WELT HUNGER HILFE

AGRICULTURE WITH SALTY WATER

Agriculture with Salty Irrigation Water; an introduction

Question: Can you describe fresh water?

It tastes sweet/ has no taste, is clear in colour and may come from rain or snow melt.

Water is: an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless, and nearly colorless chemical substance.

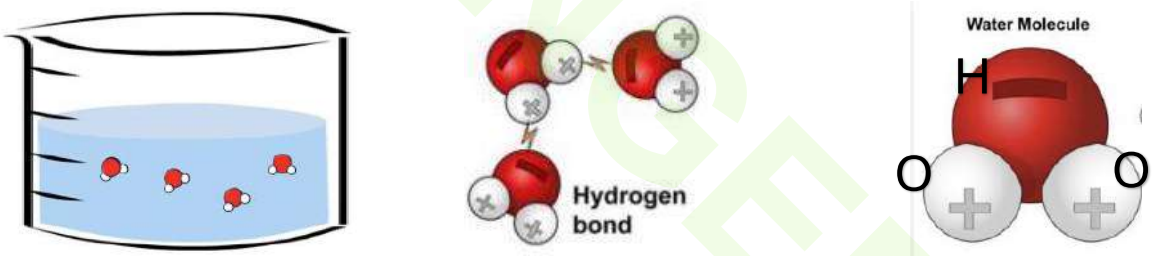
It is the main constituent of Earth's hydrosphere and the fluids of all known living organisms.

Question: Can you describe salty, dirty bitter water?

Tastes salty, bitter or metallinc, has colour. Is not clear, usually comes from underground or is stored underground.

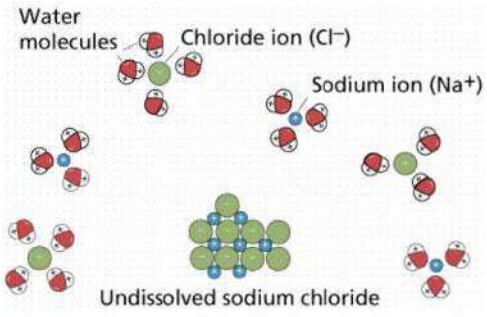
It does not provide food energy or organic micronutrients, but it is vital for all known forms of life. Its chemical formula, H_2O, indicates that each of its molecules contains one oxygen and two hydrogen atoms[1].

Diagram 1: Water, H_2O molecules



Salinity is caused by a range of salts made up of cations (positively charged ions e.g. sodium (Na^+), calcium (Ca^{2+}) and magnesium (Mg^{2+})) and anions (negatively charged ions e.g. chlorides (Cl^-), bicarbonates (HCO^{3-}) and carbonates (CO_3^{2-})) in the water.

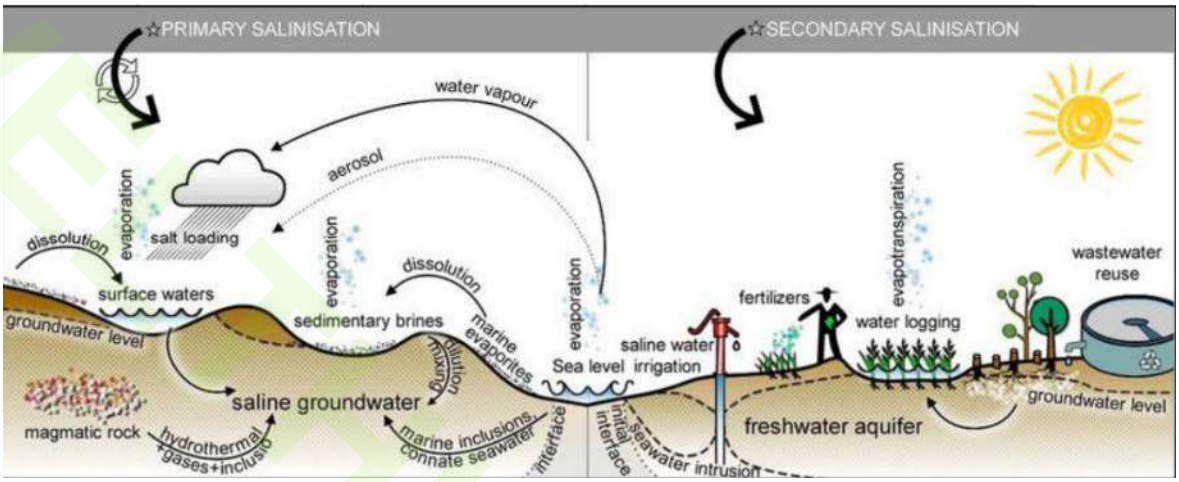
Diagram 2: H_2O with NaCl (table salt) molecules



[1] Water - Wikipedia

Salinity is a major natural resource issue. Its harmful effects include lost agricultural production, salinization of waterways and damage to infrastructure and environmental costs.

Diagram 3: Processes of Primary and secondary salinity



There are 2 main types of salinity[2]:

- Primary salinity - naturally occurring **in soils and waters.**
- Secondary salinity - resulting from human activities such as **land development and agriculture.**

Common forms of secondary salinity are:

- Irrigation salinity—occurs in irrigated areas, either as a result of rising groundwater tables (from excessive irrigation) or the use of poor quality water.
- Dryland salinity—occurs in non-irrigated landscapes, generally as a result of clearing vegetation and changes in land use.
- Point source salinity —occurs when large levels of salt in effluent from intensive agriculture and industrial wastewater, which contain salts.

In Afghanistan farming has traditionally been **rainfed**, with fresh water from rain (fresh water).

For irrigated agriculture, the water in the **irrigation canals** is usually quite fresh at the start because it comes from rainfall runoff and snow melt. However, as it flows through the irrigation canals on farmland it becomes more salty as fertilizers and salts in the soil are dissolved into it.

More recently farmers have been using solar pumps to **irrigate their fields with groundwater**. These bores and pumps access water with a wide range of water quality that can be fresh, saline or even contaminated with heavy metals. It is very important to test these waters before using them for irrigation, or they may increase soil salinity or cause toxicities in the soil, reducing the long term viability of agriculture in that place.

[2] Types of salinity | Environment, land and water | Queensland Government

Indicators of Salinity:

Changes on the ground

- Ground surface becoming permanently or seasonally waterlogged (or remaining damp) after extended periods of rain.
- Intermittent streams flowing for longer periods.
- Areas of bare soil—in worst case, crystals of various salts are present.
- Increase in salt-tolerant plants in an area.
- Deterioration in the quality of groundwater or surface water.
- Livestock rejecting water.
- Roads or concrete buildings deteriorating and crumbling.

Figure 1: Salt crystals on the surface between irrigation canals

Changes in vegetation

- Non-salt tolerant plants being replaced by salt-tolerant species.
- Vegetation dying in low-lying areas.
- Failure of plants to germinate or grow.
- Changing pasture composition and reduced diversity caused by the dominance from salt tolerant plants (such as couch grass).

Figure 2: Areas of bare soil where plants have failed to germinate

Problems with agricultural plant growth

Signs that plants may be suffering from too much salt in the water include:

- Stunted plant growth.

- Plant leaves having a blue-ish to green colour.
- Leaf burn and dead tissue along the outside edges of older leaves.
- Young leaves appear yellow.
- Plants look like they are wilting, even when they have enough water.

Figure 3: Impact of salinity on plant leaves

Figure 4: Impact of saline water on tomato plants

Why is salinity a problem to plants?

Ion toxicity: Some ions (particularly chloride) are toxic to plants and as the concentration of these ions increases, the plant is poisoned and dies. Ions like sodium (Na+) and chloride (Cl-)while necessary in small amounts, become detrimental in high concentrations. Sodium can disrupt enzyme function and interfere with the uptake of other essential nutrients, such as potassium (K+). Chloride, similarly, can accumulate to toxic levels in leaves, leading to leaf burn, necrosis, and premature leaf drop.

Reduced nitrogen uptake: Salinity also affects production in crops, pastures and trees by interfering with the uptake of nitrogen and other nutrients, uptake, reducing growth and stopping plant reproduction.

Dehydration: Water moves into plant roots by a process known as osmosis, which is controlled by the level of salts in the soil water and the salts in the water contained in the plant.

If the level of **salts** in the soil water is too high, water may flow from the plant roots back into the soil. This results in dehydration of the plant, causing yield decline or even death of the plant.

Diagram 4: The concept of osmosis

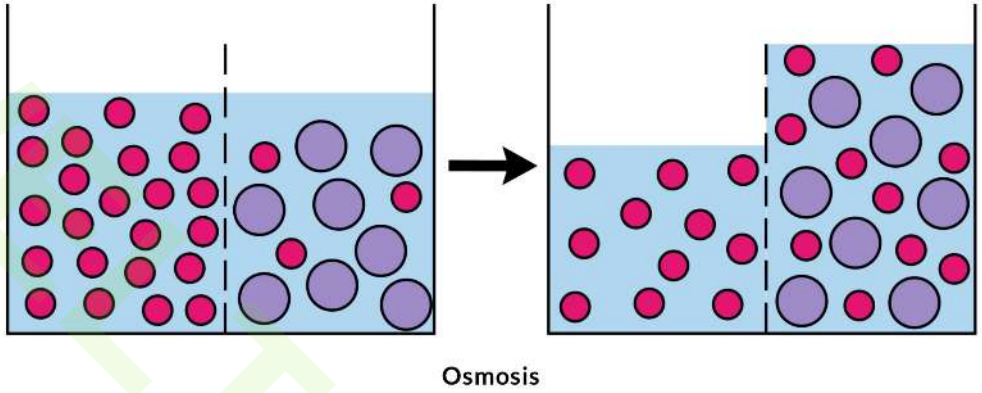
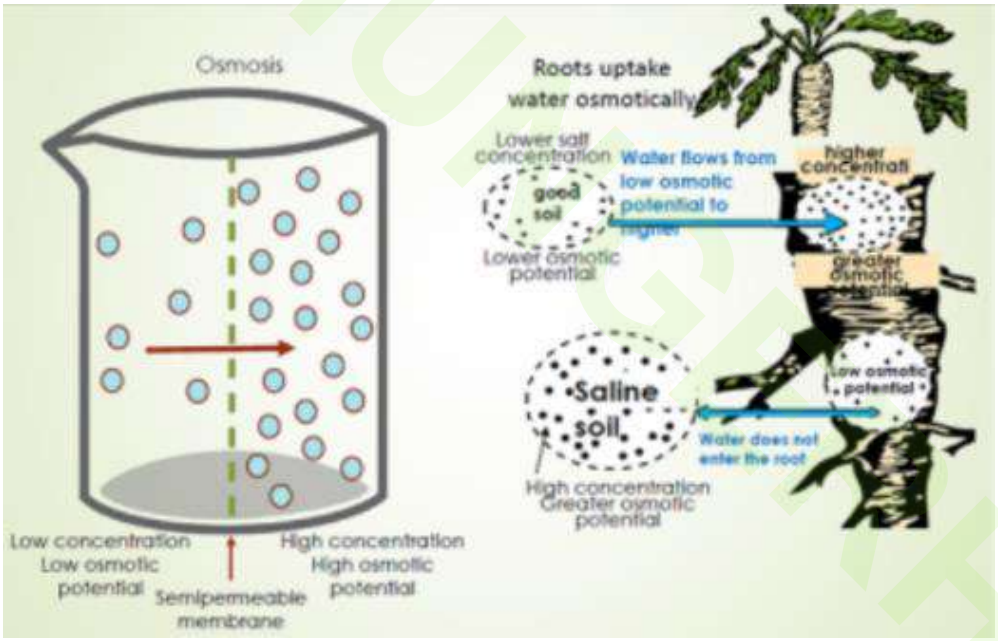


Diagram 5: Osmosis in plant roots in good soil and saline soil.



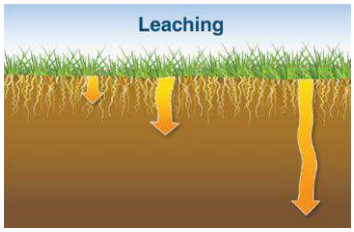
Crop yield losses may occur even though the effects of salinity may not be obvious. **The salt tolerance of a specific crop depends on its ability to extract water from salinized soils.**

Irrigation

All irrigation water contains some salts, which may remain on the soil surface or on leaves of plants after evaporation. Therefore, any irrigation system has the potential to deliver an increased amount of salt to the soil.

The problems from irrigating with saline water are greatest in drier environments, where rates of **evaporation** are usually very high. Salts are less likely to be leached from the soil in low rainfall areas and therefore **poor quality irrigation water with high levels of salts will have a greater impact on the soil.**

Leaching is the removal of minerals from the soil that have been dissolved in water.



Sodic irrigation water contains a high level of sodium salts compared to calcium and magnesium salts. It may result in soil dispersion, with consequent soil surface sealing, crusting, erosion, poor water entry and poor seedbeds.

Figure 5: Sodic soils

Methods to prevent primary salinity affecting agriculture[3]:

- Stop further loss of deep-rooted native vegetation in high-risk areas as well as areas that contribute groundwater to them.
- Retain and regenerate native vegetation.
- Avoid building reservoirs or dams at sites where the water table is high.
- Maintain good soil cover in rangeland areas through conservative stocking rates.

[3] Impacts of salinity | Environment, land and water | Queensland Government

Methods to prevent secondary salinity affecting agriculture[4]:

To reduce the impact of moderately salty water on crop production, consider the following;

- Salty irrigation water will be less of a problem in sandy soil than in clay soil.
- Plants are more impacted by salty water during germination and at the seedling stage than when they are fully grown. Farmers should irrigate with the best quality water available when plants are germinating and small.
- To wash salt away from the root zone of plants, irrigate more deeply, less often. This causes water to drain below the crops root zone. *The worst thing to do with salty irrigation water is to do light irrigation when the weather is hot. This will increase the amount of salt close to the plant roots.*
- Avoid fertilizers containing chloride.
- Drip irrigation allows water with a higher salt content to be used as there is less evaporation.
- Local experience also shows that holding salty water in a surface reservoir for several days before irrigation, reduces the impact of poor ground water quality on plants.

Testing and monitoring water salinity

One way to measure how salty soil or water is, is through measuring **Electrical conductivity (EC).**

Soil and water testing is necessary to confirm a salinity problem.

Pure water does not conduct electricity very well. It is the amount of ionized substances (or salts) dissolved in water which determines water's ability to conduct electricity.

EC measures a water samples ability to conduct an electrical current, which is used as a measure of the concentration of dissolved salts. Conductivity varies with the type of salt.

However, **EC cannot tell you WHAT ions or salt are in the sample**. For this, detailed soil and water tests should be done through a laboratory to determine the ions and their relative concentrations.

A higher EC indicates more dissolved ions and therefore potentially higher salinity.

Units for measuring EC are recorded as **the amount of electrical current** (deciSiemens, milliSiemens, microSiemens **by area** (metre or centimetre).

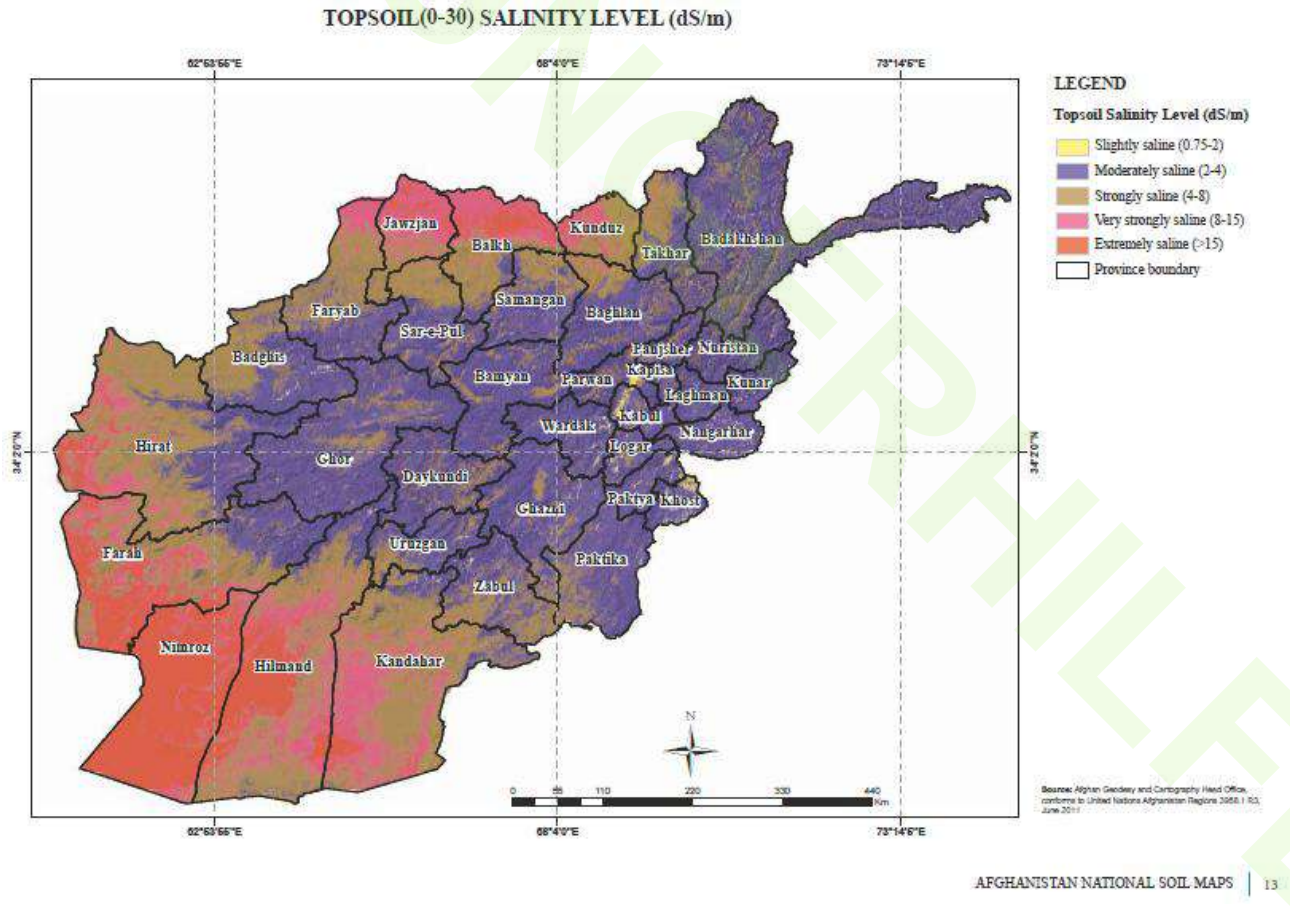
The preferred unit for electrical conductivity is deciSiemens/metre (dS/m), but it is measured in a range of other units as well. Table 2 shows how to convert between the different units.

[4] Managing Saline and Sodic Soils and Irrigation Water | USU

Conductivity values (for a soil saturation extract) may vary from 0.1dS/m (low salinity hazard) to >16.dS/m (very high).

Table 1: General Soil Salinity Classifications[5]

Soil extracts electrical conductivity (dS/m) or (mS/cm)	Salinity class	Crop sensitivity
0 - 2	Non saline	Suitable for most crops
2-4	Very slightly saline	Salt-tolerant vegetables, many grains, and forages
4-6	Slightly saline	Highly salt-tolerant plants
8-16	Moderately saline	Not suitable for crops
>16	Strongly saline	Not suitable for crops



[5] Natural Resources Conservation Service (1990)

Source: The IRA Soil Atlas, *Afghan Geodesy and Cartography Head Office, conforms to United Nations Afghanistan Regions 3958.1 R3, June 2011*

Method for measuring EC of water with a field EC meter

1. Calibrate the field EC meter according to the instructions in the box. Calibration is easier to do at the office, and should be done at least two times per month when in regular use, or when it has not been used for several months.
2. Take a clean sample bottle approximately 250 mL in size and rinse 3 times in the water to be sampled.
3. Fill the bottle more than half full.
4. Turn on the field EC meter and place in the sample.
5. When the EC number has stabilised (and a smiley face ☺ appears on the screen) record the number, being careful to note whether the units are µS/cm or mS/cm.
6. Clean the electrode of the EC meter with de-ionised water or distilled water.

Method for measuring EC of soil with a field EC meter

1. Calibrate the field EC meter according to the instructions.
2. Take a clean sample bottle (with a lid) approximately 250 mL in size, and fill approximately one quarter with the soil to be tested.
7. Add de-ionised water or distilled water almost to the top.
3. Put on the lid firmly and shake for several minutes until the soil and water are well mixed.
4. Let the sample settle for approximately 20 minutes.
5. Turn on the field EC meter and place in the sample.
6. When the EC number has stabilised (and a smiley face ☺ appears on the screen) record the number, being careful to note whether the units are µS/cm or mS/cm.
7. Clean the electrode of the EC meter with de-ionised water or distilled water.

The texture of the soil can influence salinity because of the degree of leaching of saline water through different soils. Different seasons can also influence the degree of salinity in a soil profile as winter rains can result in leaching. The degree of salinity for different soil textures is shown in Table 2: The degree of soil salinity (mS/M) from nil to extreme for sand, loam and clay soils[6].

Table 7. The degree of soil salinity (mS/m) from nil to extreme for sand, loam and clay soils. (Source: DPIRD, 2020).

Texture group	Soil salinity (mS/m)				
	Nil	Slight	Moderate	High	Extreme
Sand	0-15	15-25	25-50	50-100	>100
Loam	0-20	20-35	35-70	70-150	>150
Clay	-25	25-50	50-100	100-200	>200

[6] https://library.dpird.wa.gov.au/nrm_factsheets/26/ DPIRD 2020

Table 2: Conversion factors for measurements of soil and water salinity

The conversions are based on the estimate that 670mg of a mixture of salts in 1L of water will have a conductivity of approximately 1dS/m.

Soils and water salinity units	dS/m	mS/cm	µS/cm	mg/L or ppm	grains/gal
deciSiemens per metre (dS/m)	**–**	**1**	**1000**	**670**	**40**
milliSiemens per centimetre (mS/cm)	**1**	**–**	**1000**	**670**	**40**
microSiemens per centimetre (µS/cm)	**0.001**	**0.001**	**–**	**0.67**	**0.04**
milligrams per litre (mg/L) or parts per million (ppm)	**0.0015**	**0.0015**	**1.5**	**–**	**0.06**
grains per gallon (grains/gal)	**0.02**	**0.02**	**20**	**14**	**–**

Example: To convert dS/m to mg/L multiply it by 670—i.e. 7 dS/m = 4690 mg/L

Alot of detailed and practical information is available here: Contents and foreword—Salinity management handbook - Salinity management handbook - Publications | Queensland Government

آب کم نمک؛ گیاهان "حساس" به نمک

محصولات گیاهی

فاصلیه

زردک

شلغم

درخت‌ها/میوه

ناک

سیب

زردالو

آلوچه

سایر محصولات

کنجد

ماش

لوبیای سیاه

در خاکی که میزان نمک آن (EC) بین ۰ تا ۸۰ باشد، این محصولات قابل کشت هستند.

آب با شوری متوسط؛ گیاهان "نسبتاً حساس" به نمک

محصولات گیاهی


بادنجان رومی


بادرنگ


گلپی


کرم


جواری


پالک


بادنجان سیاه


کدو


کچالو

درخت‌ها/میوه


انگور


پسته


شفتالو


بادام


سیب**


ناک


آلوچه**

سایر محصولات


خربزه


رشقه


ماش

در خاکی که میزان نمک آن (EC) بین ۸۰ تا ۲۵۰ باشد، این محصولات قابل کشت هستند.

آب شور؛ گیاهان "نسبتاً مقاوم" به نمک

محصولات گیاهی	درخت‌ها/میوه	سایر محصولات
کدو سبز	انجیر	آفتاب پرست
		
بادنجان سیاه**	انار	گندم
		
کرم **	زیتون	جو
		
پیاز**	خربزه**	لوبیای سفید
		
سیر**		پنبه
		

در خاکی که میزان نمک آن (EC)بین ۲۵۰ تا ۵۰۰ باشد، این محصولات قابل کشت هستند.

آب خیلی شور؛ گیاهان "مقاوم" به نمک

محصولات گیاهی	درخت‌ها/میوه	سایر محصولات
قابل کشت نیست	زیتون روسی 	جو 
	انار 	پنبه 
		ارزن 
		گندم** 

در خاکی که میزان نمک آن (EC) کم‌تر از ۵۰۰ باشد، این محصولات قابل کشت هستند.

** الی ۲۵٪ کاهش محصولات