EFFECTS OF POPULATION GROWTH AND WATER SCARCITY IN THE MENA COUNTRIES

EFFEKTER AV BEFOLKNINGSTILLVÄXT OCH VATTENBRIST I MELLERSTA ÖSTERN OCH NORRA AFRIKA

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Abstract
Water shortage is a problem in the Middle East and Northern Africa (MENA). The population growth is estimated to be high. Given the hydrological situation and the estimated huge population growth, people will try to escape from poverty and conflicts. To counteract these effects, resources must be allocated to implement more efficient use of the available water resources, mainly to produce more food. This will, however, not be enough since the water volumes needed for future food production is not available. Economic development is a necessity for the countries to fight poverty and to be able to import food for the growing population. If not, the living conditions will become so repulsive that poverty and starvation, most probably followed by conflicts, will result in enormous suffering and large internal migration and external migration to e.g. Europe in a much larger scale compared to what we have seen so far. Thus, economic development is a necessity.

Keywords: Water scarcity; Irrigation; Food production; Population increase; Migration; Conflicts.

Sammanfattning
Vattenbrist är ett stort problem i Mellersta Östern och Norra Afrika, samtidigt som befolkningstillväxten är mycket hög. Detta medför stora risker för svält, fattigdom och konflikter, vilket människor kommer att försöka fly från. För att motverka detta måste de tillgängliga vattenresurserna utnyttjas mer effektivt för att maximera produktionen av mat. Detta kommer emellertid inte att vara tillräckligt, eftersom de vattenmängder som behövs för att producera mat till den växande befolkningen inte är tillgängliga. Ekonomisk utveckling är därför nödvändig för att bekämpa fattigdom och för att kunna importera mat till den ökande befolkningen. Om detta inte sker kommer ökande fattigdom och svält, troligen följt av konflikter, att resultera i enormt lidande samt stora interna och externa migrationsströmmar till framför allt Europa i en mycket höge grad än tidigare. Ekonomisk utveckling är således nödvändig.

Introduction

Water is needed for all life on earth. Humans need 2–5 liters per person and day for drinking, but a lot more for production of the food needed. For a vegetarian diet, some 1000–2000 liters per person and day is needed and for a meat diet 2 or 3 times as much (IWMI, 2007). Of course, large variations occur depending on kind of crops used, soil conditions, climatic conditions etc. For estimates, roughly 1 m^3 of water per person and year is needed for drinking and 1000 m^3 per person and year is needed for production of food.

Only renewable water is normally included when water availability is considered, although some recirculation is sometimes included (White, 2012). For example, fossil water, which is available in some areas, is not included. The available surface water resources per capita is defined as scarcity if it is in the range 500–1000 m^3 per person and year and as absolute scarcity if it is below 500 m^3 per person and year according to the so called Falkenmark Indicator (Falkenmark, 1989). Using this definition, large parts of the world are facing water scarcity (see e.g., IWMI, 2007; UN Water, 2015; UN Water, 2016). In some cases, the total renewable water resources are not restricted to the local (i.e., per country) available freshwater, but it also includes the water resources originating from upstream countries (Burek et al., 2016). This does make a large change in some local areas, e.g. in Egypt, where the vicinity to the river Nile secures plenty of water, while the rest of the country suffers due to a deficit. However, also with this definition, large parts of the world are facing water scarcity. Rijsberman (2006) argues, however, that also the "green water" should be included, i.e. the water infiltrated in the soil. This water becomes soil moisture and evapotranspires without having entered into either rivers or groundwater and is for most human uses not relevant, as it cannot be taken out and used for any other purpose. For the largest water user of all, agriculture, as well as for the environment, this water is obviously hugely important. Thus, irrigation is an intervention to supplement deficits in soil moisture. More complex indicators are however not widely applied because data are lacking to apply them and the definitions are not intuitive. Below, therefore, only the "blue water" is considered, i.e. renewable water resources as they are usually defined: the runoff in streams and rivers plus the annual recharge to aquifers.

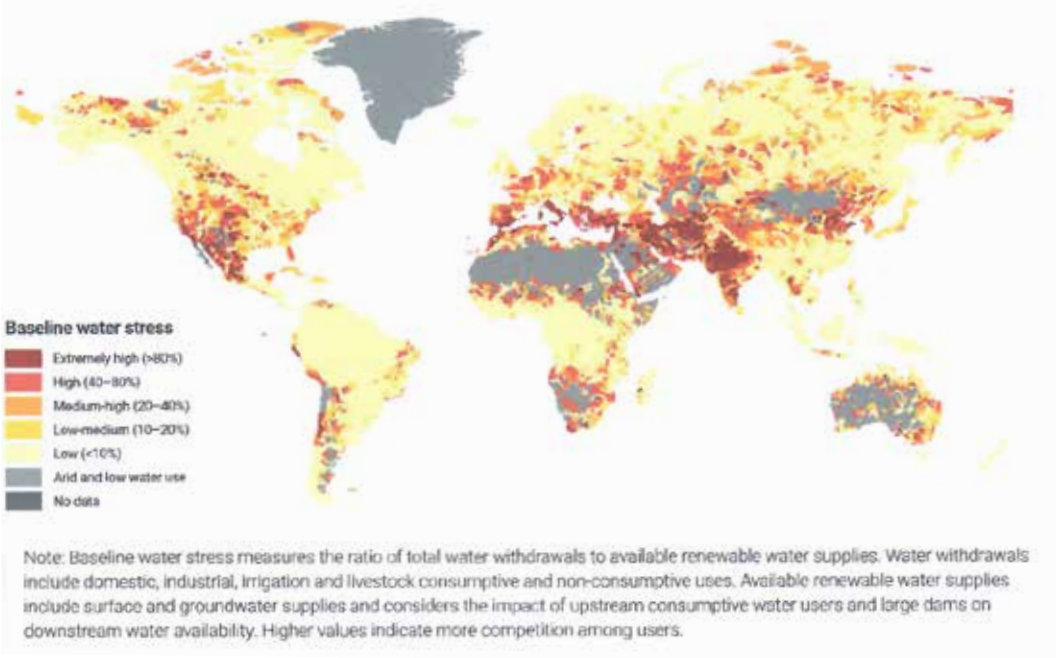
In large parts of the world, the water volumes available is now in the range 500–1000 m^3 per person and year. The largest area facing water scarcity covers Northern Afrika, the Middle East and a large part of Asia across northern China. Within this area, most countries are expected to have a fast increase in population. Thus, these countries are facing problems to produce enough food for the growing population. This combination of water scarcity and population growth will result in poverty and enormously suffering, which might create conditions for local or large-scale migration and conflicts.

Below, the effect of water scarcity and population growth is limited to the area covering the Middle East, Northern Africa (MENA) and the western part of Asia.

Water availability

As mentioned, the water need for drinking is roughly about 1 m^3 per person and year and for food production about 1000 m^3 per person and year. Irrigation for food production accounts for about 70% of the water use globally. Domestic water use, which accounts for only about 10% of the water used globally, is normally in the range 20–500 litres per person and day, the highest number if potable water is available at home at no cost, the lowest if the water must be fetched far away and carried home (IWMI, 2007).

The water access is globally very uneven distributed. In many countries in the MENA region the renewable water available is already too low for the present population, i.e. below 1000 m^3 per person and day, and in others close to this value. With a fast-growing population, the situation will become serious. By looking only at the yearly water volumes available in average (IWMI, 2007; UN Water, 2015; UN Water, 2016) and not capturing the seasonal fluctuations in water consumption and availability, the water scarcity is underestimat-



Figur 1 *Annual water baseline stress (UN Water, 2020).*

ed (Mekonnen and Hoekstra, 2016; UN Water, 2020; World Data Lab, 2021).

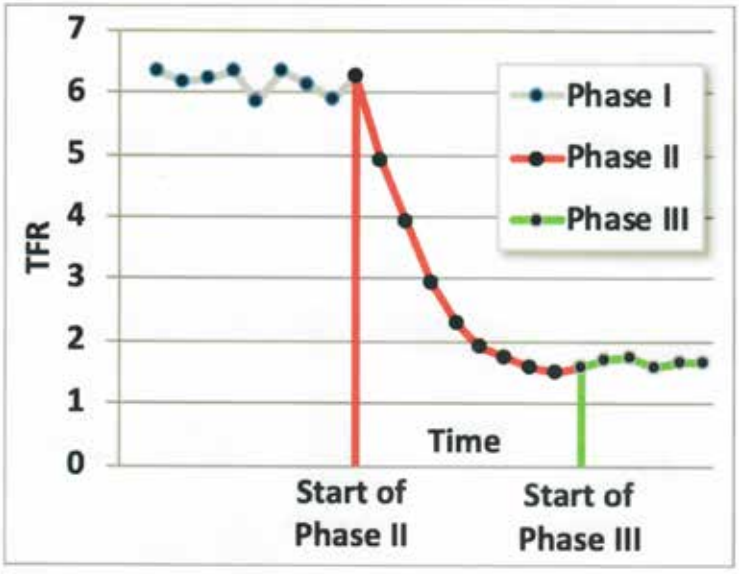
"Global water use has increased by a factor of six over the past 100 years and continues to grow steadily at a rate of about 1% per year because of increasing population, economic development and shifting consumption patterns. Combined with a more erratic and uncertain supply, climate change will aggravate the situation of currently water-stressed regions and generate water stress in regions where water resources are still abundant today. Physical water scarcity is often a seasonal phenomenon, rather than a chronic one, and climate change is likely to cause shifts in seasonal water availability throughout the year in several places. Vulnerability to climate change is moderate to high across the region, with a generally increasing gradient from north to south. For Western Asia and North Africa, runoff and evapotranspiration generally follow the same trends as precipitation, although evapotranspiration is limited by water scarcity" (UN Water, 2020). As can be seen in Figure 1, the water use is extremely high in large parts of this area with total water withdrawals higher than 80%. In these areas, the water withdrawals can hardly be increased. 100% is of course not possible to reach for practical reasons. It is also not desirable since it would kill natural growth and wildlife. Thus, ways have to be found meeting at the same time immediate societal needs through proper management of ecosystem services, and long-term eco-system needs to secure social and economic development (Falkenmark, 2000).

It has been argued that how much renewable water a country has is not a meaningful metric since water is a renewable resource and used water can be treated and reused (Biswas and Tortajada, 2019). Treatment and reuse is, however, extremely difficult when the main part of the available water is used for irrigation for food production, although dramatic reduction of agriculture water abstraction has been achieved by using more efficient farming and irrigation methods. A large part of the water will nevertheless be lost by evaporation and plant transpiration.

Population increase

In 2011 United Nations published a prognosis forecasting the population development in all countries from 2010 to 2100 (UN, 2011). Several prognoses were made using different assumptions. In what was assumed to be the most realistic prognosis, the fertility level in less developed countries was assumed to change in the same way it has changed in developed countries, i.e. from a high and stable fertility to a second phase with declining fertility and into a third phase with a low and stable fertility close to the replacement level slightly higher than 2 children per woman. This is illustrated in Figure 2. The methodology used for the population estimates and projections is described in UN World Population Prospects (UN, 2019; UN, 2019a). A later prognosis was published 2019 (UN, 2019b).

For most of the countries in North Africa, the Middle East and Western Asia the fertility level was described as "intermediate", i.e. 3–5 children per woman, and declining in most of the countries. However, even with an expected continued declining fertility, a remarkably high population growth was forecasted. The reason for this is a very young population. It was shown that the percentage of the population younger than 24 years is between 50% and 60%, while in developed countries the corresponding percentage is about 30% (UN, 2011). This means that a large part of the population is in or will soon be in a fertile age. As an example, the demographic profiles for Afghanistan and Sweden are shown in Figure 3. Most of the population in Afghanistan was in 2020 below the age of 25, which was in sharp contrast to the demographic situation in Sweden (UN, 2019b).



Source: (Alkema and others, 2011).

Phase I: High-fertility, pre-transition phase. Not modelled.
Phase II. Fertility-transition phase, modelled by double-logistic function using a Bayesian hierarchical model.
Phase III. Low-fertility, post-transition phase, modelled with a first-order auto-regressive time series model, AR(1), in a Bayesian hierarchical framework.

Figure 2. *Schematic phases of the fertility transition (live births per woman) (UN, 2019a).*

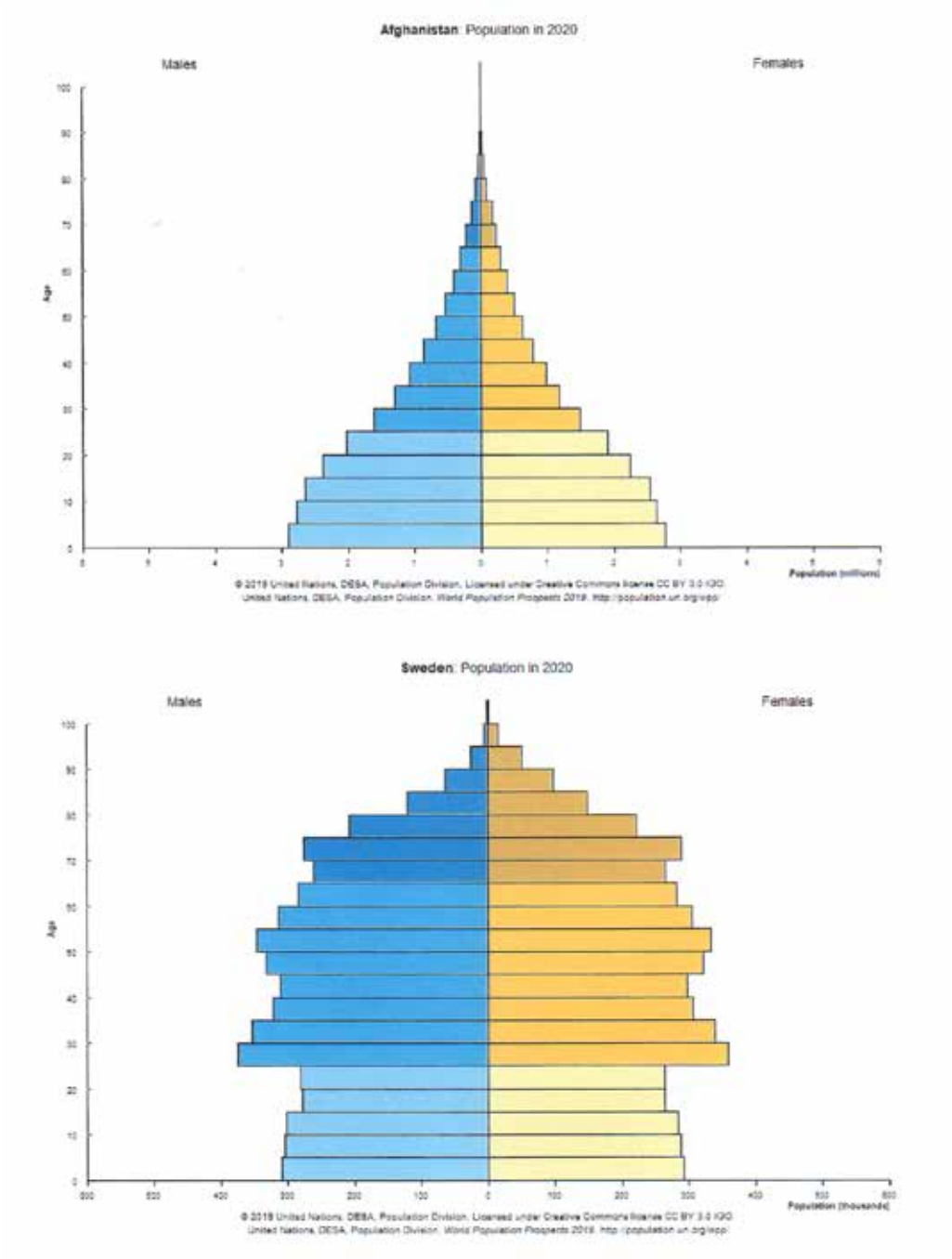


Figure 3. *Demographic profiles for Afghanistan and Sweden 2020 (UN, 2019b).*

In Table 1 the expected population 2020 and 2070 are shown for some of the countries in Northern Africa, the Middle East and western Asia. As can be seen, the expected increase in population is very high during a relatively short period of time. However, a few countries are expected to have a relatively low population increase, e.g. Libya, Marocco, Tunisia and Iran, and in one case even a decreased population (Lebanon). Never the less, as forecasted in this prognosis, several of the countries will double its population in 50 years or even triple (UN, 2019b).

The world population is supposed to peak at nearly 11 billion by the year 2100. The growth will almost totally be concentrated to Africa and Asia, while e.g. Europe will have a decreasing population (UN, 2019b).

The UN prognosis spans over the period 2020 to 2100, which is a long time. Several things could affect the population growth which makes the prognosis unreliable. However, without such extraordinaire circumstances the prognosis should be fairly accurate for a period of about one generation.

Most of the countries in northern and north-eastern Africa, the Middle East and western Asia will however probably never reach the forecasted population. The reason could be conflicts/war, destroying normal life. Another reason could be that the production of food will not be sufficient for the growing population. Looking at the fact that much of the renewable water is already used, it can be concluded that there will not be water enough for food production for the growing population, which means that irrigation is needed for food production in almost the entire area of northern and north-eastern Africa, the Middle East and western Asia. An additional difficulty is that the urbanization is expected to continue (UN, 2019b). This means that food must be transported into large population centres, demanding large scale production of food. This calls for large scale irrigation, since the potential for rain fed agriculture is very low in this area (IWMI, 2007). The needed water volumes will however not be available. Unless measures are taken to counteract the situation, the population will reach a level, at which the living conditions will be so repulsive that poverty and starvation followed by conflicts and increased migration will be at hand.

Effects of water scarcity

The most fundamental prerequisite for all life is access to water. Scarcity of water might therefore result in competition for this vital resource. The population increase in regions with already high levels of water scarcity will most probably generate water crises. What may be foreseen is an increasing risk for international controversies, disputes, and even militarized conflicts in regions where water-deficient countries share river basins (Falkenmark 1989a). Local conflicts have been caused by water scarcity (see e.g. Levy and Sidel, 2011; Schlein, 2011; Ligtvoet et al., 2017; Fröhlich, 2012; Bijani et al., 2020). Water infrastructure has also been a target in armed conflicts between nations. The intension has in these cases not been to conquer water sources, but to destroy important infrastructure (Zeiton, 2007; Zeiton et al., 2014). Armed conflicts between nations have often been shown to scrupulous targeting sensitive objects even if there will be civilian causalities (Gregory, 2010).

A general belief has been that shortage and competition of water will result in war between nations for this resource (Asser, 2010; Barnaby, 2009). There are, however, few indications of this. During the last five decades of the twenties century there were no formal declarations of war over water between nations (Yoffe and Wolf, 2003; Yoffe, Wolf and Giordano, 2003). In most of the cases when there were conflicts over water, these were solved by negotiations and agreements (Detges et al., 2017). War was never used as a mean to solve the water situation. Thus, it can be concluded that nations do not go to war over water (Coscun, 2007; Barnaby, 2009; Fröhlich, 2012).

Three out of four jobs worldwide are water dependent. Water shortages and lack of access to water may limit economic growth (UN, 2016a). It has been shown that development of agriculture has been a major engine for economic growth and

Table 1. *Expected population (million) in some countries in northern Africa, the Middle East and western Asia the year 2020 and 2070 (data from UN, 2019b*).*

Country/Year	2020	2070	Increase, Milj.	Increase, %
Algeria	43.8	67.4	23.6	54
Chad	16.4	46.9	30.5	186
Egypt	102.3	193.3	91	89
Eritrea	3.5	7.6	4.1	117
Ethiopia	114.9	256.4	141.5	123
Libya	6.9	8.6	1.7	25
Mali	20.2	61	40.8	202
Mauritania	4.7	12.4	7.7	164
Morocco	36.9	47.8	10.9	30
Niger	24.2	105.3	81.1	335
Somalia	15.9	51.7	35.8	225
South Sudan	11.2	25.9	14.7	131
Sudan	43.8	108.2	64.4	147
Tunisia	11.8	13.8	2	17
West Sahara	0.6	1.2	0.6	100
Afghanistan	38.9	75	36.1	93
Iran	84	104.1	20.1	24
Iraq	40.2	89.5	49.3	123
Israel	8.7	15.2	6.5	75
Jordan	10.2	14	3.8	37
Lebanon	6.8	6.5	-0.3	-4
Pakistan	220.9	387.1	166.2	75
Syria	17.5	36.1	18.6	106
Sweden	10.1	12.1	2	20
Europe	748	667	-81	-11
World	7 795	10 459	2 664	34

* *Different calculations using different assumptions regarding changes in fertility were made in the prognosis published by UN. In this table, the so called "median" calculation has been used, which is believed to give the most realistically forecast. Here, the fertility is assumed to follow the fertility change that occurred in developed countries until "replacement fertility" is reached.*

poverty reduction. Scarcity of water is therefore a threat to poverty alleviation (Baker et al., 2000). Poor access to water and a highly informal water economy are also characteristics of low-income countries (Shah, 2005). Thus, shortage of water will most likely prevent economic development in poor countries and the people will remain poor. Without water, economic development is prevented. It has also been shown that rational planning of water use has been prevented due to conflicts of interest in countries (Zeitoun et al., 2012).

An example showing that water scarcity can result in poverty and instability is what happened in Syria: "Beginning in the winter 2006/2007, Syria

…… experienced the worst 3-year drought in the instrumental record. …. The most significant consequence was the migration of as many as 1.5 million people from rural farming areas to the peripheries of urban centers" (Kelley et al., 2014). These people were due to lack of water forced into a situation where they had difficulties to support their families, which resulted in political unrest.

Poverty by itself is unlikely to lead to conflict (Goodhand, 2001). A Swedish Finance Minister said in 1928 that "poverty is accepted if it is equally shared" (Wikipedia, 2021). This is seldom the case. Horizontal inequalities and social exclusion, particularly when they coincide with identity or regional boundaries, may increase a society's predisposition towards violent conflict (Goodhand, 2001). Civil wars are organized group conflicts, not a matter of individuals randomly committing violence against each other. Horizontal inequalities occur when members of ethnic, religious, or other identity groups have unequal access to public goods, opportunities and resources. Group-level inequalities can generate social and economic polarisation that increases the risk of violent conflict (Østby, 2008; Stewart, 2009). Religion was shown to be one of the most important group identity factors in a study of the situation in Ghana and Nigeria (Langer et al., 2009). Purely economic or ethnic polarization seems to have little effect, in contrast to social inequality, which turn out to be significant (Østby, 2008). Of course, these dynamics alone do not start wars. Political or religious grievances and conflict proneness are most likely to lead to violence – from terrorism to civil war – when poverty and inequality combine with repression (Marks, 2016). Thus, poverty is a hotbed for corrupted leaders and extreme political and religious organizations and might lead to armed conflicts.

Conclusions

The fast-increasing population in the MENA countries and in the countries in western Asia, where water scarcity will make it difficult or – in some countries – even impossible to produce food enough in the near future, is a problem which will be necessary to handle. A fast reduction of the population growth is not realistic because an exceptionally large part of the population already is in a fertile age. Thus, a large increased population can be foreseen within a period of about one generation (UN, 2019b).

Lack of confidence to the state organisation and a high degree of diversified group identities creates problems in most of the MENA countries (see e.g. Verstegen, 2001). Since horizontal inequalities between ethnic, religious or other groups in poor countries increase the risk for violent conflicts, it is important to fight inequalities and poverty. One important factor that prevents economic development is water scarcity. It is therefore important to introduce more efficient method for use and reuse of water and more effective farming methods and more suitable crops. Much has been done in this field, but more efforts must be made. Of outmost importance is to implement these methods in practise. Furthermore, cheaper and more efficient methods for desalination of seawater must be developed. Such technologies are also used. Today, reverse osmosis seems to be the only realistic method. Unfortunately, this method is expensive. One of the reasons for this is that the membranes used are blocked due to growth of microorganisms. Expensive chemical cleaning must be applied, but relatively soon the membranes must be replaced by new ones. A pre-treatment method has however been developed, which extends the membrane lifetime and the total cost is reported to be less than 60 US cent per m^3 (Jacobsen, 2016). Although suitable for domestic water supply, this is unfortunately in most cases too costly for water to be used for irrigation, at least in large scale. Other methods are available for desalination, but the problem is the cost and to apply the methods in large scale.

Increasing the water use efficiency is important to fight poverty but will not be enough. The countries in northern Africa and the Middle East will not be able to produce food enough for the growing population due to shortage of water. The potential for rain fed agriculture is low in northern Africa, the Middle East and western Asia. Irrigation is needed and the water for this will only part-

ly be available. Therefore, to support the growing population with food the economy must be developed. Thereby, the countries in this region will be able to import the food needed. This represents a "virtual flow of water" since the import of food for one person for one year is equivalent to the import of about 1000 m^3 of water (Allan, 2000).

To make economic development possible in the countries where conflicts are going on, these conflicts must come to an end. The situation is however quite different in different countries. Possession of oil will make import of food possible and presence of fossil water will make production of food possible as long as these resources are available. When this is not the case other measures are needed. Large efforts can presently be made in many countries lacking resources like oil and fossil water. Outside experts must however realise the role of politics in the countries in North Africa and the Middle East, which has not always been the case (Allan, 2000). It is also important that the economic development occur in such a way that horizontal inequalities between different identity groups are not created. If such inequalities are created, tensions resulting in conflicts could be created.

By developing the economy, the countries will get the means to import food. For a sustainable, long-term solution the MENA-countries must open for foreign investments and the world open for favourable trade with the countries in the region. If not, the living conditions will become so repulsive that poverty and starvation, most probably followed by conflicts, will result in enormous suffering and large internal migration and external migration to e.g. Europe in a much larger scale compared to what we have seen so far. Thus, economic development is a necessity.

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