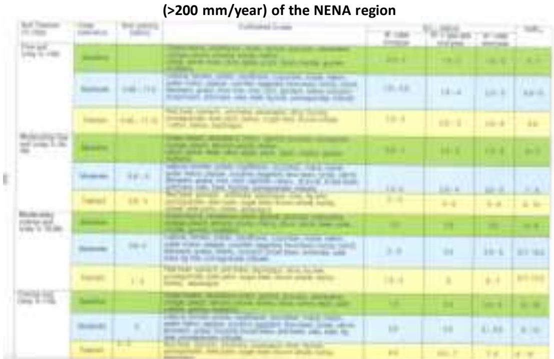


Suitable and sustainable fish

IAA integrated versus separate

	water footprint (l/kg)		
Food	Separate	IAA	Savings
1kg fish	1000	100	
3kg potato	900	900	
Food basket	1900	1000	47%

Guidelines for Brackish water use for agricultural production in <u>Rainy</u> countries (>200 mm/year) of the NENA region



The Development of Guidelines for NENA Countries

<u>Scope</u>: In accordance with the FAO Regional Water Scarcity Initiative, and within the framework of LAS (League of Arab States) Arab Water Security Strategy (2010 – 2030), and FAO/AWC cooperation on "Sustainable Management of Brackish Water Agriculture Use," it was agreed that AWC, jointly with FAO, would work on developing **"Guidelines for Brackish Water Use for Agricultural Production in the NENA Region."** Work on producing the technical guidelines started in January 2014 and ended in June 2015.

<u>Objectives</u>: The main objectives of this report are:

- To develop guidelines to use brackish water for irrigation in NENA Region countries;
- To recommend appropriate integrated management strategies for soil, water and crops as good agricultural practices for NENA region conditions;
- To propose alternative non-conventional crops that are better adapted to soil and water salinity problems for better economic returns to farmers.

Logical sequence for application of the brackish Water Use Guidelines

Guidelines for brackish Water for agricultural production in non-rainy countries (<200 mm/year) of the NENA region

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