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# Significance of Water Footprints of a Nation in Water Resources Management

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**ABSTRACT: Water is a scarce resource and needs to be treated economically. All human activities consume and pollute a lot of water. Agriculture consumes a substantial volume of water and domestic and industrial sector pollute the water. There is an urgent need to develop appropriate concepts and tools to tackle the problem of water shortage in India. A bridge is required to be built between water management practices and economic thinking. The water has to be allocated efficiently. At local level the water user plays a key role. Local water use efficiency can be increased by creating awareness, charging prices based on full or marginal cost and by use of water saving technology. The paper highlight the concept of water footprint of a nation, average water footprint per capita per country, and comparison of water footprint of different nations. It also suggests measures to reduce water footprints and relevance of the concept.**

**Keywords:** Virtual water, Water footprint, water shortage

## INTRODUCTION

Water is becoming increasingly a scarce resource and needs to be treated economically. More than one third of the world population will face water shortage by the year 2025. All human activities consume and pollute a lot of water. Agriculture consumes a substantial volume of water and domestic and industrial sector pollute the water. There is an urgent need to develop appropriate concepts and tools to tackle the problem of water shortage in India. A bridge is required to be built between water management practices and economic thinking. The water has to be allocated efficiently. At local level the water user plays a key role. Local water use efficiency can be increased by creating awareness, charging prices based on full or marginal cost and by use of water saving technology. The paper highlight the concept of water footprint of a nation, average water footprint per capita per country, and comparison of water footprint of different nations. It also suggests measures to reduce water footprints and relevance of the concept.

As far as, agricultural trade is concerned it has been practiced since centuries across the nations. The embedded water is exported / imported when food/product is traded. This has been taking place since trade began. We are only now calling it with new names 'Virtual Water' and 'Water Footprints'.

Water pollution and consumption can be associated with specific activities such as irrigation, bathing, washing, cleaning, and processing. Total water consumption and pollution are generally regarded as sum of multitude of independent water demanding and polluting activities.

The objective of the paper is to create a better understanding of virtual water, water footprints and to share views on the applications and relevance this in water resources management.

**VIRTUAL WATER CONTENT OF FOOD/PRODUCTS:** Agricultural water productivity is a key parameter in irrigated agriculture. Productivity of water refers to the benefits obtained from its use. In case of food product, the benefit derived is "Crop yield" in Kilogram/per hectare. Therefore, crop yield divided by water-use (evapo-transpiration) results into water productivity (Kilograms/per unit of water). The Virtual Water Value (VVV) is reverse of above, i.e. water required to produce one kilogram of product (yield).

Table 1 shows some typical Virtual Water Values. As can be seen, it takes much less water to produce rice, wheat or maize (vegetarian products) as compared to beef, pork or chicken (non-vegetarian products) due to food chain effect.

**Table1: Amount of Water Required to Produce One Kilogram of Product**

| Product (one kilogram) | Amount of Water (liter) |
|---|---|
| Rice<br>Wheat<br>Maize | 1000 to 3000 |
| Beef (kg)<br>Pork<br>Chicken | 3000 to 16000 |

*(Source: Sustainable Water Management by Dr Prabhas Sinha & Sanjay Rana, Pentagon Press, 2009,pp.46)*

The VWV of processed products would include water used to reach that end product in addition to VWV of the primary product, i.e. say crop yield. The VWV of by products and multiple products would be even more complicated (Zimmer and Renault, 2004).

**WATER FOOTPRINT OF A NATION:** People use lots of water for drinking, cooking and washing. They also use water for producing things such as food, paper, cotton clothes, etc. The water footprint of an individual, business or nation is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual, business or nation. The water footprint concept is closely linked to the virtual water concept. Since not all goods consumed in one particular country are produced in that country, the water footprint consists of two parts: use of domestic water resources and use of water outside the borders of the country. In order to give a complete picture of water-use, the water footprint includes both the water withdrawn from surface and groundwater and the use of soil water in agricultural production. The first assessment of water footprints of nations was carried out by Hoekstra and Hung (2002).

When assessing the water footprint of a nation, it is essential to quantify the flows of virtual water leaving and entering the country. If one takes the use of domestic water resources as a starting point for the assessment of a nation's water footprint, one should subtract the virtual water flow that leaves the country and add the virtual water flow that enters the country. The virtual water flows between nations are substantial. All studies showed that the global sum of international virtual water flows may exceed 1000 billion cubic meters per year (Hoekstra and Hung, 2002; Chapagain and Hoekstra, 203a; Zimmer and Renault, 2003; Oki et al., 2003).

Knowing the virtual water flows entering and leaving a country can put a completely new light on the actual water scarcity of a country, Jordan, as an example, imports about 5 to 7 billion cubic meter of virtual water per year (Champaign and Hoekstra, 2003a; Haddadin, 2003), which is in sheer contrast with the 1 billion cubic metre of annual water withdrawal from domestic water sources (Yang and Zehnder, 2002; Chapagain and Hoekstra,2003; Zimmer and Renault,2003).

People in countries where water is a comparatively scarce resource could thus aim at importing products that require a lot of water in its production and exporting products or services that require less water. This is import of virtual water will relieve the pressure on scarce water resources.

The water footprint of a country (WFP, $m^3$/year) is to the total volume of water used, directly or indirectly, to produce the goods and services consumed by inhabitants of the country. A national water footprint has two components;

- The internal water footprint
- The external water footprint.

The internal water footprint is the use of domestic water resources to produce goods and services consumed by inhabitants of the country. The external water footprint (EWFP) of a country is the annual

volume of water resources used in other countries to produce goods and services consumed by the inhabitants of the country concerned. Both the internal and the external water footprint include the use of blue water (ground and surface water) and the use of green water (moisture stored in soil profile).

In order to make cross –country comparisons, it is useful to calculate the average water footprint per capita per country (WFPpr, $m^3$/cap/yr):

WFPpc = WFP/Total population

The global water footprint is 7459 $Gm^3$/yr, which is 1240 $m^3$/cap/yr as an average. In absolute terms, India is the country with the largest footprint in the word, with a total footprint of 987 $Gm^3$/yr. However, while India contributes 17% to the global population, the people in India contribute 13% to the global water footprint. On a relative basis, it is the people of the USA that have the largest water footprint, with 2480$m^3$/yr per capita, followed by the people in south (2300-2400 $m^3$/yr per capita). High water footprints can also be found in Malaysia and Thailand. At the other side of the scale, the Chinese people have a relatively low water footprint with an average of 700 $m^3$/yr per capita. The size of the global water footprint is largely determined by the consumption of food and other agricultural products.

**REDUCING WATER FOOTPRINTS:** Water footprints can be reduced in various ways as under;

- To break the seemingly obvious link between economic growth and increased water–use, for instance by adopting production techniques that require less water per unit of product.
- To shift to consumption patterns that require less water for instance by reducing meat consumption.
- To shift production from areas with low water productivity to areas with high water.

The water footprint of a nation is an indicator of water use in relation to the consumption volume and pattern of the people. As an aggregated indicator it shows the total water requirement of a nation, a rough measure of the impact of human consumption on the natural water environment therefore virtual water can be regarded as an alternative source of water. Virtual water can be used by national governments as a tool to release the pressure on their domestic water resources.

Global virtual water trade can effectively save water if products are traded from countries with high water productivity to countries with low water productivity.

**RELEVANCE OF THE VIRTUAL WATER CONCEPT:** The concept suggests that a water scarce country should import food thereby preserving the precious scarce water for some other useful purposes in its own country. However, the countries concerned should have a capacity to import desired food in required quantity However, prosperous countries like Japan and South Korea, does not have enough land to produce required food. They therefore, depend on imported food in exchange of export products and achieve food security. Oil exporting West Asian countries, similarly, export oil products to import food, to make up for deficit due to shortage of water.

Those countries producing surplus food, export Virtual Water and those like Saudi Arabia and Kuwait with food deficiency but are economically well-off (high GNP) import food/products or Virtual Water. At the same time, the countries like Sub-Saharan African countries, having food deficiency and low GNP or those countries having food sufficiency (India and China) with low or lower-middle GNP may not be able to practice Virtual Water Trade due to economic and political reasons.. Since food is traded across countries (water goes along with it) virtual water really makes water a global issue. The relevance of the concept of Virtual Water for countries in the world should be debated by keeping in view the following points:

**I.** Increased dependency on exporting countries;
**II.** Local agriculture may be damaged;
**III.** The exporting country may interface in the policies of importing countries; and
**IV.** Imports may result in severe foreign reserve depletion.

If water is not used for agriculture (food), it could be alter-natively used by industry or environmental sector (conservation of bio-diversity). The share of water for optimal use between People sector (Drinking and Industry), Food Production and Nature Sector is best resolved by considering basin as a Unit in any river system. In a few cases there could be no conflicts and it may be just complimentary, as had been the

case in some of the results obtained from Country Policy Support Program (CPSP) results in respect of basins in India and China. CPSP opens a new opportunity to revisit policy options keeping future scenarios (CPSP, 2005).

The food security has been defined as the capability of a country to provide access to adequate food to all its citizens. Populous countries like China, India and Indonesia would like to be self-sufficient in their food requirements. Self-sufficiency of China and India is in the interest of world food market, which otherwise would significantly distort the demand/supply equation (increase in food prices), due to Virtual Water Import, for numerous developing and least developed countries.

Many least developing countries lack the ability to produce enough for them and hence depend on Food Aid. These countries have to put all their available resources to develop their rain fed/irrigated agriculture first.

The Virtual Water Concept suggests "Countries might be better off using their scarce water resources for economic activity that bring higher economic returns and buy food instead of growing it themselves". The concerned countries need to debate and answer the following issues:

**I.** Are investments in development of infrastructure (irrigation, drainage and flood management) necessary and justified to obtain food self-sufficiency; or could these investments be used for other sectors while importing the required food?

**II.** How reliable are global producers, the international food market and the access to this market?

**III.** To what extent is food security through local production at the cost of environment justifiable?

**IV.** What are the food safety risks as an imported (agrochemicals and genetically modified food?

**V.**

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