Virtual water trade and water scarcity in Algeria: lessons from a global practice

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Abstract:

The virtual water trade is evoked like adaptation strategy to water scarcity and an element of water demand management (WDM). This paper aims to discuss the concept of virtual water, the relationship between the production of goods, and the availability of water, and to understand the trend of global virtual water trade flows.

Algeria as an arid and semi-arid country imports about 17,31 Bm^3/year as virtual water contained in imports which would exceed even the natural potential of the country (16,24 Bm^3) and by far the exploitable volumes (10,47 Bm^3).

The article aims also to measure the degree of the contribution of this strategy in the mitigation of the water scarcity in Algeria. The limits of this practice will be analyzed from an economic point of view.

Keywords: Algeria, virtual water, exchange, management, adaptive capacity, comparative advantage.

JEL Classification Codes: Q25, C82, F14.

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1. INTRODUCTION

The challenges related to water resources are huge and will eventually lead to a vicious circle of water resource degradation if serious measures are not put in place. This is due to several factors including population growth leading to increased demand for agricultural products, urbanization, coastal development, increased needs for economic development, and especially the recurrent drought sequences due to the climate change phenomenon. Such a tragedy is already underway as according to the United Nations (UN), it is estimated that in 2017, more than 785 million people lack basic drinking water services (UN, 2019). In 2015, 6 out of 10 people did not have access to safely managed sanitation services and 892 million people continued to practice open defecation (UN, 2018). In addition, in terms of food, it takes between 2 and 5 m^3 per day to be converted by the biophysical process of evapotranspiration to nourish a person (Molden et al., 2005), which raises the constraint of food needs satisfaction of a growing population. Most of the countries where water is recognized as a gift from God, meaning that its cultural or religious value takes precedence over its economic value and utility, suffer from major water problems. Therefore, the water problem is related to the social perception of the good.

Water management continues to focus on supply, while the context requires a shift to water demand management (WDM) involving all stakeholders and integrating all dimensions. Nowadays, we are even witnessing a reconsideration of a management approach based solely on the dual: supply/demand. Moreover, Allan (2003) has advocated a shift from integrated water resources management (IWRM) to integrate water resources allocation and management (IWRAM). The OECD (2012) proposes a multi-level governance approach that examines the coordination links between formal administrations and informal institutions through central actors. These new approaches plead for a revalorization of the water existing potential, through policies and instruments aimed to water saving, cooperation between actors, and the call for a water culture (Cosgrove and Loucks, 2015; Dziegielewski, 2003; Pahl-Wostl et al., 2008).

In the face of these challenges and this context, trade can contribute to the containment of the problem of water scarcity. Thus, the evolution of international trade has been influenced by two main factors: unequal distribution of production factors, notably natural resources, and a difference in the endowment of these same resources. Traditional theories of international trade have emphasized that differences in factor endowments lead countries to specialize and focus on the production and export of goods and services in which they have a comparative advantage.

Consequently, some countries mobilize indirectly another adaptive capacity to water scarcity. This is the virtual water trade, which remains a very little explored issue in Algeria. Virtual water trade is often referred to an adaptation strategy to water scarcity and a component of water demand management (WDM). We aim in this paper to verify to **what extent this strategy is likely to face the problem of the scarcity of water resources specifically for Algeria?** This is done by reviewing the literature on international trade in goods and services, by analyzing the statistics related to virtual water trade flows, and by highlighting the limits and risks that the application of such a policy generates.

2. WATER ENDOWMENT: A PRODUCTION CONSTRAINT AND AN EXCHANGE FACTOR

The Heckscher-Ohlin theorem (H–O model) has already confirmed the usefulness of trade between countries by showing that factor endowment is a keystone of unequal resource distribution. According to this theory: "*A country will export the good whose production requires the intensive use of the factor that is relatively abundant in the country (and therefore inexpensive) and will import the good whose production requires the intensive use of the factor that is relatively scarce (and thus expensive)*" (Guillochon and Kawecki, 2006 p. 40). It is thus an important source of global social welfare improvement through gains from trade. Initially, the theory was restricted to the analysis of two factors, namely labor and capital, at which time the problem of water scarcity had not yet been posed given its abundance. Over time, the model was extended to include several factors (transport costs, economies of scale, human capital, etc.).

At present, after the awareness on the water value, since it is now "*a rare and specific economic good*" (Hanemann, 2006), water is, so, a determinant input of the exchanges. Researchers have proposed a model of specialization that takes into account the water endowment. Accordingly, trade-in water-intensive products can contribute to solving the problems of the unequal geographical distribution of water. This model is represented by the "virtual water trade". They note a similarity between this practice of "virtual water trade" and "comparative advantage" by taking the endowment of water resources and the opportunity costs[1]. Wichelns (2004) states the theory as follows: *« If a water-short nation can produce two goods at a lower cost than a water-abundant nation, the water-short nation will have an absolute advantage in the production of both goods, even if water is a key input. The absolute advantage does not imply that the water-short nation should export both of the goods. The optimal trading strategy can be determined only by examining comparative advantages »* (Wichelns, 2004, p. 51). According to this theory, the water-short nation should not be the only exporter of the two goods. Thereupon, it will have gains from trade if it specializes in the production of the good for which it has a comparative advantage (or a low opportunity cost). While it imports the good in which it has a comparative disadvantage (or a high opportunity cost).

L'OECD (2010) and Wichelns (2004) argue that the determination of comparative advantage must go through two steps. First, an assessment of opportunity costs within the country. Second, a comparison of these same opportunity costs between countries, especially those involved in the exchange. Let us cite as an example the calculation of opportunity costs and the method of estimating the gains from trade: Let there be two countries (A) and (B) whose production capacities are presented in Table 1.

[1] Opportunity costs are "resource costs". They are incurred when one user deprives another of the opportunity to use water and the alternative use would have been of greater value. Supposed to be zero when there is no competition between alternative uses (OECD, 2010).

Table 1. Productivity per hectare of two products in two countries.

Countries \ Products	Rice	Cotton
Country A	6 tons/hectare	2 tons/hectare
Country B	4 tons/hectare	1 tons/hectare

Source: summarized from Wichelns (2004).

Supposing that both countries have the same level of technology and the same area of agricultural land: 40 hectares. The water supply is limited by the climatic conditions of each country. The annual water supply is 180,000 m^3 and 90,000 m^3 for the two countries (A) and (B) respectively. The irrigation of rice and cotton fields requires 18,000 m^3/hectare and 6,000 m^3/hectare. Taking this constraint into account, country (A) can irrigate 10 hours of rice or 30 hours of cotton. As for country (B), the water supply allows it to irrigate 5 h of rice and 15 h of cotton. Table 2 summarizes the model.

Table 2. productivity per hectare and opportunity costs considering water.

Countries	Crops	Yield (t/ha)	Maximum water supply (m^3)	Maximum production (t)	Opportunity costs
A	Rice	6	180 000	60	1 cotton
	Cotton	2	180 000	60	1 rice
B	Rice	4	90 000	20	0,75 cotton
	Cotton	1	90 000	15	1,33 rice

Source: Wichelns (2004, p. 56).

At first view, country (A) has an absolute advantage in the production of both products. But a study of opportunity costs revealed the possibility of exchange through specialization according to comparative advantage. Thus, country (A) can specialize in cotton production and country (B) in rice production. This specialization is a source of economic gains if countries engage in trade. However, the ability of this model to trigger such specialization is not without criticism. Wichelns (2004) himself shows in other scenarios the insufficiency of arguments that lead to exchange from the point of view of comparative advantage, he mentions, however, that water is only one input among other more determining (technical progress, land...). The OECD (2010) also considers that this model is not based on a solid theoretical foundation: "there is no theoretical framework to support it". Moreover, it is very delicate to impose a specialization at the expense of several priorities linked obviously to a country's food self-sufficiency, public policy, and the fight against poverty.

Turton (2002) and Turton et Lichtenthaeler (1999) reminds us that importing virtual water is the last step in water management after supply-side management, demand-side management (WDM) (use efficiency and allocation efficiency) to reach a natural resource reconstruction (NRR) process. The latter concept is developed by Allan and Karshenas (1996). NRR exists when the state (society) introduces WDM measures effectively and efficiently, including the reallocation of water from one sector to another. It calls for strict implementation of the water allocation policy.

3. VIRTUAL WATER TRADE: AN INVISIBLE SOLUTION TO WATER STRESS

If at the beginning the abundant water availability did not pose major problems to the production chain of goods and services, nowadays, it is not the same due to the scarcity; hence the appearance of virtual water trade. Water could be recognized as a determining asset in international trade, in the same way as labor and capital.

3.1. Virtual water: A concept in constant evolution

During the 1970s, the analysts noted a steady increase in imports from countries with both water scarcity and high population growth rates. This practice often referred to as “virtual water imports”, has been of great interest to researchers. However, it is in constant evolution.

3.1.1. The emergence of the concept: Virtual water as an improvised strategy

The concept of virtual water was first used by Antony ALLAN in the 1990s to illustrate how countries in the Middle East, where water is scarce, were able to stem their deficits by trading (importing) agricultural products with the rest of the world. Virtual water has allowed MENA countries, suffering from water deficit, to implement a "water closed policy", i.e. to reduce the volume of water for one use while increasing it for another (e.g. domestic use at the expense of agriculture). The interest of this practice is embodied in its contribution to reducing the intensity of water scarcity. For some, it is thanks to this practice that the water war was avoided in the Middle East (Allan, 1998; 1996; Roch and Gendron, 2005). Virtual water is defined as the amount of water used to produce a good or service (not to be confused with the water content of a product) (Aldaya et al., 2010).

3.1.2. From virtual water to water footprint

There is another concept that allows calculating the real use of water in a country and that highlights the relationship between the consumption pattern and the impact on water; it is the “water footprint.” Forged by Hoekstra (2003), the water footprint refers to the total volume of water contained in the goods and services consumed by an individual, several individuals, or a country. It is equal to the total of the country's domestic consumption, supplemented by its virtual water imports and reduced by its virtual water exports, which means that there are two footprints. First, the internal water footprint, which includes all the water resources used by a country to produce goods and services consumed by its inhabitants. Second, the external water footprint measures the volume of water used for goods and services imported and consumed by the inhabitants. (Chapagain and Hoekstra, 2004).

A country's water footprint is a useful indicator of the demand it places not only on its water resources but also on those of the planet. However, determining factors explain its importance from one country to another, such as the volume of consumption economically dependent on income, the consumption pattern (for example the degree of meat consumption that varies according to the type of diet (for example, a survival diet requires 1 m^3 of water per day, compared to 2.6 m^3/day for a vegetarian diet and more than 5 m^3/day for a meat diet), the country's climate and agricultural policies such as water efficiency measures.

4. WATER AND FOOD PRODUCTION

The concept of virtual water as cited above draws attention to the relationship between the production of goods and services and water availability. Indeed, the production process (agricultural or industrial) in any case requires huge quantities of water (Table 3). The virtual water import through the import of these products is a solution that depends on the comparative advantage of each country, that is to say, a country with limited water resources could import products requiring a large amount of water and direct its resources to the production of goods requiring less water to produce them and conversely for countries where resources are abundant

Table 3. Virtual water in selected products (liters of water per kg of crops)

Product	Wheat	Rice	maize	Potato	Soya	Beef	Pork	Poultry	Eggs	Milk	Cheese
UNESCO -IHE	1150	2656	450	160	2300	15977	5906	2828	4657	865	5288
California	1160	1400	710	105	2750	13500	4600	4100	2700	790	..
Japan	2000	3600	1900	..	2500	20700	5900	4500	3200	560	..

Source: Hoekstra (2003, p. 16).

4.1. The main exchange poles of virtual water: A chosen or imposed specialization?

The increase in food imports is strongly correlated with the depletion of water resources. This state of affairs has allowed the trade in virtual water to grow steadily over the past forty years. Indeed, virtual water-intensive products are traded over long distances and on a large scale. This is confirmed by the global volume of virtual water trade flows, which was 1625 Bm^3/year for the period 1997-20012001 (Chapagain and Hoekstra, 2004), while it became 2320 Bm^3/year between 1996 and 2005 (Hoekstra ad Mekonnen, 2011a; 2011b).

Table 4 shows that 88% of virtual water trade is related to international trade in agricultural products, of which 69% is related to trade in agricultural products for export and 19% of products re-exported after import. In contrast, trade-in industrial products accounts for only 12% of the total, of which 7% is dependent on industrial products exported directly and 5% on industrial products re-exported (either as is or after processing) after being imported. Quant à la structure des échanges par produit entre 1996 et 2005, la plus grande part des flux est liée au commerce des oléagineux (42,7%) et des céréales (17%). Le commerce de viande bovine est également important en termes de commerce mondial d'eau virtuelle (6,7%).

Table 4. Virtual water trade (VWT) flows (1996-2005)

	VWT of agricultural products	VWT industrial products	Totals
VWT related to the export of locally produced goods	1597	165	1762
VWT related to re-export of imported goods	441	117	558
Totals	2038	282	2320

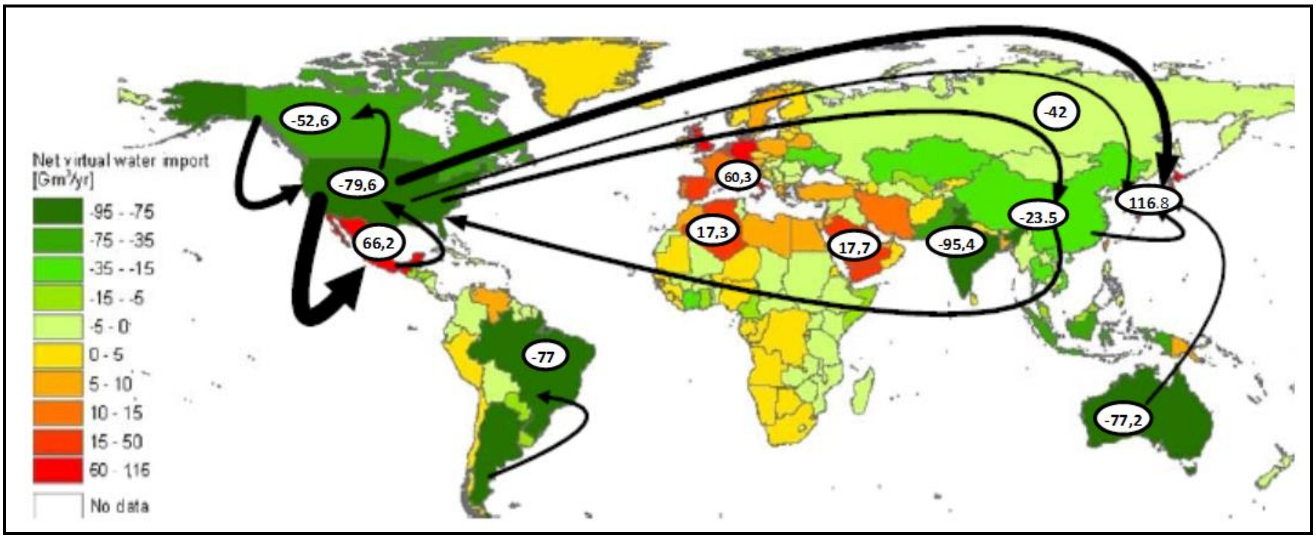
Source: Hoekstra and Mekonnen (2011a, p. 20)

Several countries such as Japan, Mexico, most of Europe, and MENA countries are net importers of virtual water. Therefore, the water security of these countries depends on external resources. The Mediterranean Region, in the sense of 21 countries, is a net importer of virtual water (Fig. 1). Plan Bleu (2008) estimates the volume imported since 1990 at 220 Bm^3/year for vegetable products and 50 Bm^3/year for beef, it is clear that virtual water is a way of sharing and balancing resources that are unequally distributed in the world

global trade in virtual water can save water if these products are traded from countries with high water productivity to countries with low water productivity, for example, Mexico imports wheat, maize, and sorghum from the United States which requires 7,1 Bm^3 of water per year in the United States, if Mexico produced the imported crops, it would require 15,6 Bm^3. This exchange operation has saved 8,5 Bm^3 of water per year. The global volume of water saved by international trade, between 1996 and 2005, was estimated at 369 Bm^3/year or 13,5% of the global volume of water used for agricultural production (Kherbache, 2014). Many countries have reduced the use of internal resources through virtual water import: Japan has saved 134 Bm^3, Mexico 83 Bm^3, Italy 54 Bm^3, Great Britain 53 Bm^3, Germany 50 Bm^3, North Africa (including Egypt) 114.9 Bm^3, etc. The products that allow the countries of the world to achieve these water savings are cereals with 196 Bm^3 (maize 71 Bm^3, wheat 67 Bm^3, rice 27 Bm^3), oilseed products 82 Bm^3 (soya 60 Bm^3 and others 21 Bm^3), and animal products 56 Bm^3 (poultry 25 Bm^3, milk products 16 Bm^3, beef 16 Bm^3, pork 2 Bm^3 and a global water loss on the horse, sheep, and goat trade 3 Bm^3) (WWDR3, 2009; Hoekstra and Mekonnen 2011a; 2011b).

While importing saves water, exporting causes a "national water loss" insofar as water consumed by the inhabitants of an importing country is not available for internal use by the exporting country (Chapagain et *al.*, 2005). However, the overall loss of water results from a misplacement of the absolute advantage, for instance, the production of one ton of wheat in Egypt and the United States requires 930 m^3 and 1707 m^3 respectively. Importing wheat saves Egypt 930 m^3/tons of water. This overall saving does not exist since the water needed for wheat production in the United States is higher than in Egypt, so that an overall water loss of 777 m^3/ton (1707-930) is required (Aldaya et al., 2010).

Fig.1. Net virtual water import flows related to agricultural and industrial products (1996-2006) in Bm^3/year (Balance= Imports-Exports)



Source: Hoekstra and Mekonnen (2011a, p. 21) modified from Mekonnen and Hoekstra (2011b).

4.2 Water footprint: A tool to measure external water dependency

The water footprint provides another indicator for the water pressure and helps to assess the extent to which a region or country is consuming resources following the global sustainability criterion. For the period from 1996 to 2005, the water footprint for production is estimated at 9087 Bm^3/year, of which 92% for agricultural production, 4.4% for industrial uses, and 3.6% for domestic uses. The rate of contribution to the global water footprint differs from one country to another, with developed countries and those with large populations contributing the most, led by China (1368 Bm^3/year), followed by India (1145 Bm^3/year) and the United States (821 Bm^3/year) (Hoekstra and Mekonnen 2011a, 2011b).

4.2.1. Water footprint of industrialized countries

The industrialized countries have a water footprint that varies between 1250 m^3/Capita/year and 2850 m^3/Capita/year. Great Britain has the lowest rate (1258 m^3/Capita/year), while in the United States the rate is estimated at 2842 m^3/Capita/year. The differences can be partially explained by variations in the consumption pattern from one country to another. For example, beef consumption is 43 kg/Capita/year in the United States (4,5 more than the global average), while in Great Britain it is estimated at 18 kg/Capita/year.

4.2.2. Water footprint of developing countries

In developing countries, the water footprint varies from 550 m^3/Capita/year to 3800 m^3/Capita/year, i.e. much higher than in industrialized countries. The lowest level (552 m^3/Capita/year) is recorded in the Republic of Congo, while Bolivia, Niger, and Mongolia show the highest rates with 3468 m^3/Capita/year, 3519 m^3/Capita/year, and 3775 m^3/Capita/year, respectively.

On the one hand, the weakness of this footprint for some countries can be explained, according to Hoekstra and Mekonnen (2011a), by shortcomings in national statistics and the low standard of living of the inhabitants. On the other hand, the size of the footprint, especially for agricultural products, is attributed to the low productivity of water, which calls for increasingly high consumption. As an example, in Bolivia, the meat consumption per capita is 1,3 times the global average, but the water footprint per ton of meat is 5 times the global average. For Niger, per capita, cereal consumption is 1,4 times the global average, but the water footprint per ton is 6 times the global average. As a result, a higher water footprint in developing countries than in industrialized countries is strongly attributed to lower water productivity than to the consumption pattern.

We have raised above a distinction between the internal water footprint and the external footprint. The footprints are of great interest to measure the degree of water dependence of a country to others. The ratio of external footprint to total footprint determines the degree of water scarcity at the national level and thus its dependence on external sources. In addition, a high ratio jeopardizes a country's water security and even its food security. The majority of poor countries have worrying ratios, e.g. Kuwait has a 90% dependency ratio, Jordan 86%, Algeria 52%, Japan 78%, etc. (Hoekstra and Mekonnen, 2011b).

5. VIRTUAL WATER TRADE: IS IT THE SOLUTION TO WATER STRESS IN ALGERIA?

According to the experts (Chapagain, Allan, and Hoekstra), the new virtual water approach is a tool for demand management. In other words, it is a choice of specialization given the scarcity of the resource. However, this practice is only one solution among many, and so many more crucial factors come into play to explain the use of virtual water imports.

Although Algeria's virtual water balance is largely in the deficit with a net import balance of 17,31 Mm^3/year (Table 5), the water incorporated in imported industrial products is only 409,4 Mm^3/year while that contained in exports amounts to 420,8 Mm^3/year, which means that the virtual water balance for Algeria's industrial products shows a surplus of 11,4 Mm^3/year. This situation is all the more surprising for a country that imports practically everything to satisfy its growing needs. In our view, this assessment underestimates the water incorporated in industrial products imported by Algeria. Identifying the source of the underestimate is difficult given the lack of a content specification of the industrial products component in the Hoekstra and Mekonnen (2011b) study. Virtual water could be an indirect explanation for the low demand for industrial water (PNE, 2010) especially if we look at the import structure where the overwhelming majority of imported industrial products are manufactured by water-intensive industries.

Table 5 corresponds to the period (1997-2006), note that since the period from 2006 to 2015 the import bill of agricultural products, animal products, and industrial capital goods has experienced a clear upsurge both in terms of volume and value. Obviously, the import of virtual water has followed the same rhythm with the rate of import of the same products. The value of imports reached USD 55,028 billion in 2013 compared to USD 21,456 billion in 2006, an increase of 156,5% (Algex, 2014).

Table 5. Algeria's virtual water flows (in Mm^3/year)

Imports (M)			Exports (X)			Balance= M-X		
Agricultur	Animal	Industrial	Agricult	Animal	Industrial	Agricult	Animal	Industrial

al products	product s	products	ural products	products	products	ural products	products	products
16266,7	1 359,9	409,4	251	53,1	420,8	1 6015,7	1 306,8	-11,4
Total net of virtual water import						17 311,1		

Source: calculated from Hoekstra and Mekonnen (2011b).

6. VIRTUAL WATER IMPORT: RISKS AND CONSTRAINTS

Although the international exchange of virtual water is, according to the supporters of this thesis, beneficial for all countries where the problem of scarcity is acute, this practice gives rise to perverse effects, which affect the food security of countries and calling to question their independence. Indeed, the choice of imports requires flexibility in the production system; a failure to reorient the labor force in importing countries, where the agricultural sector contributes considerably to employment, leads to rural exodus. However, the infrastructure in the cities is already insufficient to meet demand, which tends to exacerbate the problems (of water and others). Moreover, the methodology for calculating virtual water consists to estimate the total amount of water consumed by a good during the whole production chain under the conditions of the country where it is consumed, while there are goods that cannot be produced by the importing country (Roch et Gendron, 2005) (how to calculate the water needed to grow rice or tropical fruits in Algeria, when these products are not cultivable in this country?)

In addition, adopting virtual water is synonymous with giving up on food independence, even if this challenge seems difficult to meet in most MENA countries, particularly for Algeria. The issue of food security comes to the fore in times of food shortages on the world market, due to an unforeseen drop in production, resulting in a surge in the price of agricultural products. Lorsque l'augmentation du prix concerne un produit stratégique comme le blé, cela nécessite davantage de moyens de paiement. This was the case during the fires that affected cereals crops in Russia in 2010, prompting the government to impose an embargo on cereal exports in August 2010. As a result, the price of wheat has increased by almost 70%. Knowing that the increase has not only affected feed cereals, exported by Russia, but also food cereals while Russia is the second-largest exporter of wheat 18,5 million tons (mt) in 2009 (3,3 mt in 2010 before increasing 10.4 mt in 2011) and the fifth-largest producer in the world with 61,7 million tons in 2009 (43,5 mt in 2010, 54,7 mt in 2011).

For Allan (1996), even in a context of very high prices, virtual water trade remains a good deal and an ideal and invisible solution to the water deficit, but at this stage, it would be urgent for a poor country to find the means of payment. In our opinion, the situation of virtual water is favorable when the world prices of products are lower than the production costs in water-poor countries. Finally, in addition to the risks associated with highly import-oriented strategies, we find that the determinants of agricultural trade are only marginally related to water. Land availability, technical progress, trade costs, labor costs, national food policy, multilateral trade agreements, or political reasons are much more structuring and explanatory factors. For example, theoretically, Japan does not lack water (3360 m^3/Capita/year), but it is a major net importer of virtual water (116,8 Bm^3/year). It is the scarcity of agricultural land that seems to be the main explanation for this. The same is true of Mexico (66,2 Bm^3/year) and Germany (60,3 Bm^3/year).

7. CONCLUSION

While decision-makers and politicians continue to confirm that their countries are safe from the water crisis, especially in the MENA region, research shows that the MENA region is hiding behind the availability of foreign currency reserves that allow for the import of food (and even industrial products) under the metaphor of virtual water without the anxiety of the related risk. These imports for wheat in 2009 for the MENA region, estimated by FAO (2012), reached 31,6 million tons. By a standard of 1,15 m^3/kg, this constitutes a virtual water equivalent equal to 36.34 Bm^3.

The risk becomes effective when the virtual water paradigm moves from a descriptive to a prescriptive status, on the one hand, or when it abandons the explanatory character of international exchanges in favor of a normative character on which water management policies are conceived, on the other hand. Nevertheless, this new paradigm of water policy does not explain the ideas defended by these researchers insofar as the countries involved in the trade of virtual water have not abandoned the production of water-intensive products, but because of a demographic increase, they are not sufficient to meet the needs of the population (decline in production per capita) hence the recourse to imports. For illustration, according to FAO statistics (2012), Egypt's cereal production, which was estimated at 14.6 million tons in 1992, reached a record high of 23.7 million tons in 2008 before declining in 2010 to 19.4 million tons. Knowing that this observation is valid practically for most countries qualified as net importers of virtual water.

The virtual water import as an adaptive capacity has allowed Algeria to temporarily escape water vulnerability and relatively avoid the hazards of water deficit, especially since the volumes of virtual water imported (17,31 Bm^3) exceed the water potential of the country (16,24 Bm^3) and by far the exploitable volumes (10,47 Bm^3). Obviously, this policy remains full of uncertainties and risks insofar as it requires the availability of foreign currency to continue the import process. Virtual water is, therefore, only one solution among others. It is not, in fact, a panacea or a miracle solution to a water scarcity that limits the development and economic growth of the country.

Since 2001, Algeria has implemented colossal public investment programs (PIP). These PIPs accompanied by institutional reforms have led to an improvement in several water indicators. As a consequence, the country has achieved target 7.C of the Millennium Development Goals (MDGs) related to drinking water and sanitation, since 2012 even before their UN deadlines in 2015. The drinking water connection rate increased from 78% in 1999 to 98% in 2015, and the sewerage connection rate increased from 72% in 1999 to 90% in 2015. According to data from the Ministry of Finance, the amount of real investments for the MDG period, between 2000 and 2015, is estimated at 1,367 billion current DA, or about \$11,4 billion for the drinking water/water supply subsector and 531 billion current DA, or more than $4,4 billion in sanitation subsector. Certainly, important constraints are affecting the water sector in Algeria (Kherbache and Oukaci, 2020, 2017).

The current challenge is to achieve the Sustainable Development Goals (SDGs), in particular, SDG 6: "*Ensure access to water and sanitation for all and ensure sustainable management of water resources*" and to meet the challenge of food security by reducing the virtual water imports. This cannot be achieved without an agricultural specialization policy that takes water as structuring and limiting production factor alongside a water policy that valorizes the resources already available and mobilized in a context of climate change and groundwater overexploitation. This requires a real transition to water demand management (WDM), especially because the institutional and regulatory framework (law 05-12 related to water) for water allows it. Finally, it is necessary to adopt a strategy that leads to reduce losses, fight against global climate change, increasing water productivity, and protecting the resources from a major risk of pollution, in order to achieve effective standards of governance at local and national levels that require the minimum of the financial cost, the minimum of social cost and offer the maximum of social welfare.

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