Food and Agriculture Organization of the United Nations

The multi-faced role of soil in the Near East and North Africa

GLOBAL SOIL PARTNERSHIP

POLICY BRIEF

Key messages

- In the most arid region of the world, the Near East and North Africa (NENA) region, water scarcity issues are foreseen to increase in the coming decades;
- Green water comes from precipitation and is stored in the topsoil and root zone;
- Green water flows are dominant in the hydrological cycle of arid and semi-arid regions where they can lead to major changes in downstream water flows;
- Green water is fundamental for rainfed agricultural systems and for the recharge of aquifers, but if soils are degraded water is lost by runoff instead of being stored. This increases the risk for erosion and flooding;
- Sustainable soil management practices improve green water infiltration and retention and increase water use efficiency and productivity;
- In drylands or savannah regions, the increase of green water use from 10 –30 percent to 50 percent lead to significant increases in yields;
- Green water should be included in the national water budget;
- Awareness should be raised on the link between soil and water as their management cannot be addressed separately.

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Soils and green water

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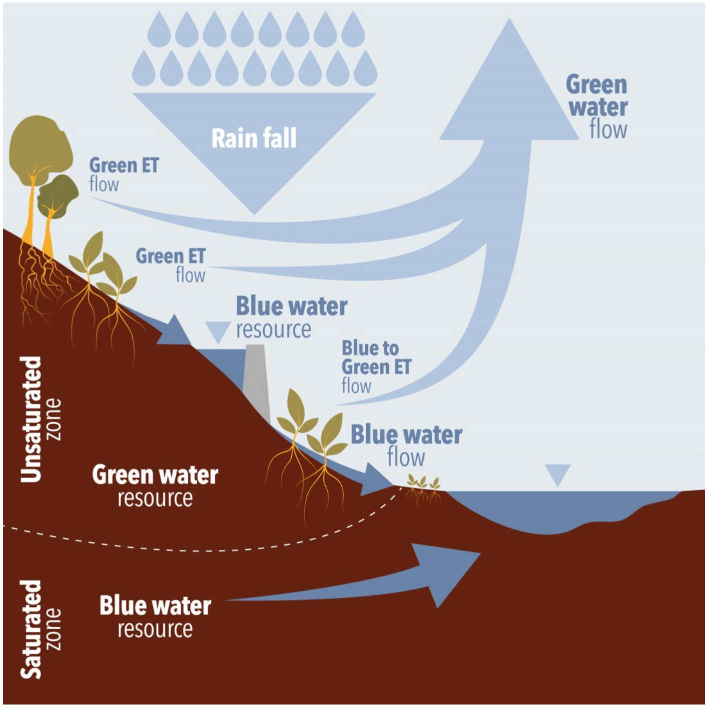
Background

In the Near East and North Africa (NENA) region, the rate of per capita renewable freshwater is less than 10 percent of the world average (FAO, 2017a). The most water-stressed countries in the region (< 100 m^3 of water per capita per year) are Bahrain, Kuwait, Qatar, KSA, UAE and Yemen, followed by Algeria, Jordan, Libya, Palestine, Oman, Syria and Tunisia (100–500 m^3 of water per capita per year), Egypt and Morocco (500–1 000 m^3 of water per capita per year) and Iran, Iraq, Lebanon, Mauritania and Sudan (> 1 000 m^3 of water per capita per year) (FAO, 2015). Although 85 percent of the renewable fresh water resources of the region are currently used for irrigated agriculture, competition for the use of this resource between sectors (industrial, municipal and agricultural) is increasing (FAO, 2017a). In the coming decades, water scarcity issues will increase in the region due to several drivers related to demography, food security policies, conflicts, overall socio-economic development and climate change (FAO, 2017b). According to ACSAD (2013), rapid population growth made the rate of per capita freshwater plummet from 3 500 m^3 to less than 1 000 m^3 in the Arab Region in the last 50 years. Actions to preserve and sustainable manage this scarce resource are urgently needed.

Blue versus green water

Water is not only stored in rivers, lakes and reservoirs (**blue water**) but also in the fragile topsoil layer and root zone (**green water)** (Sood *et al.,* 2014). The water cycle itself makes a distinction between blue and green flows (Maimbo *et al.,* 2007).



Continental precipitation in terms of green water and blue water (modified from Falkenmark and Rockström, 2006)

Rainfed agriculture is the predominant farming system in NENA and is based on the use of green water. Irrigation agriculture is also practiced and is based on the use of green and blue water (FAO, 2015). Green water flows are dominant in the hydrological cycle of arid and semi-arid regions where they can lead to major changes in downstream blue water flows. In this regard, it is important to manage water resources at the catchment level, with consideration of the linkages between green and blue water flows and the role that soils and land play in it (Jewitt, 2006).

Because of global warming, the precipitation rate in arid and semi-arid regions is expected to decrease by more than 20 percent in the next century and rainfall events to become more erratic and violent (Misra, 2014). With less blue water available, it is still possible to build water resilience and cope with water scarcity by increasing green water use efficiency (Hsiao *et al.,* 2007; Rockström *et al.,* 2009). Soil degradation (especially soil compaction) greatly limits the potential of green water as rainfall infiltration is dramatically reduced (FAO and ITPS, 2015).

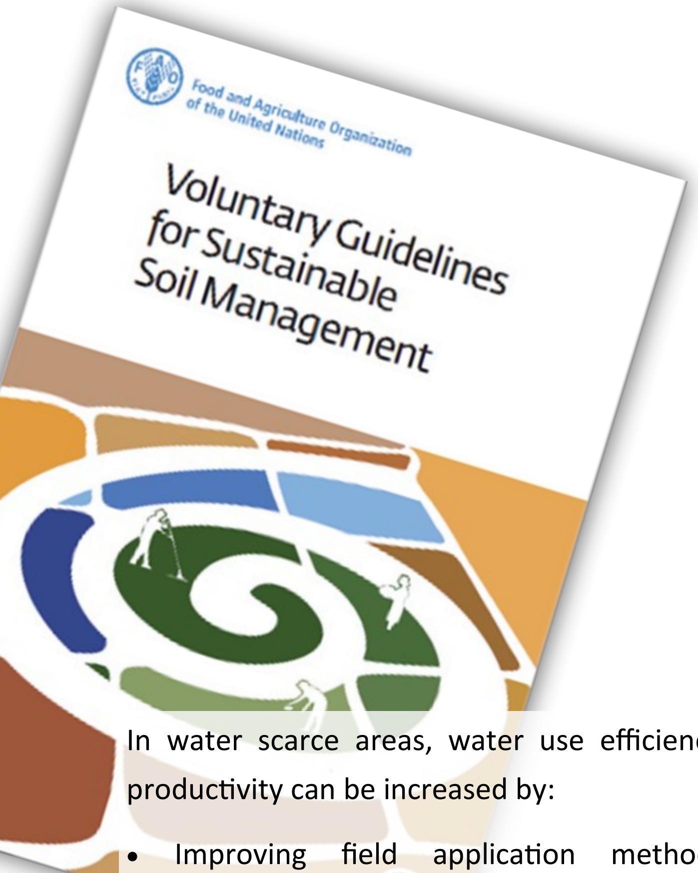
Improvements of the soil-water management system may lead to reduction of the evaporation rate (unproductive green water) and to the increase of the transpiration rate (productive green water) (Falkenmark and Rockström, 2006). Ultimately, an increase of the green water use from 10–30 percent to 50 percent can lead to significant increases in yields (Hsiao *et al.,* 2007; Rockström *et al.,* 2009). Improvements in water productivity, or the crop yield produced per unit input of water consumed (Cai *et al.,* 2011), can decrease the water requirements for food production in 2 050 by almost 2850 $km^3\ yr^{-1}$, with savings of 725 $km^3\ yr^{-1}$ of blue water from irrigation and 2 125 $km^3\ yr^{-1}$ secured through green-water resources such as rain-fed agriculture (Hsiao *et al.,* 2007; Rockström *et al.,* 2010).

Depending on the situation, three strategies referring to three different water sources can be implemented to improve food security. Based on Rockström *et al.* (2009):

Strategy	Application
⇒ Increase the use of **blue-water** resources	Doable as long as it does not stress water scarcity issues and does not harm aquatic ecosystems or land subsidence
⇒ Expand rain-fed agriculture (**green water** based) into native terrestrial ecosystems and rehabilitated wastelands	Doable in countries that can expand green-water resources for food production. Attention should be paid not to affect biodiversity and increase local runoff
⇒ **Virtual water** imports also through national and international trades of agricultural products	Doable in countries that are already chronically blue- and green-water-short

Sustainable soil management: a solution to water scarcity

As stated in the Voluntary Guidelines for Sustainable Soil Management (VGSSM) (FAO, 2017c), sustainably managed soil has rapid water infiltration, optimal soil water storage of plant available water and efficient drainage when saturated. However, when these conditions are not met, waterlogging and water scarcity problems arise.



In water scarce areas, water use efficiency and productivity can be increased by:

- Improving field application methods of irrigation water (for example scheduled drip or microsprinkler irrigation) that reduce evaporation and percolation losses of irrigation water, as well as through better soil water reserve estimation, better species or variety choices, and better computing of water loading periods and amounts applied within the plant root zone.
- Managing soil cover (for example previous crops, forage and fallow) and water harvesting to increase soil water availability at sowing, reducing topsoil runoff and evaporation rate, and ensuring that there is adequate water available at each stage of crop development. These measures often involve trade-offs and risks that should be recognized and managed;
- Retain crop residues on the soil surface to act as mulch which also can control weeds and minimize/avoid the use of herbicides;
- Optimizing the soil water extraction by the crop through the selection of appropriate cultivars and careful timing of agronomic operations; and
- Regularly monitoring irrigation water quality for nutrients and potential harmful substances.

In Oman, a study conducted in a palm tree plantation proved that the use of subsurface drip irrigation systems contributed to save up to 40 percent water without reducing fruit production. Under these conditions, water productivity also increased by 53 percent compared to bubbler irrigation system (MAF, 2016).

Dripping irrigation, Lebanon

Other techniques that increase the green water in the soil are:

Zero tillage

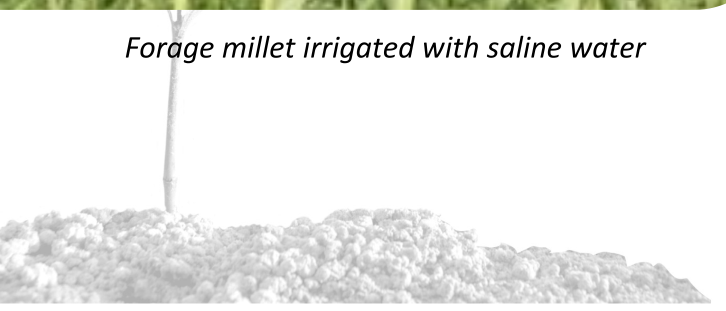
Laser land-leveling

Crop residues on the soil surface

Mulching

Forage millet irrigated with saline water

Water harvesting to capture water



Act now!

- Increase the productivity of green water per unit of land by using better cultivars and by implementing better soil management practices;
- Include green water in national water budgets. At present, countries focus their water resources management and planning on blue water;
- Care about the soil! Water management cannot be separated from soil management. Soil and water are a continuum.
- Raise awareness on the importance of sustainable soil management for water use efficiency and productivity;
- Train farmers on the practice of sustainable soil management;
- Endorse, monitor and implement agricultural policies aiming to improve soil quality and its ability to retain water;
- Promote research and development activities for enlarging existing databases on the connection between soil management, land use and water use efficiency, and for introducing innovative technologies on the management of the water-soil system in agriculture.

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