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M.Sc. Geography of Global Change
Course: Places of Global Change

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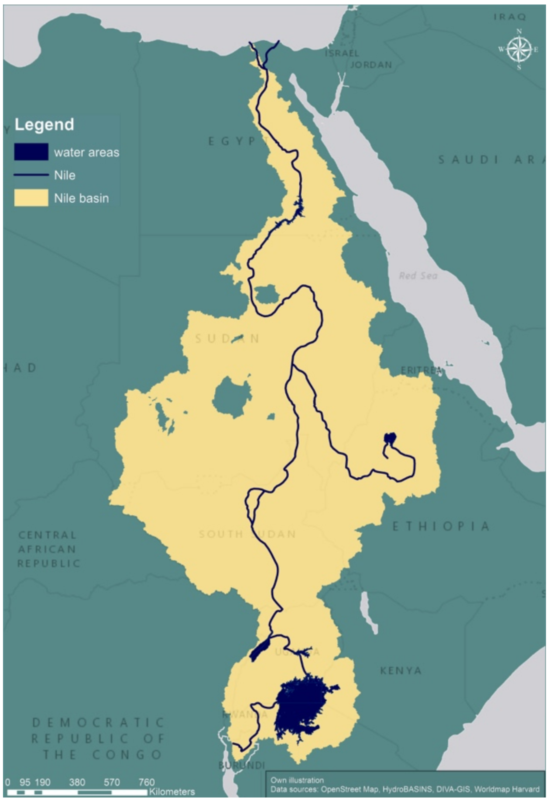
The Nile under pressure – additional information

Egypt's water shortage



Water resources and food security

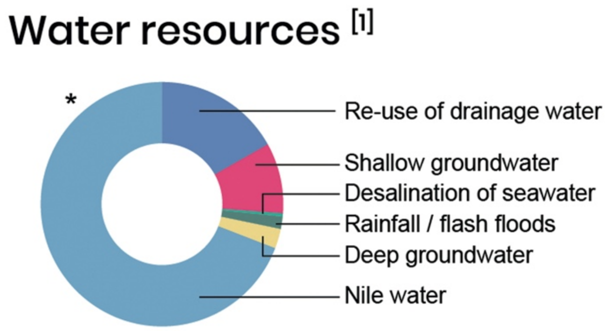
Egypt's country area counts 100.145.000 ha but only 2,73% are arable land (Food and Agricutural Organization (FAO), 2016b). Due to the arid climate, 98% of the cultivated area in Egypt depend on irrigation. Therefore, water resources and agriculture are especially connected. The agricultural sector consumes 79% of the water resources in Egypt (Food and Agricutural Organization (FAO), 2016a) and is contributing 14,5% to the GDP of the country. In the 1960's this contribution was much higher (30%), but the sector still plays a very important role for many people as sustenance farming (Ministry of Water Resources and Irrigation, 2005). Competing interests of the consumption of Nile water exist between ten riparian user countries: Egypt, Burundi, Democratic Republic of the Congo, Rwanda, Kenya, Tanzania, Uganda, South Sudan, North Sudan.

Diagram 1: Water resources

Egypt's water resources depend highly on the Nile River which supplies the country with 55.5 billion m^3/y (Fanack Water, 2019). Other important water resources are the re-use of drainage water (agriculture) with 13.5 billion m^3/yr and shallow groundwater in the delta region with 7.5 billion m^3/yr. Deep groundwater (2.1 billion m^3/yr), rainfall / flash floods (1.3 billion m^3/yr) and desalination of sea water (0.35 billion m^3/yr) are currently playing a less important role for the water supply.

Diagram 2: Water withdrawal by sector (in 2017)

The agricultural sector utilizes with an annual withdrawal of 61.35 billion m^3 the largest amount of water in Egypt (79%) (Food and Agricutural Organization (FAO), 2016a). The water requirements for the domestic sector are estimated to be 10.75 billion m^3 (14%) and those for the industrial sector 5.4 billion m^3 (7%).



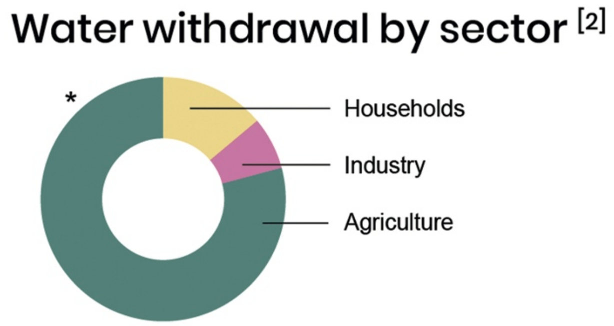


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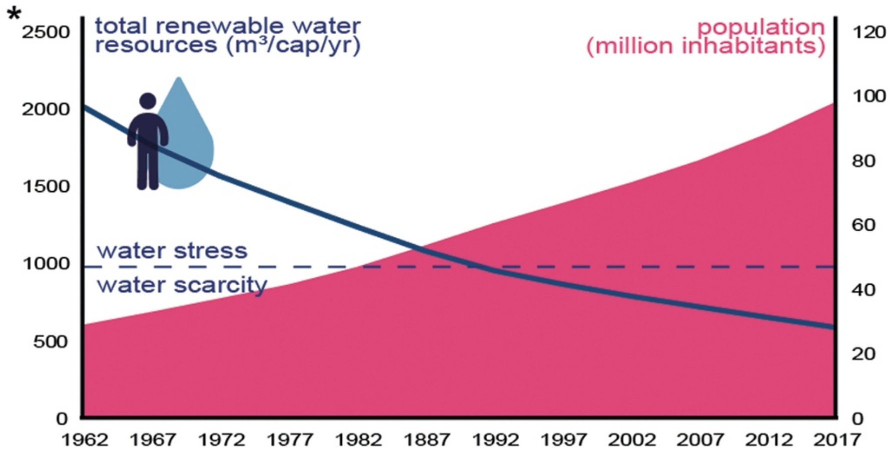
Diagram 3: Population growth and declining water resources

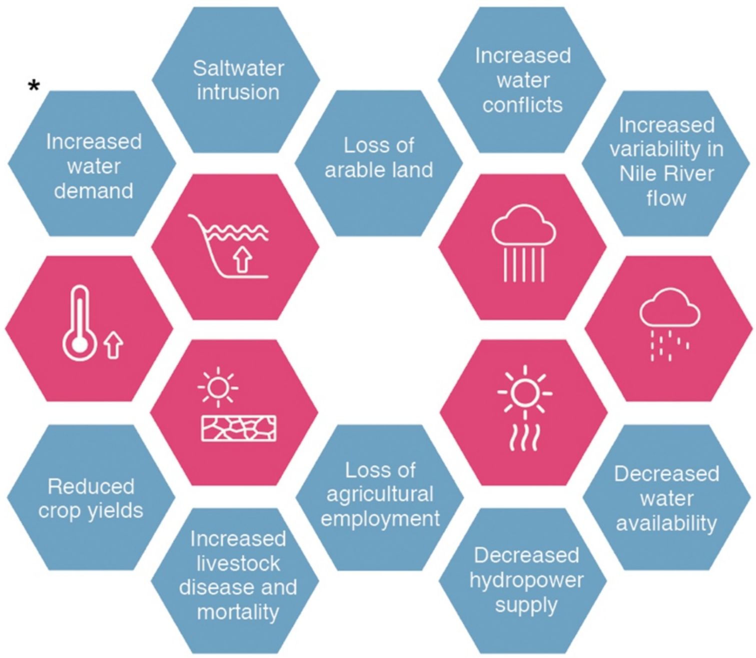
The Egyptian population highly increased over the last decades. In 1962 the country had 28.5 million inhabitants (Food and Agricutural Organization (FAO), 2016a).This number grew up to 97.6 million inhabitants in 2017. With this population increase water resources have been stressed more and more which is shown in the balance of total renewable water resources per capita. In 1962, 2017 m^3/yr of renewable water resources were available per capita. This amount declined to 589,4 m^3/yr per capita in 2017, a number which lies way below the required 1000 m^3/yr per capita (Falkenmark, Lundqvist and Widstrand, 1989). The growing water consumption in these countries also effects Egypt. If the water resources which mainly depend on the River Nile decrease due to socio-political reasons or climate change impacts the balance of population and food security is highly effected.



Climate Change

Climate change works as an external driver for the water scarcity and therefore agricultural problems in Egypt (USAID, 2018). Climate projections show that the mean annual temperature will increase 2°C-3°C in Egypt by 2050. Furthermore, a tendency towards slightly drier conditions in most months becomes apparent which among others leads to an increased drought frequency and duration. On the other hand, heavy rains will increase. Projections until 2085 show that the sea level could rise 3-61 cm in the Nile delta. Also, a significant increase in the duration of long-lasting heat waves (duration 9-77 days) will take place.
Those effects will trigger different problems regarding water resources and agricultural production in Egypt which are listed on the poster.

An external driver for water scarcity [5]



The Grand Ethiopian Renaissance Dam

The Grand Ethiopian Renaissance Dam is located approximately 500km northwest of the capital Addis Ababa along the Blue Nile which is an important tributary of the River Nile. For Ethiopia the dam is essential for its development, but for Egypt the dam could be a threat to its survival (Harb, 2019). In 2011 Ethiopia announced to build the dam for 5 billion US-Dollar. At the end of its construction, the dam will be the largest hydroelectric power plant in Africa and the 7th largest in the world (Salini Impregilo, 2019). It will be 1800m long, 155m high with a total volume of 10,4 million m^3. Its reservoir will hold up 67 billion m3 of water and will take at least 7 years to fill. During this time period the flow of the Blue Nile river will decrease at least by 25%. The Egyptian Nile is fed from water resources in Ethiopia by 83% (Ahmed and Helmy Elsanabary, 2015).
The Nile River is the most important natural resource for at least 10 countries in the region. The already existing water shortage in the Nile countries is becoming more topical due to the construction of the dam and shows that the resource water is highly politicized in these days.

Further information:

Importance of the River Nile and its water resources for Egypt:
https://www.youtube.com/watch?v=N7i3UnHU2eg (07.01.2020 16:10)

Short input on the Grand Ethiopian Renaissance Dam:
https://www.youtube.com/watch?v=nWDTRdj3kJk (07.01.2020 16:17)

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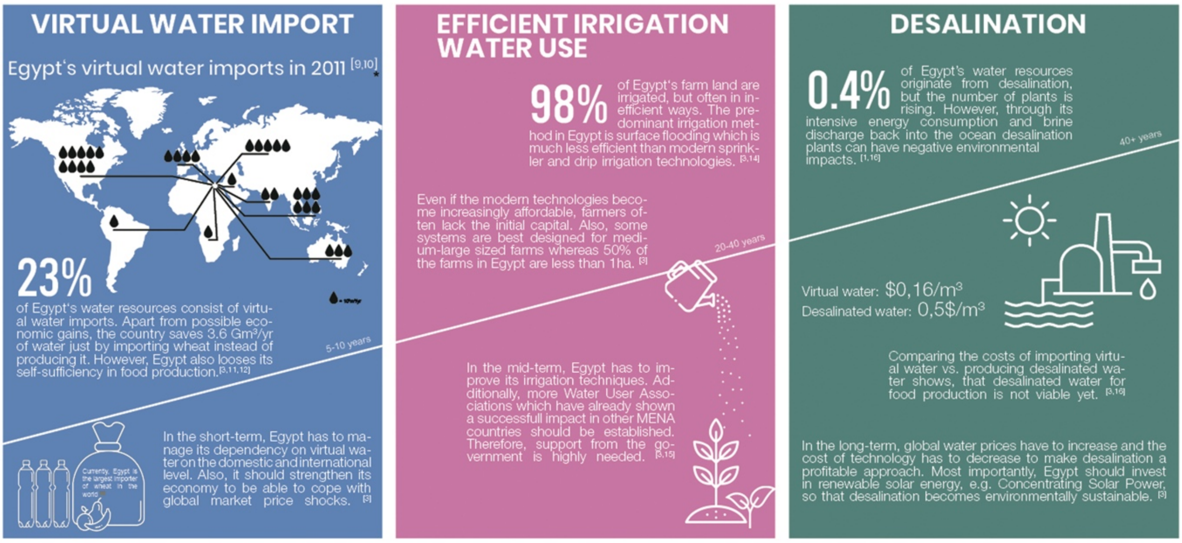
Roadmap to solution – three approaches



Virtual water import

Virtual water imports in general

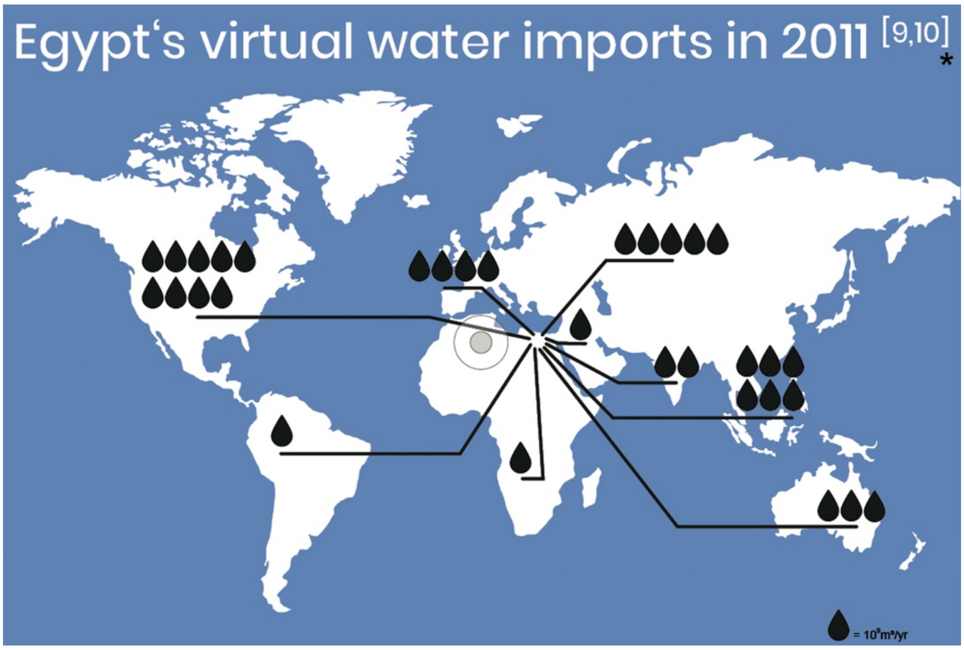
The term virtual water was introduced by Tony Allan who defined it as the water needed to produce (agricultural) commodities (Allan, 2003). The concept virtual water links water, trade and food - as water resources are redistributed on a global level - and raises awareness to local water shortages. These occur because of an increasing water demand which is driven by four main factors (Antonelli and Tamea, 2015):

1. an increasing population,
2. rising standards of living, industrial activities and energy demands,
3. a dietary shift towards higher calorie intake of (water-intensive) animal-based products
4. and the impact of climate change

Virtual water imports in Egypt

Currently, Egypt is the largest importer of wheat and the 4th largest importer of maize in the world (Food and Agricutural Organization (FAO), 2015). The annual import of wheat alone lies at 7 billion m^3 of water (Allan, 2011). Virtual water imports are a popular solution to physical water scarcity. Water which can be saved through imports can be used for other purposes like household consumption or manufacturing (Bargout and Fraser, 2018). Apart from that, the country saves alone by importing wheat instead of producing it locally 3.6 Gm^3 of water every year (Chapagain, Hoekstra and Savenije, 2006).

On the other hand, the most problematic disadvantage of the imports is that Egypt is not self-sufficient in food production and extremely dependent on food imports (Bargout and Fraser, 2018). Furthermore, if a country like Egypt depends on the global food market it often imports cheap products which destabilizes the domestic market and therefore its own agriculture. In the early 2010's this dependency on food exports resulted in socio-economic and political turmoil in Egypt starting the Arab Spring (Bargout and Fraser, 2018). Also, virtual water often offers political and economic benefits only to the net food exporters which are mostly developed countries (A. El-Sadek, 2010).



The map shows the regional distribution of Egypt's virtual water imports in 2011 (one unit is 10^9 m^3/yr) (Abdelkader *et al.*, 2018). Therefore, the authors used the National water, food, and trade modeling framework (NWFT model) which focusses on specific crop and animal products. The data shows the virtual water imports of Egypt from nine world regions: Africa ($1x10^9$ m^3/yr), Middle East and North Africa ($1x10^9$ m^3/yr), East Asia and Pacific ($6x10^9$ m^3/yr), South Asia ($2x10^9$ m^3/yr), East Europe and Central Asia ($5x10^9$ m^3/yr), Europe ($4x10^9$ m^3/yr), North America ($9x10^9$ m^3/yr), Latin America and Caribbean ($1x10^9$ m^3/yr), and Oceania and New Zealand ($3x10^9$ m^3/yr).

Because of the specific model simulation and the focus on crop and animal products, the data shows only a part of the real virtual water imports which are extremely difficult to calculate or simulate. Nevertheless, the data shows an approximate distribution, so that a rough picture of the virtual water trade can be presented.

Over the next 5-10 years it is recommended that Egypt manages its dependency on virtual water on a domestic and also international level. Also, the country should strengthen its economy so it is able to cope with market price shocks (Bargout and Fraser, 2018). Among water scarce countries coalitions have to be formed to find international solutions and emergency non-trade considerations regarding water scarcity (Gualtieri, 2008).

Efficient irrigation water use

In Egypt, 98% of the farm land are irrigated, but often in inefficient ways (Food and Agricutural Organization (FAO), 2016b). The predominant irrigation method in Egypt is surface flooding which is much less efficient than modern sprinkler and drip irrigation technologies (Bargout and Fraser, 2018).

There has been a slow transformation towards the use of modern irrigation technologies in Egypt in recent years. The new technologies nowadays become increasingly affordable, but farmers often lack the initial capital. Also, some systems are best designed for medium-large sized farms (> 30ha) whereas 50% of the farms are less than 1ha (Bargout and Fraser, 2018).

To use scarce water resources more efficiently it is important for Egypt to improve its irrigation techniques over the next 20-40 years (Bargout and Fraser, 2018). The establishment of Water User Associations has already shown a successful impact in other MENA countries and should also be expanded in Egypt (Frija *et al.*, 2011). Therefore, support from the government and collaboration with the farmers is highly needed.

Other important fields to improve water use efficiency are e.g. plant water use efficiencies or an improvement of the wastewater management. Those areas couldn't be mentioned on the poster due to shortage of space but are also highly important in the next decades.

Desalination

Comparing the costs of importing virtual water ($0,16/m^3) versus producing desalinated water (0,5$/m^3) shows, that desalinated water for food production is not viable yet and also that desalination will only become viable if the economic value of water becomes high enough to outweigh the cost of treating saline water (Alaa El-Sadek, 2010; Bargout and Fraser, 2018).

0.4% of Egypt's water resources originate from desalination, but the number of plants is rising (Fanack Water, 2019). Desalination might be the most successful strategy for many MENA countries as it is highly important for them to create alternative sources of freshwater. However, through its intensive energy consumption desalination plants can have a negative environmental impact. Also, brine discharge back into the ocean has unsustainable impacts on the water quality and marine ecology (A. El-Sadek, 2010).

In short-term, Egypt cannot afford to invest in desalination as heavily as other MENA countries, but desalination could become viable in 40-50 years (Bargout and Fraser, 2018). In the long term, global water prices have to increase, and the cost of technology has to decrease to make desalination a profitable approach. Most importantly, investments in renewable solar energy, e.g. Concentrating Solar Power (CSP), have to be done to make desalination environmentally sustainable and economically affordable (Bargout and Fraser, 2018).

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– for the poster and the additional information –

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