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nexus

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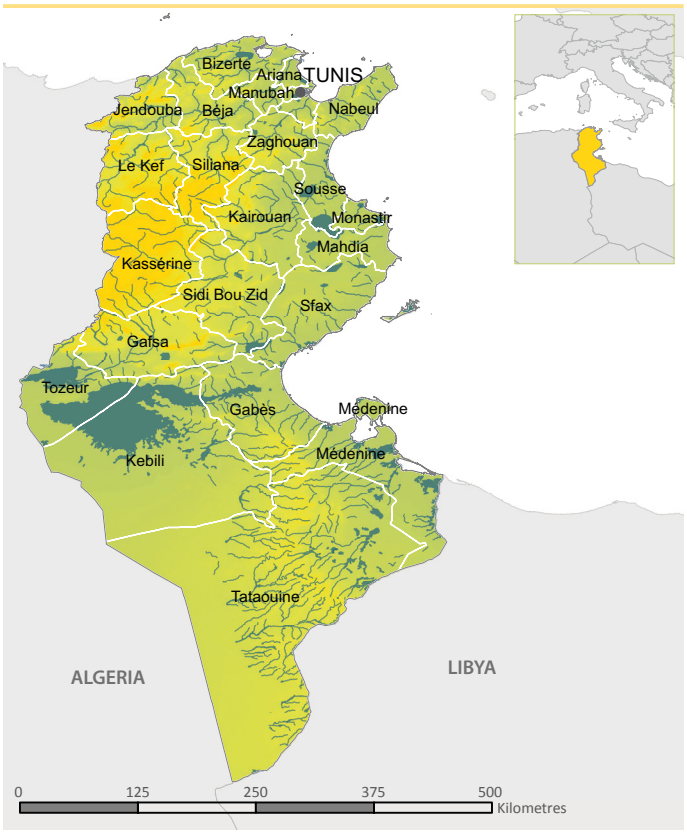
The Water-Energy-Food Security Nexus Country Profile

- Tunisia is located from 30°N to 37°N in northern Africa; it shares borders with Algeria to the west and Libya to the east. The Mediterranean Sea lies to the north of the country.
- Four geographic regions exist in the country: the mountainous north-east, the southern mountains of lower altitude, the eastern coastal plains and the desert plains in the south-west which are home to several chotts (i.e. salt lakes that remain dry for much of the year) [1].
- The climate is essentially Mediterranean with mild rainy winters and hot dry summers. The predominant land covers are cultivated crops, rangeland, permanent grassland, forests, steppes, wetlands and desert lands [1][2].
- After the uprising during the Arab Spring, the country held its first democratic elections in 2011 [3].

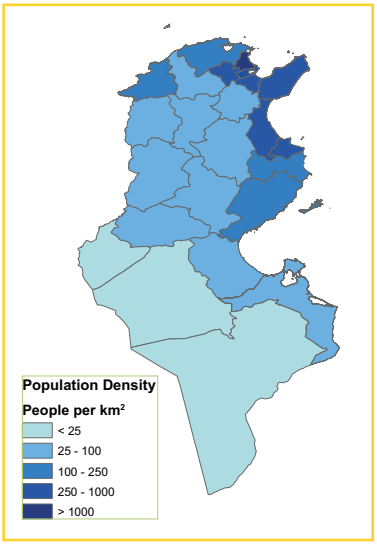


LEGEND:

- Governorate boundaries
- Rivers
- Water bodies
- Capital city
- max: 1441
- Elevation (masl)
- min: -39

Data from [4][5]

POPULATION DENSITY



Highlighted Nexus-related challenges faced by Tunisia:

- The rate of groundwater extraction in many aquifers is unsustainable [6]. This problem is exacerbated by an inconsistent institutional framework to ensure the sustainability of groundwater use and unauthorised drilling for aquifer exploitation [7].
- Although the implementation of solar pumping irrigation systems encourages renewable energy use, there is a risk of increased groundwater overexploitation [7].
- Tunisia has a high energy balance deficit and electricity production is highly dependent on imported natural gas [7][8]. The country seeks to achieve a renewable energy target of 30% of the electricity generation mix by 2030, with the diversification of the energy mix aiming to improve energy security [9].
- Agricultural production is very vulnerable to drought, especially in the northern regions, where 97% of the cereal crops are rainfed [10].
- Energy demands are high for irrigation, water transfers, pumping from deep aquifers, desalination processes and wastewater treatment [7].
- Uncontrolled land use practices are contaminating aquifers in the country and inefficient agricultural techniques contribute to the overexploitation of water resources [7][11].

GENERAL INFORMATION

163,610 km² Size [12]

11,532,100 Population (2017) [12]

1.1% Population growth
annual (2017) [12]

68.6% Urban Population (2017) [12]

40.3 billion US$ Total GDP (2017) [12]

3,500 US$ GNI per capita[i] (2017)
World average: 10,366 [12]

2.0% Poverty headcount ratio at $1.90 a day (2010) [12]

0.358 Gini coefficient[ii] (2010) [12] [13]
Ranked the 39th most unequal of 158 countries rated

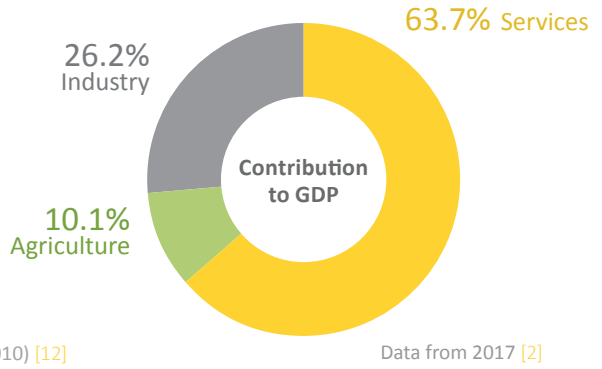
0.735 HDI[iii] (2017)
Ranked 95th of 188 countries rated [14]

98.6% School Enrolment, Primary (2013) [12]

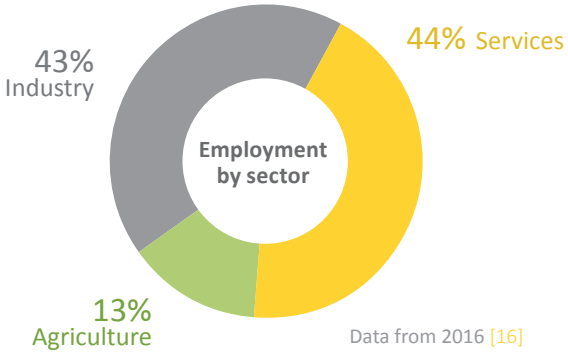
79.0% Literacy rate[v] (over 15) (2014) [12]

75.7 years Life expectancy (2016) [12]

11.2% Infant mortality rate (2017) [12]

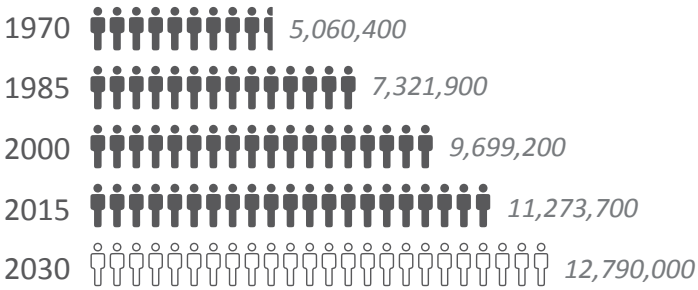


Data from 2017 [2]



Data from 2016 [16]

Population growth[vi]



Data from: [12][15]

- The overwhelming majority of the population live in the northern half of the country, predominantly along the coast [5].
- The percentage of people living in urban areas continues to rise. In 1970, only 44% of the population lived in urban areas. This number was 68.6% in 2017 and is projected to be 77% by 2050 [17].

- The poverty rate (at $1.90 per day) has dropped from 10.9% in 1995 to just 2.0% in 2010 [12].
- Tourism plays an important role in the Tunisian economy, representing a direct contribution of 6.6% to the country's GDP in 2016 (a total contribution to GDP of 13.7%) [18]. Tourism numbers dropped in 2016 following two major terrorist attacks in 2015, but since then, the sector has recovered [19][20].
- The ongoing civil war in neighbouring Libya is concentrated near the border region with Tunisia. The regional instability, security threats, impacts on trade and closure of crossings have acted as destabilising forces on Tunisia [21].
- Although progress has been made with the political transition to a democratic governance after the 2011 uprising, internal constrains have slowed economic recovery [22].

i. The gross national income (GNI) is the sum of a nation's gross domestic product and the net income it receives from overseas.

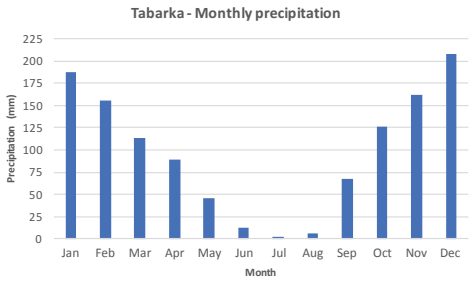
ii. The Gini coefficient is used as a gauge of economic inequality, measuring income distribution among a population. The coefficient ranges from 0 to 1, with 0 representing perfect equality and 1 representing perfect inequality.

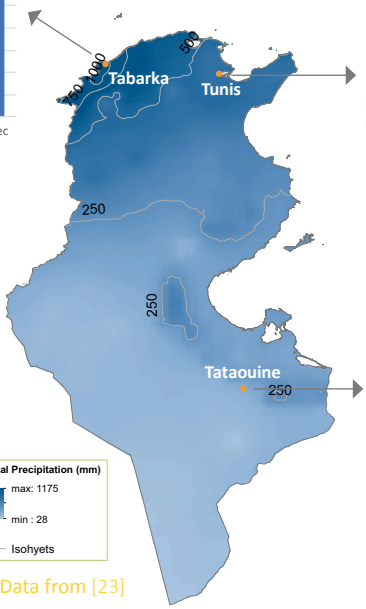
iii. The Human Development Index (HDI) measures a country's overall achievement in social and economic dimensions, using life expectancy, education and per capita income indicators.

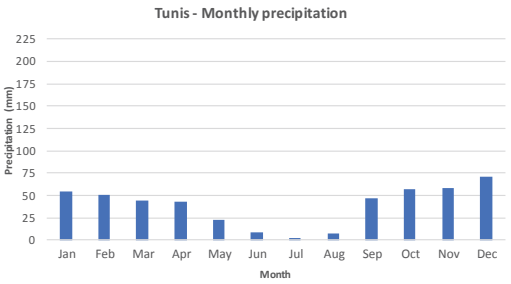
WATER SECTOR

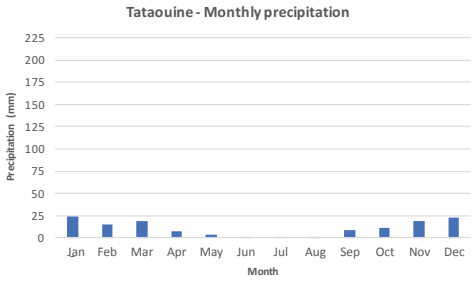
Due to precipitation patterns, surface water availability is considerably higher in the northern part of the country, especially in the Medjerda River Basin, which originates in Algeria [6]. Over 60% of the water consumption is extracted from groundwater [1]. Water transfers from supply areas or desalination are needed to meet demands along the highly-populated coastline [17]. The renewable water resources per capita are expected to drop from 419 m^3/person/year in 2015 to 300 m^3/person/year by 2030 [7].

28 to 1,175 mm	Annual precipitation *(average of 223 mm)* [23]
4,195 x 10^6 m^3/yr	Internal renewable water resources[iv] [1]
420 m^3/yr	Internal renewable water resources per person (2013) [1]
3,305 x 10^6 m^3/yr	Total water consumption (2011) [1]
9%	Water dependency ratio[v] [1]
94.2%	Population with access to improved drinking water sources (2015) [12]
93.1%	Population with access to improved sanitation facilities (2015) [12]
2,677 x 10^6 m^3	Total capacity of dams/reservoirs (2012) [1]



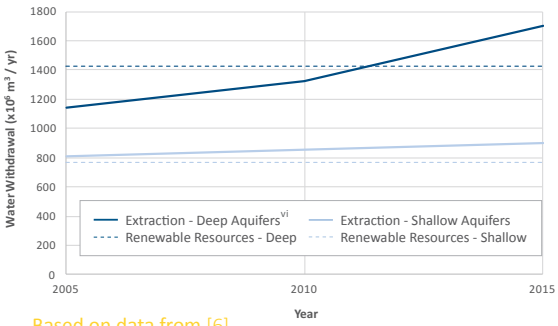






Water availability: Projections under the A2 climate scenario indicate that the frequency of droughts will increase by 10 to 30% by 2050 and that conventional water resources will decrease by about 28% from 1961 to 1990 levels. More efficient water conservation strategies and programmes of activities have been identified as necessary to ensure future water demands are met [24].

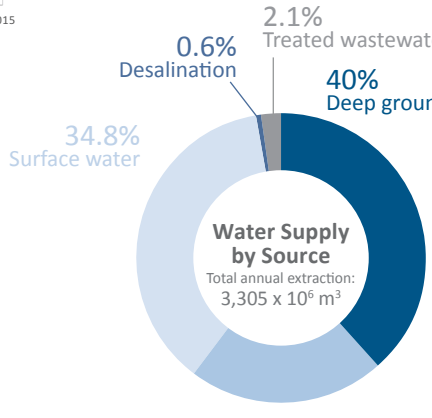
Data from [23]



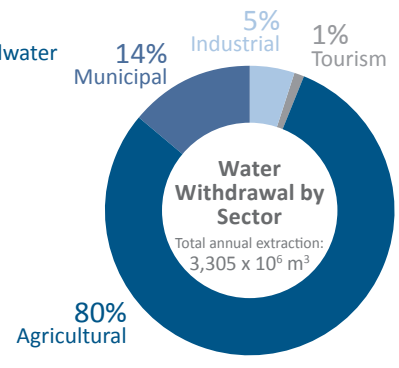
Based on data from [6]

- The Société Nationale d'Exploitation et de Distribution des Eaux (National Water Operation and Distribution Company, SONEDE) is responsible for the production and distribution of drinking water [7].
- The Office National de l'Assainissement (National Office for Water Sanitation, ONAS) is responsible for sanitation, which includes wastewater treatment [7].

Aquifers in the centre of the country are the most overexploited of the groundwater sources [6]. There is an inconsistent institutional framework to ensure the sustainability of groundwater use, [7] and furthermore, uncontrolled land use practices are contaminating aquifers in the country [11]. Unauthorised drilling for aquifer exploitation is also abundant [7].



Data from 2011 [1]



Data from 2011 [1]

[iv] The internal renewable water resources are the part of the water resources (surface water and groundwater) that is generated from precipitation within the country.

[v] The water dependency ratio is defined as percentage of total renewable water resources that originate outside of the country.

[vi] Approximately 47% of the listed deep resources are considered non-renewable [6].

ENERGY SECTOR

The electricity sector in Tunisia has a very high dependence on natural gas, much of which is exported from Algeria. The system is also characterised by a lack of large storage capacities and a high daytime peak demand in the summer months [7].

2.59 metric tonnes per capita CO_2 emissions
world average: 4.97 (2014) [12]

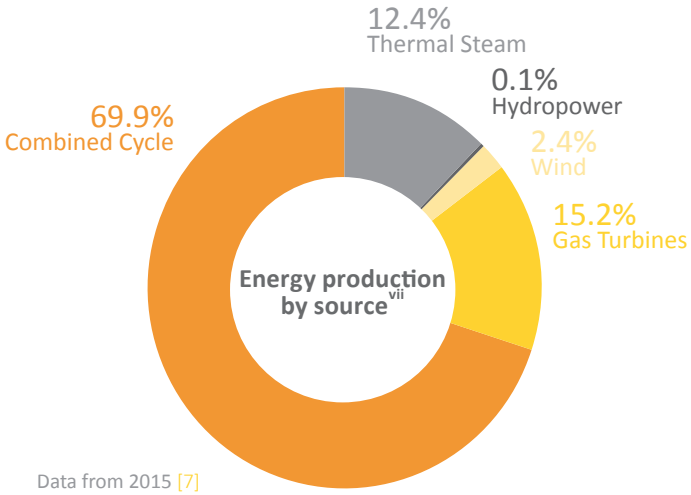
1,444 kWh per capita Electric power consumption
world average: 3,125 (2014) [12]

15,655 GWh Total electric power consumption (2016) [25]

19,133 GWh Total electricity production[vii] (2016) [25]

37 GWh Net imported electricity (2017) [25]

100% Percentage of population with access to electricity (2016) [12]

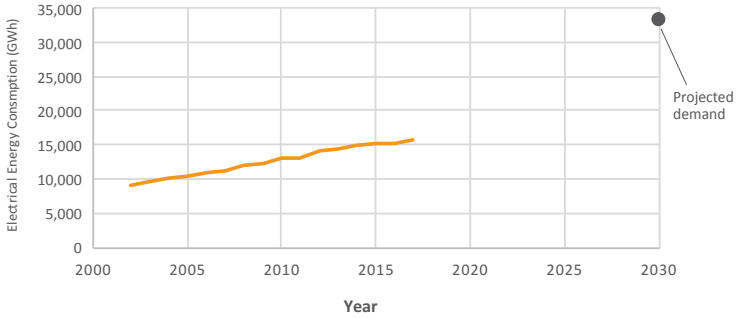


Data from 2015 [7]

Tunisia has a single public utility, the Société Tunisienne de l'Electricité et du Gaz (Tunisian Company for Electricity and Gas, STEG) that has the monopoly on transmission, distribution, import and export of electricity and gas. STEG remains the single buyer, but independent power production has been permitted since 1996 [26]. In 2017, 80.8% of the national electricity production was from STEG and 18.6% from the Carthage Power Company (CPC). In 2017, 97.5% of power was produced from conventional sources [25].

After being an energy net exporter for decades, Tunisia's energy balance deficit has grown substantially over the last decade, reaching 4,033 million Tunisian dinars (approximately 1.7 billion USD) in 2017, representing approximately a quarter of the country's total trade deficit [8]. Due to the high importation levels for its energy needs, the security of energy supply is of critical importance. There are also initiatives which plan to connect Tunisia to regional European grids [7].

Historical and Future Electricity Consumption[viii]



Based on [25][28][29][30]

Although the reliance is currently almost exclusively on fossil fuels, Tunisia aims for a carbon intensity reduction of 41% by 2030 compared to the 2010 base year [27]. Tunisia's Solar Plan (formulated in 2012 and revised in 2015) seeks to achieve a renewable energy penetration target of 30% of the electricity generation mix by 2030 [9].

Energy consumption by sector

Data from 2015 [7]

vii. This graph only considers power generated by STEG and CPC, which accounted for 99.4% of generated power in 2017.

viii. The electricity consumption projection shown for 2030 assumes a higher growth rate than the projections from STEG [30].

FOOD AND AGRICULTURAL SECTOR

The relief and geomorphology of Tunisia allow it to dedicate a large amount of the land area to agricultural land (64.8% of the land area is currently used for agricultural purposes). Permanent cultivation only exists on approximately 15% of the land [31].

1,309 million US$ Food exports (2014) [32]

2,144 million US$ Food imports (2014) [32]

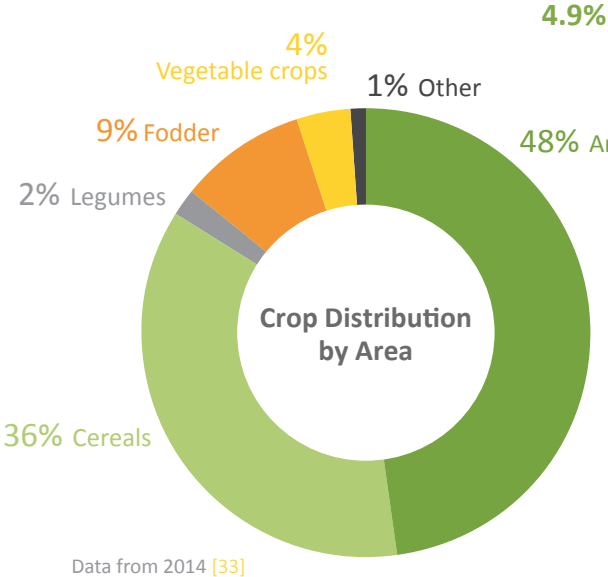
101,000 km² Cultivated area (2014) [32]

4,085 km² Irrigated area (2014) [32]

32.8 kg per hectare of arable land Fertiliser use
world average: 138 (2015) [12]

10.1% of GDP Value added by agriculture (2017) [2]

4.9% of population Prevalence of undernourishment (2016) [12]

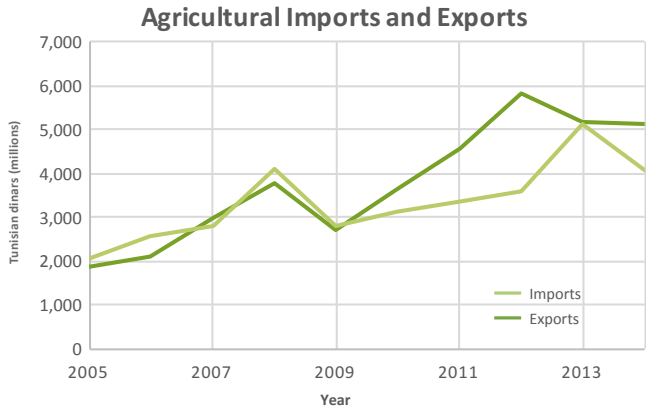


Data from 2014 [33]

The agricultural land is divided into three natural areas, thus enabling a diverse range of agricultural products broadly categorised by [1]:

- Cereals and fodder in the north
- Predominantly olive plantations in the centre
- Predominantly date palms in the south

Over 97% of the cereal production is grown under rainfed conditions, making the production highly vulnerable to drought. The latest drought in 2015-2016 caused a drop in cereal production of 43% compared to the previous season [10].



Based on data from [31]

In only four of the fifteen years from 2000 to 2014 have the agricultural export receipts covered the import expenditures. From 2013 to 2014, olive oil and dates made up 29% and 17% of the agricultural exports, respectively [31].

- More than 75% of the farms in Tunisia are less than 10 ha in size [33].
- Since the revolution in 2011, various inefficiencies in the agricultural sector have caused large variations in agricultural production. Surpluses of certain products have also occurred in some growing seasons [34].
- Organic farming areas have increased significantly, from only 300 ha in 1997 to 220,000 ha in 2015 [33].

ENVIRONMENT

- Solid waste management problems have been prevalent in the urban centres, particularly revolving around collection and removal [35]. In 2017, there were 119 wastewater treatment plants in the country [7]
  - Despite the high identified potential for reusing wastewater for irrigation and the "Safe Use of Wastewater in Agriculture" initiative led by UNU-FLORES, minimal progress has been made in large-scale use of wastewater for this purpose [7]
  - Using treated wastewater for groundwater recharge remains at the pilot stage and is being tested for two groundwater aquifers [7]
  - Less than 3% of wastewater in Tunisia is reused [36]

7% of total land area Forest areas (2014) [32]

7.9% of total land area Protected land areas (2017) [12]

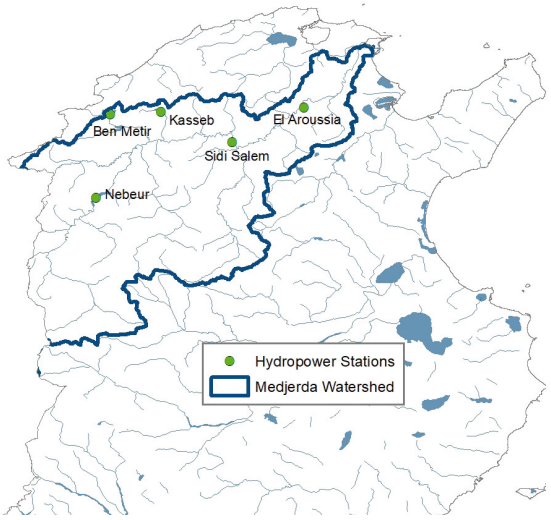
1.0% of territorial waters Protected water areas (2017) [12]

- Various forms of pollution, especially nitrate, are affecting water quality in aquifers [11][7]
- Tunisia is susceptible to losing up to half of its arable lands due to erosion and desertification by the year 2050 [7]. Estimates show that this would have pronounced effects on country's GDP [31]

WATER - ENERGY INTERCONNECTIONS

Water for Energy

All five hydropower plants are located in the north of country within the Medjerda watershed [1]. During the period 2005 – 2016, hydropower plants had a combined annual average production of approximately 70 MW. This energy generation corresponds to less than 1% of the total production of the country [7].



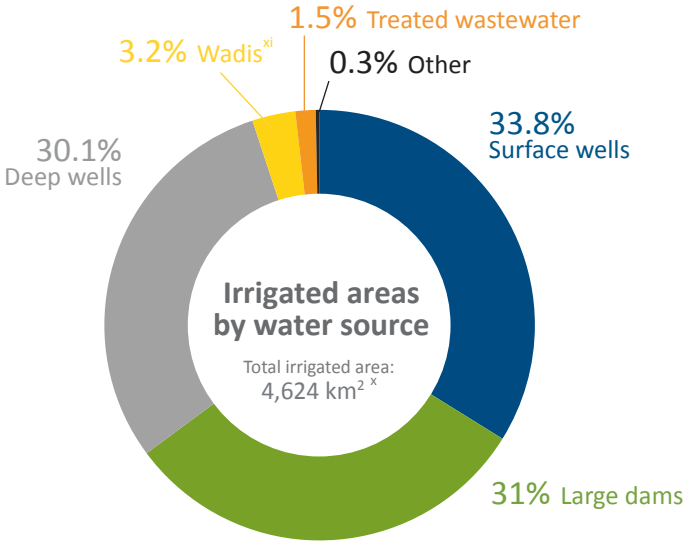
Based on data from[1][37]

Energy for Water

- Energy demands are high for irrigation, water transfers, pumping from deep aquifers, desalination processes and wastewater treatment. More than a quarter of the SONEDE network is more than 37 years old, water leaks are prevalent and the network efficiency in 2017 was only 71.5%. Rehabilitation of the network takes place at approximately 200 km per year (the total network length exceeds 53,000 km) and is needed to conserve water and electrical energy [7].
- The use of solar energy systems, such as solar pumping irrigation systems, have facilitated access to water resources and solutions for desalination systems [7].
- In addition to brackish water desalination, Tunisia is also moving towards seawater desalination to meet the drinking water needs of coastal areas. By 2020, desalination is expected to supply a drinking water potential of 80 x 10^6 m^3/yr (in 2011, the total municipal water use was 463 x 10^6 m^3) [1][7].

WATER - FOOD INTERCONNECTIONS

Tunisia currently has 115 Wastewater Treatment Plants, which produce 270 Mm^3 per year. Due to their quality, only 33 plants are capable of producing treated water for irrigation, providing 20 Mm^3 per year, which covers only 1% of the total demand of the agricultural sector [38].

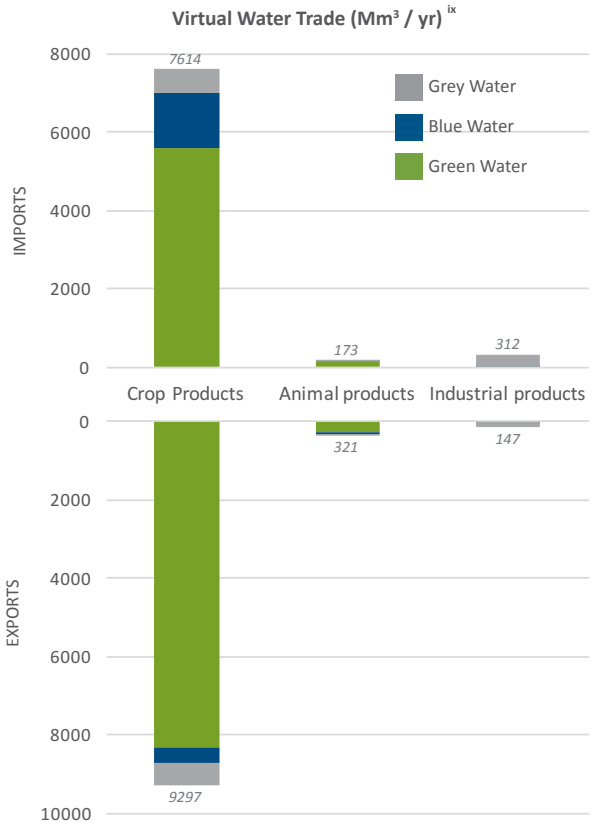


Data from 2011/2012 [7]

> The majority of the water for irrigation in Tunisia comes from groundwater extraction and dams. The use of treated wastewater is minimal [7].

Agricultural Effects on Water

- Agriculture contributes to the degradation of water quality (pollution from pesticides and fertilisers or salinisation due to overexploitation) [7]
- Inefficient irrigation techniques used in agriculture contribute to the overexploitation of water resources (low productivity of water consumed) [7]



Based on [39]

[ix] Virtual water refers to the amount of water needed for the production of food and other products. It can be separated into green water (water from precipitation that is stored in the root zone of the soil), blue water (water sourced from surface or groundwater resources) and grey water (the fresh water required to assimilate pollutants to meet specific water quality standards).

[x] The reported value here is greater than the total irrigated area in 2014 reported by the FAO [40].

[xi] A wadi commonly refers to a dry (ephemeral) riverbed that contains water only during times of heavy rain [41].

ENERGY - FOOD INTERCONNECTIONS

Agriculture for Energy

The use of traditional biomass is minimal due to the high access to electricity and gas for cooking, even in remote areas. Less then 1% of the rural population and a negligible amount of the urban population use wood or charcoal for cooking [27].

Energy for Food & Agriculture

- Most of the energy consumed by the agricultural sector (75%) comes from petroleum products. Diesel is widely used in agricultural machinery [7].
- Solar pumping irrigation systems (SPIS) are used to pump water for irrigation purposes, and owing to subsidies provided by government bodies, the farmers' demand for SPIS is increasing. From 2010 to 2017, 124 pumps were installed with a combined capacity of 1.07 MWp [7].

GOVERNANCE

Two national strategies were introduced which are related to elements of the Nexus, but they did not directly address Nexus interconnections [42]:

- Long-term Water Strategy (2003–2030) which builds the basis for integrated water resources management considering the needs of all water users (including the agricultural and energy sector) and the preservation of water resources
- National Energy Strategy (2014-2030), which aims at increasing energy efficiency and at increasing the share of renewable energies beyond biomass to 12% by 2030

Example of Nexus cooperation: The energy consumption for water distribution has been increasing significantly because of the increasing water demand. This situation generates significant energy costs and increasingly weighs on the cost price of water. Facing the energy challenge, SONEDE has put in place an energy management programme with the objective to participate effectively in the national plan for energy, which includes stabilising the cost of water exploitation through the diversification of energy resources and the use of renewable energies. [7].

Challenges faced in the governance of the WEF Nexus:

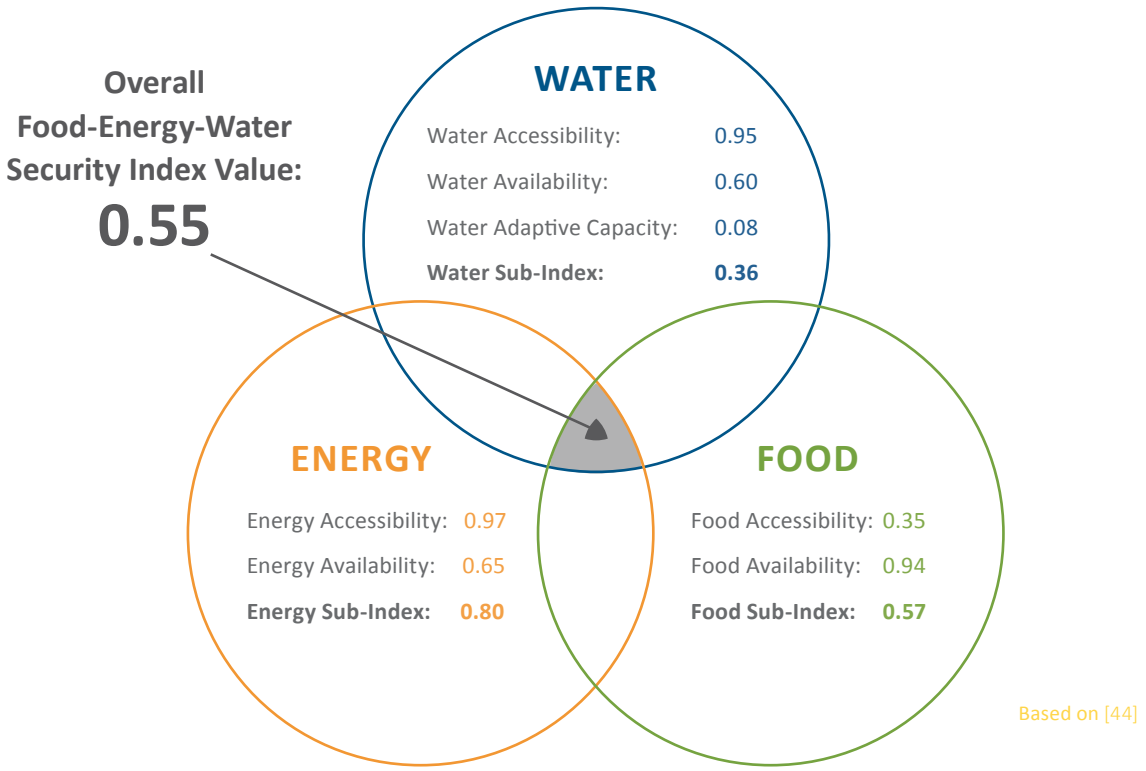
- The economic and ecological potential of the agricultural sector are affected by an unsustainable use of land and water resources [7].
- The optimisation of water and energy use in the large-scale irrigation agriculture is recognised as one of the main challenges to overcome in order to ensure food and water security [43].
- The promotion of solar pumping irrigation systems encourages a shift to renewable energies, but there is a risk of this leading to an overexploitation of groundwater resources [7].

NEXUS EVALUATION

Applying the Pardee RAND Food-Energy-Water Security Index

To gain insight into the security level of each Nexus element and the overall resources security, the Pardee RAND Index for Tunisia is presented. It is calculated the following way:

- The Index is based on availability and accessibility[xii] of the resource, and in the case of the water, an analysis of the adaptive capacity is also part of the calculation.
- Normalised scores are derived by assigning a value between 0 and 1, where 0 represents the minimum value and a score of 1 represents the conditions for that sub-index which are sufficient to meet basic needs.
- All three Nexus elements are equally weighted to determine the overall security index value (Willis et al., 2016).



Based on [44]

[xii] The availability considers the national scale while the accessibility considers the access to resources at the individual level.

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