



WASAG

The Global Framework on
Water Scarcity in Agriculture

Consultation Meeting on SALINE AGRICULTURE

*28 May 2018, 9:30 – 15:30
German Room, FAO HQ, Rome*

www.fao.org/land-water/overview/wasag



FAO activities related to saline agriculture

Inputs from:

- Land and Water Division (CBL)
- Geospatial Group (CBDS)
- Plant Production and Protection Division (AGP)
- Fisheries and Aquaculture Policy and Resources Division (FIA)
- Resilience Programme Management Team (SP5)
- Regional Office for Africa (RAF)
- Subregional Office for North Africa (SNE)

1. Land and Water Division (CBL)

Central Asian Countries Initiative for Land Management (CACILM) 2 Integrated natural resources management in drought-prone and salt-affected agricultural production landscapes in Central Asia and Turkey

Salinity

Globally

Saline soils: 397 million ha

Sodic soils: 434 million ha

Salt-affected soils

45 million ha (19.5 %) of 230 million ha of total irrigated land

32 million (2.1 %) of 1 500 million ha of dryland agriculture

Source: FAO/UNESCO soil map of the world (1970-1980)

CACILM 2

GEF-funded project entitled

“Integrated natural resources management in drought-prone and salt-affected agricultural production landscapes”

GEF budget: 10.8 million USD

Total budget: 75 million USD (GEF + Co-finance)

Duration: 5 years, operational by 16 Oct 2017

Project Countries

Kazakhstan	Tajikistan	Turkmenistan
Kyrgyzstan	Turkey	Uzbekistan

CACILM 2

Project Objective

Scale up integrated natural resources management in drought prone and salt affected agricultural production landscapes in the Central Asian countries and Turkey.

Through sustainable management practices that

- minimize pressures and negative impacts on natural resources,
- reduce risks and vulnerability,
- enhance capacity of rural communities to cope with or adapt to drought and salinity.

CACILM 2

Components

- 1:** Multi-country collaboration and partnership to foster the effective delivery of INRM
- 2:** Integration of resilience into policy, legal and institutional frameworks for INRM
- 3:** Upscaling of climate-smart agricultural practices in drought prone and/or salt affected production landscapes
- 4:** Monitoring and evaluation



CACILM 2

Overview of Central Asia

Country	Land area ('000 ha)	Cultivated land		Irrigated area		Irrigated land (salinized)	
		Area ('000 ha)	% of total land area	Area ('000 ha)	% of cultivated area	Area ('000 ha)	% of irrigated area
Azerbaijan	8,660	2,160	25	1,425	66	636	45
Kazakhstan	272,490	29,527	11	1,200	4	404	34
Kyrgyzstan	19,994	1,281	6	1,023	80	49	5
Tajikistan	14,255	730	5	742	100	23	3
Turkmenistan	48,810	1,940	4	1,991	100	1,354	70
Uzbekistan	44,740	4,400	10	4,198	95	2,141	49
Turkey	78,356	20,706	26	5,340	26	1,519	28

Source: Aquastat

CACILM 2

Challenges

- Severe **land degradation** (including salinization of irrigated land)
- **Water scarcity** (institutional and economical)
- **Water demand** (Low efficiency of canal irrigation systems and low agricultural water productivity)
- **Skill gap** (Lack of new young qualified professionals and inadequately trained / equipped Water User Associations)
- Increasingly complex structure of the **water-food-energy nexus** in a changing environment
- High **vulnerability of livelihoods** to climate change impacts, particularly extreme weather events (e.g. droughts and floods)

CACILM 2

Indicators for impact assessment

Global Environmental Benefits	
Indicator	Target
Land under integrated management (ha)	298 254 ha of demo areas 2 590 770 ha of upscaling area
GHG emissions avoided or reduced (tons CO ₂ e)	<u>Demo areas:</u> 8.65 million tons CO ₂ e over a 20 years capitalization phase; or 29.0 tons CO ₂ e per hectare <u>Upscaling area:</u> 69.7 million tons CO ₂ e; or 26.9 tons CO ₂ e per hectare
Area with improved irrigation efficiency (ha)	146 050 ha of demo area 1 215 605 of upscaling area
Socio-economic benefits	
Indicator	Target
Beneficiaries in pastoral, agro-sylvo-pastoral, tree-based, irrigated and, rainfed systems	665 294 people in demo areas 2 661 380 people in upscaling areas
Improvement in incomes from INRM (disaggregated by gender)	25%

2. Land and Water Division (CBL)

Global Soil Partnership Saline Soil Management in Eurasia



Global Soil Partnership (GSP)

- Focus on soil salinity in Eurasia
- Research projects on the assessment, monitoring and reclamation of saline soils
- Publications:
 - ✓ Land resources and food security of Central Asia and Southern Caucasus
 - ✓ Handbook for saline soil management
 - ✓ Upcoming: Saline soil management and remediation in Eurasia: project results

Soil salinity – Main outputs

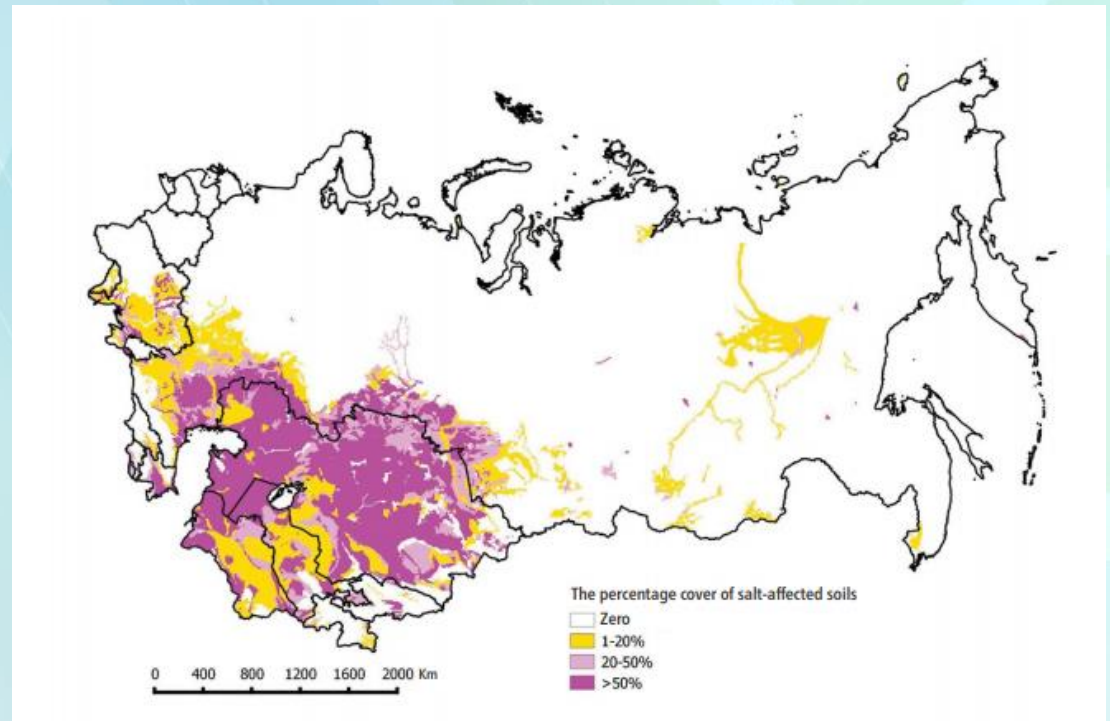
- Determined correlations between the degree of salinization, alkalization and crop yields.
- Analysed spatial and temporal changes in soil properties and developed recommendations on most effective methods for revegetation and other management practices.
- Developed new remediation methods that are soil type specific.
- Assessed the current ecological state of soils and of the ecosystem services that they could provide after reclamation.
- Assessed and forecast the development of soil salinization and alkalinisation processes
- Assessed the capability of soil tolerant plants to remove soluble salts from soils and assessed their nutritional value as fodder.

Project highlights

Determination of salt-affected soils distribution in Eurasia

Innovative methods of mapping and monitoring saline and alkaline soils:

- Electromagnetic induction
- Remote sensing



<http://www.fao.org/3/i7318en/i7318EN.pdf>

Project highlights

Remediation of saline soils using agroforestry

- Trees are able to efficiently take up saline groundwater
- Soil nitrogen content increased by up to 30%
- Soil organic carbon reserves increased by 20%



Project highlights

- Varieties of halophyte species grown on soils affected by saline irrigation water.
- Species were determined to successfully take up soluble salts from soil.
- Species chosen for their nutritional composition and ability to serve as fodder for livestock.



GSP Mapping Experience

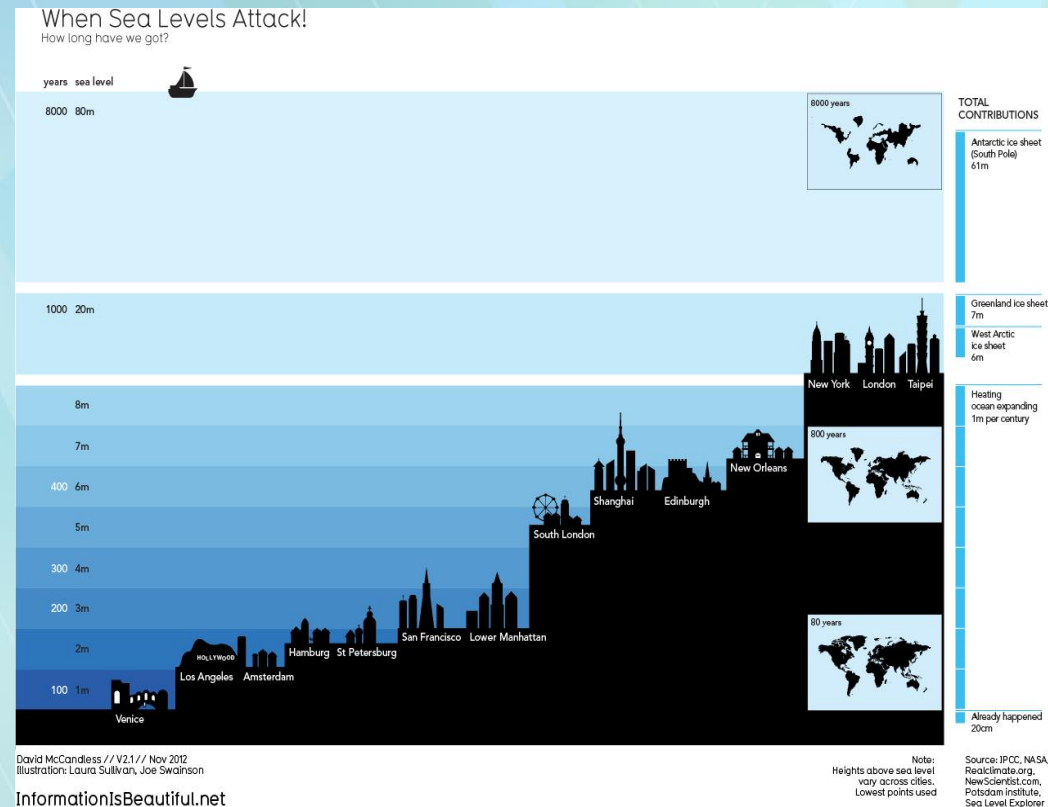
- GLOSIS (Global Soil Information System) is a GSP framework for making global data products based on country-driven approach
- Example – GSOC map
- Country-driven process steps:
 - Formulating guidelines and specifications for the product
 - Capacity development for the countries (where needed)
 - Practical manuals
 - Workshops
 - Country experts produce the maps according to specifications
 - FAO provides methodological support to country experts (where needed)
 - FAO collects the national maps and metadata
 - Quality control
 - Harmonization
 - Release of the global product

Geospatial Group (CBDS)

- Vegetation and salinity indices can be used for accessing soil salinity.
 - Salinity Index (SI)
 - Normalized Differential Vegetation Index (NDVI)
 - Normalized Differential Salinity Index (NDSI)
 - Vegetation Soil Salinity Index (VSSI)
 - Soil Adjusted Vegetation Index (SAVI)
 - ...
- The indices can be calculated using satellite images (Landsat, Sentinel, ASTER, IRS-1B, LISS-II ...). In combination with field data to find the correlation to the electric conductivity (EC) of the soil.
- Different natural conditions give different results. No specific vegetation or salinity index could be utilized for every natural conditions with proper results.
- High Spectral Resolution Satellite and UAV can be used to determine the salt fields but costly.

Geospatial Group (CBDS)

- Climate change scenarios, sea level rise scenarios (IPCC) can be model using specific applications
 - Global Climate Models (GCMs) and Regional Climate Models (GRCMs) and General Circulation Models
 - Sea Level Rise Viewer (<https://coast.noaa.gov/digitalcoast/tools/slr>)
 - Mike Flood
- ... in combination with elevation data to measure the salinity affected area.



Geospatial Group (CBDS)

- The modern technology using geostatistics, machine learning and data mining methodologies which has been used successfully for Soil Organic Carbon Mapping or SoilGrids
 - Regression kriging (RK)
 - Decision trees (DT)
 - Random forest (RF)
 - Artificial Neural Network (ANN)
 - Support Vector Machine (SVM)
 - ...
- Requirements:
 - Representative dataset for model calibration
 - Spatially exhaustive environmental covariates (factors affecting salinity)

Divan Vermeulen, Adriaan Van Niekerk, Machine learning performance for predicting soil salinity using different combinations of geomorphometric covariates <https://doi.org/10.1016/j.geoderma.2017.03.013>.

Geospatial Group (CBDS)

Main challenges of salinity mapping:

- Local and region-specific factors affecting salinity
- No universal method – all need local calibration
- Data availability on the global level

Country-driven approach?

Advantages:

- Best available data and expertise is used on local level
- Can incorporate different methods depending on locally available data and resources
- Global product consistent with local expectations
- The process builds capacity in the countries

Plant Production and Protection Division (AGP)

Crop Production/Protection on Saline Agriculture

- Yields are decreased directly when crops are grown under saline conditions due to the accumulation of salts in the soil solution (soil + water).
- Nutrients and water absorption is reduced by roots. Energy consumption is also reduced by plants affecting growth.
- The structure of soil is destroyed reducing the water holding capacity and drainage.
- Poor quality water, overuse of fertilizers (containing chlorine, sulfates or nitrates), poor water management and poor drainage are some of the main causes of salinization especially in arid and semi-arid regions.



Plant Production and Protection Division (AGP)

Management has to be integrated in order to prevent salinization:

- Field analysis testing soil and water for electro conductivity to know the concentration of salts and take actions.
- Apply organic matter regularly.
- Keep the soil with moisture. Avoid applying fertilizers and leave the soil to get dry.
- The use of salinity resistant varieties and grafting.
- The introduction of salinity resistance crops/plants with high nutritious and economic value.



Fisheries and Aquaculture Policy and Resources Division (FIA)

Alternative Livelihood

1. Saline aquaculture provides aquatic products and income for family farm in the saline land and water;
2. Artemia production is developed as business for the local farmer and community;
3. Integration of aquaculture and vegetable helped to produce double harvest and income for farmers, and provide job opportunities for youth and women.

Fisheries and Aquaculture Policy and Resources Division (FIA)

Improved soil and irrigation

1. Saline aquaculture helped water conservation and improved the irrigation system;
2. Saline water after aquaculture proved as lower salinity and pH, which is good for agriculture purpose;
3. Diversified utilization of saline water and soil improved the productivity and livelihood of local communities, particularly the role of youth and women.



Resilience Programme Management Team (SP5)

Disasters as Drivers of Salinization

1. Storms and storm surges, tsunamis, flash floods
 2. Droughts
 3. Sea level rise
- Salt intrusion both from below and above



Resilience Programme Management Team (SP5)

Disaster risk reduction and response - entry points to build resilience and reduce damage and loss from salinization

- Leaching (cleaning the soil with clean water)
- Sustainable land and water management
- Salt-tolerant crops
- Infrastructure development, e.g. construction of dams and water diversions
- Monitoring and research
- Capacity building

➤ Both effective **response** and **prevention** are needed for impact mitigation

Regional Office for Africa (RAF)

- In Sub-Saharan Africa (SSA), the most important challenge is related to soil degradation and desertification due to inappropriate soil management practices and deforestation.
- The two major characteristics of degraded soils in SSA are: soil nutrients depletion through erosion and excessive nutrient withdrawal by crops without replenishment and soil salinization due to inappropriate irrigation practices and inappropriate fertilization practices
- In SSA, saline soils are so far mainly located in coastal areas, dry lands and semi dry lands but they may increase with the significant increase of irrigated surface area.

Regional Office for Africa (RAF)

Recommendations

- FAO to support mapping of saline soils in SSA, starting by country assessment and country specific saline soil mapping.
- FAO to develop and disseminate technologies and guidelines for managing salt affected areas and saline soils for crop production and adopt salt tolerant crops for agriculture and livestock.
- FAO to support the development and dissemination of technologies for assessing and monitoring soil and water salinity.
- RAF doesn't have specific projects on Saline Agriculture but should start collaboration and partnership with International Center for Biosaline Agriculture (ICBA) which started to work closely with some Sub-Saharan countries to cope with salinity.

Subregional Office for North Africa (SNE)

Oases: resilient agricultural systems developed with saline water

- Optimum use of saline water is achieved through the adoption of intensive cropping systems with three layers: palm dates, fruit trees and annual or multi-year crops;
- Integration of livestock fed on crops grown with bio saline agriculture, allows humans to have food autonomy in these islands of life;
- Use of agro-ecological practices are favorable to the preservation of biodiversity and maintenance of the biological balance of oases.



Subregional Office for North Africa (SNE)

Conjunctive use of small amounts of saline water with rainfall are strengthening food security in arid areas

- Adopting deficit irrigation with saline water increases agriculture resilience and rainfall water productivity;
- Saline water can help produce off-season high quality vegetables and medicinal products in desert areas, increasing cash income for small producers;
- Forage crops, highly tolerant to saline water, help sustain small ruminant livestock during years of drought.

THANK YOU FOR YOUR ATTENTION

Looking forward to a fruitful collaboration!

