Salinisation

SALINISATION is the accumulation of soluble salts of sodium, magnesium and calcium in soil to the extent that soil fertility is severely reduced.

Salt affected soil often exhibits a white or grey salt crust on the ground. The pH of the soil is around 8.5 and the salt interferes with the growth of all but the most specially adapted plants (ED).

Salinisation, also known as alkalisation or sodification, is often associated with irrigated areas where low rainfall, high evapotranspiration rates or soil textural characteristics impede the washing out of the salts which subsequently build-up in the soil surface layers. Irrigation with high salt content waters dramatically worsens the problem.

In coastal areas, salinisation can be associated with the over exploitation of groundwater caused by the demands of growing urbanisation, industry and agriculture. Over extraction of groundwater can lower the normal water table and lead to the intrusion of marine water. Natural disasters in coastal areas, such as tsunamis, can cause severe salinisation problems with several years of low fertility of the affected soil before recovery.

In Nordic countries, the de-icing of roads with salts can lead to localised salinisation.

Salinity is one of the most widespread soil degradation processes on the Earth. According to some estimates, the total area of salt affected soil is about one billion hectares. They occur mainly in the arid–semiarid regions of Asia, Australia and South America. In Europe, salt affected soil occurs in the Caspian Basin, the Ukraine, the Carpathian Basin and the on the Iberian Peninsula. Soil salinity affects an estimated 1 million hectares in the European Union, mainly in the Mediterranean countries, and is a major cause of desertification. In Spain 3% of the 3.5 million hectares of irrigated land is severely affected, reducing markedly its agricultural potential while another 15 % is under serious risk.

Salt affected soil can be divided into five main groups:

- Saline soil (Solonchak) with high amount of water soluble soils.
- Alkaline soil (Solonetz), high alkalinity and high exchangeable sodium percentage (ESP).
- Magnesium soil: high magnesium content in the soil solution.
- Gypsiferous soil: strong gypsum or calcium sulphate ($CaSO_4$) accumulation.
- Acid sulphate soil: highly acidic iron or aluminium sulphate accumulation.

In Europe, the first two groups are the most significant (see Page 16 and the section in the Atlas on the major soil types of Europe for more details on saline soil).

The factors that determine the accumulation of salt in a soil are as follows:

- source of salt (local weathering, surface and subsurface waters, human activities);
- transporting agents accumulating salts from large areas to smaller deposits as well as from thick geological strata to thinner horizons (usually water, wind);
- limited vertical or horizontal drainage conditions;
- driving force for movement of solution, usually relief (surface runoff), hydraulic gradient (groundwater flow), suction (capillary transport) or concentration gradient (diffusion);
- negative water balance (evapotranspiration greater than precipitation).

Two main types of salt accumulation in soil can be distinguished in Europe:

- Continental salt accumulation due to intense weathering and arid climate or due to hydro-geological conditions (e.g. closed evaporative basins).
- Human induced salt accumulation due to improper land use (e.g. irrigation, fertilizer application).

The Carpathian Basin in Hungary is a good example of the first case. Surface runoff, seepage and groundwater transport soluble weathering products from a large water catchment area to the lowest part of the basin where subsurface waters, enriched with sodium, calcium and magnesium carbonate (salts), accumulate in a thick continuous aquifer. In poorly drained, low lying areas, capillary flow transports high amounts of water soluble salts from the shallow, stagnant groundwater to the overlying soil horizons. Due to the chemistry of the soil solution (strongly alkaline), the sodium is the dominant element in the migrating waters. High sodium saturation of heavy-textured soil with large amount of expanding clay minerals results in unfavourable soil properties and limits their fertility, productivity and agricultural utility.

Salinity as an environmental stress and limiting factor for agriculture.

The accumulation of salts, particularly sodium salts, are one the main *physiological* threats to ecosystems. Salt prevents, limits or disturbs the normal metabolism, water quality and nutrient uptake of plants and soil biota. When water containing a large amount of dissolved salt is brought into contact with a plant cell, the protoplasmic lining will shrink. This action, known as plasmolysis, increases with the concentration of the salt solution. The cell then collapses. In addition, sodium salts can be both caustic (corrosive) and toxic (poisonous) to organic tissue. The nature of the salt, the plant species and even the individuality of the plant (e.g. structure and depth of the root system) determine the concentration of soil-salt levels at which a crop or plants will succumb. Examples of plants and crops with a high tolerance to salt include bermuda grass, cotton, date palm, peas, rape and sugar beet while apples, lemons, oranges, potatoes and most clovers have a very low tolerance.

One of the main characteristics of salt affected soils is their temporal variability. Prolonged rainfall can lead to a temporary leaching of salt from the surface layers. In many salt affected areas, small ponds are dug to drain the saline water from the soil thus allowing limited agriculture on other parts of the land. The white deposits on the bank of the pond are evaporated salt crystals (EM).

Salinization processes are near to irreversible in the case of heavy-textured soils with high levels of swelling clay. Although a combination of efficient drainage and flushing of the soil by water is often used, the leaching of salts from the profile is rarely effective

Because the reclamation, improvement and management of salt affected soils necessitates complex and expensive technologies, all efforts must be taken for the efficient prevention of these harmful processes. Permanent care and proper control actions are required. Adequate soil and water conservation practices, based on a comprehensive soil or land degradation assessment, can provide an "*early warning system*" that provides possibilities for efficient salinity (or alkalinity) control, the prevention of these environmental stresses and their undesirable ecological, economical and social consequences.

What is salinity?

Salinity is the degree to which water contains dissolved salts. Salinity is usually expressed in parts per thousand or grams per thousand grams. Normal seawater has a salinity of 33 parts per thousand. This rises to 40 parts per thousand in the Red Sea.

Soil salinisation in coastal areas affected by tsunami tidal waves

One of the long term effects of tsunami waves is the deposition of salty seawater on large flooded areas with consequent salinisation of soils. Depending on the climatic conditions, these effects can be temporary and the soils may recover rapidly by washing out the infiltrated salt deposits through heavy rainfall. In more arid or sub-humid areas the salinisation effects can on the other hand last for several years. Depending on the type of crops cultivated in the area and their resistance to salinisation there can be serious consequences on long term agricultural production and food security in the affected area.

The 9 magnitude earthquake that occurred at 00.58 UTC on 26th December 2004 at the interface between the India and Burma plates off the west coast of Northern Sumatra, Indonesia, triggered massive tsunamis that affected several countries throughout south and south east Asia (India, Bangladesh, Mynamar, Sri Lanka, Indonesia, Maldives and Thailand) as well as in East Africa (Somalia, Kenya, and Tanzania). The total inundated zone is estimated at ca. 60 000 sq. km. Soils of these areas have been affected by erosion and scouring that modifies the topography, land leveling and the elimination of bunds (for paddy fields), soil fertility losses when upper layer is washed away, deposition of salted sediment, salt infiltration and trash and debris accumulation. Recovery of the affected areas will require several years in some areas lacking sufficient rainfall for rapid outwash of accumulated salts and will be an additional burden to the local population.