Water Policy Briefing

Issue 25

Putting research knowledge into action

Does Food Trade Save Water?

The potential role of food trade in water scarcity mitigation

Comprehensive assessment of water management in agriculture

IWMI International Water Management Institute

Few people realize that we “eat” between 2,000 and 5,000 liters of water per day—depending on the composition of our diet. With increasing global water shortages and awareness of the environmental impacts associated with irrigation, the concept of trading in *virtual water*—the amount of water used to produce an agricultural commodity—is receiving attention. Growing food where water is abundant and trading it to water-short areas is being recognized, in theory, as having a large potential to save water and minimize new investment in irrigation infrastructure. However, in practice, socio-political interests and economic costs may prove stronger than water scarcity concerns.

Does Food Trade Save Water?

The potential role of food trade in water scarcity mitigation

Is Virtual Water Trade a solution for water scarce countries?

By the year 2050 there will be an additional 3 billion people to feed. Food production may need to increase by 70-90 percent from levels in 2000 to meet this global food demand. Without improvements in the efficiency and productivity of agricultural water use, crop water consumption would have to grow by the same order of magnitude.

A big challenge in water management is to grow sufficient food for a growing and more affluent population while meeting the many other demands on limited water resources—household needs, industrial requirements and environmental functions. Already, an estimated 20% of the global population lives in river basins that are characterized by physical water scarcity.

International food trade can have significant impacts on national water demand. The term 'virtual water', first introduced by Allan (1998), refers to the volume of water used to produce traded crops. By importing food a country 'saves' the amount of water it would have required to produce it on its own soil. Thus, international food trade can have important impacts on how and where water is used.

Food trade reduces water use at two levels. At a national level, a country reduces water use by importing food rather than producing it. At a global level, trade reduces water use because, at present, production in exporting countries is more water efficient than in importing countries. Moreover, four of the five major grain exporters produce under highly productive rainfed conditions while importing countries would have relied more on irrigation. In fact, without cereal trade, global irrigation water demand would have been higher by 11%.

Some researchers have suggested that international food trade can and should be used as an active policy instrument to mitigate local and regional water scarcity. They contend that, instead of striving for food self-sufficiency, water short countries should import food from water abundant countries. Indeed, food trade has a large potential to alleviate water scarcity, but in practice there are many reasons why this is unlikely to happen in the near future.

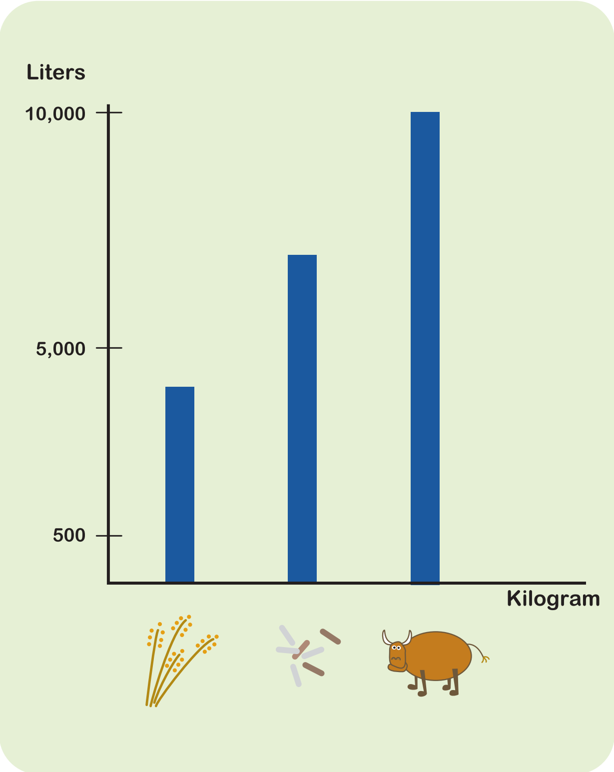
This Water Policy Briefing is based on the CA Research Report 4: *Does International Cereal Trade Save Water? The Impact of Virtual Water Trade on Global Water Use* (CA Research Report 4) by Charlotte de Fraiture, Ximing Cai, Upali Amarasinghe, Mark Rosegrant and David Molden; and on *Investing in Water for Food, Ecosystems and Livelihoods* (BLUE PAPER, Stockholm 2004, Discussion Draft) by David Molden and Charlotte de Fraiture; and on *Is Virtual Water Trade a Solution for Water Scarce Countries?* by Charlotte de Fraiture and David Molden, Bridges 2004. The full text of these reports is available at *www.iwmi.cgiar.org/assessment/files*

The Virtual Water concept examined

We "eat" between 2,000 and 5,000 liters of water per day—depending on our diet. Insignificant in comparison are the amounts of water each person uses for drinking (between 2 to 5 liters per day) and for washing, sanitation and other household needs (between 50 and 200 liters per day).

It takes between 500 to 4,000 liters of water to grow one kilogram of wheat, but up to 10,000 liters to produce one kilogram of grain-fed beef (fig.1). In the United States of America an average meat diet contains an estimated 5,400 liters of water per person per day, while a vegetarian diet contains 2,600 liters. If every person adopted a typical U.S. diet, approximately 75% more water would be needed for food production (World Water Council, *Virtual Water Trade*, March 2004).

Figure 1. Water consumption for food production



Some key definitions

Depletion is defined as a use or removal of water from a basin that renders it unavailable for further use. Irrigation water depletion refers to the water used by crops in an irrigated condition. Crop water depletion includes crop evapotranspiration and losses because of reservoir evaporation, percolation to saline aquifers and pollution.

Water productivity is an efficiency term quantified as a ratio of product output (goods and services) over water input. The output could be biological goods or products such as crop (grain fodder) or livestock (meat, egg, fish) and can be expressed in term of yields, nutritional value or economic return. The output could also be an environmental service or function. Water productivity can be at different scales and for a mixture of goods and services.

Trade in water is already happening

Though the thinking of trade in terms of water is fairly recent, trade in virtual water is as old as agricultural trade itself. Virtual water flows from exporting to importing countries inevitably take place as a by-product of the global food trade.

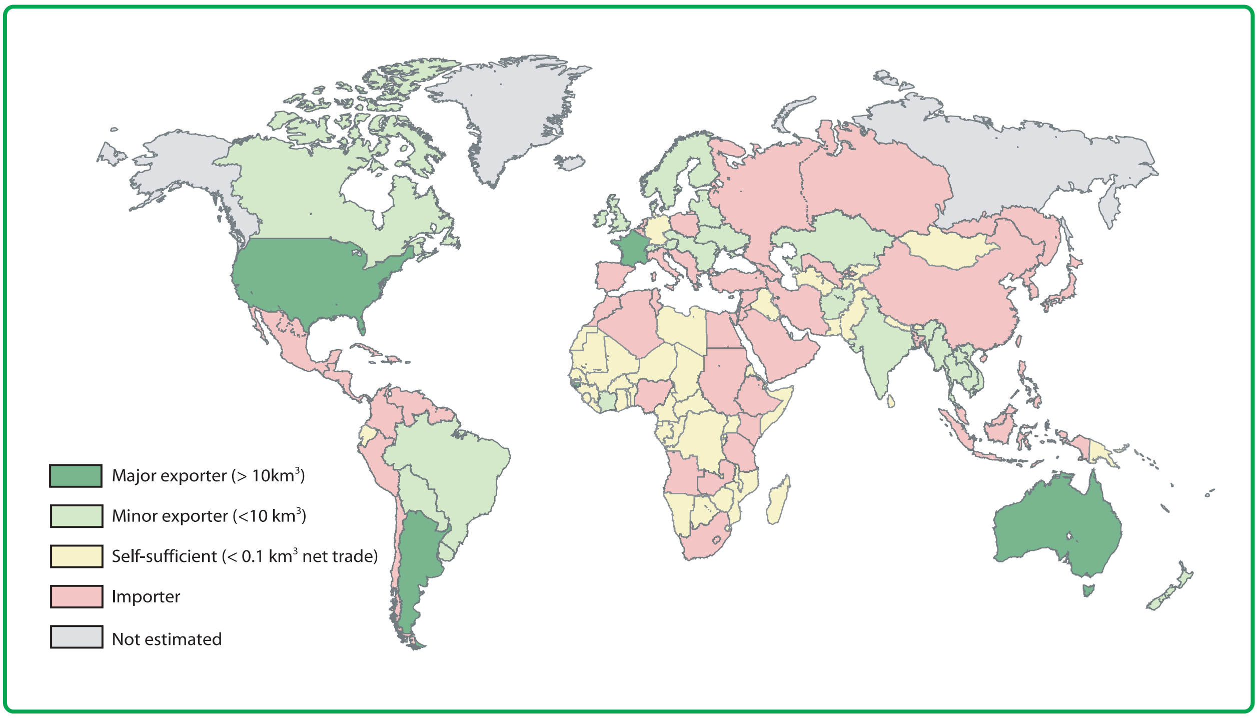
The study of the Comprehensive Assessment of Water Management in Agriculture presented in this policy brief quantified global virtual water flows—water imported in food, or exported in food—in the past from 1981 to 2000 and in the future in 2025.

In 1995, some 1,724 million tons of grain (or 12% of the global production) was traded. Eighty percent of all cereal exports are mainly grown under rainfed conditions in five regions—the USA, Canada, Argentina, Australia and the European Union. In total, 269 km^3 of crop water was depleted in the exporting countries to produce the traded amount.

Cereal importers—around 25 countries in Asia, the Middle East and Africa account for 80% of all cereal imports—would have depleted 433 km^3 of crop water and179 km^3 of irrigation water to produce the traded amount domestically. China, Japan, Korea, Indonesia, Egypt, Mexico and Iran figure among the top 10 cereal and virtual water importers.

Many sub-Saharan African countries do not feature as major food importers despite their relatively low agricultural production. This is due to the lack of financial resources in these countries to import food to meet the recommended consumption levels.

Figure 1. Trading of virtual water in 2000 due to crop trade



August 2006

The map above shows virtual water importers (in red) and exporters (in green).

Does trade save water?

Food trade saves water in the importing country. Japan—the world's biggest grain importer—would require an additional 30 billion cubic meters of water to grow the annually imported cereals on its soil. By importing grain, Egypt—a highly water stressed country—saved some 8.5 billion cubic meters of irrigation water—one sixth of the annual releases from the High Aswan Dam (fig. 2).

Globally, agricultural trade has a moderating impact on crop water depletion and irrigation water demand. Cereal trade saves crop water depletion because exporting countries tend to use the available water more efficiently. On average, exporters consumed 1.2 m^3 of water per kilogram of grain through crop water depletion, while importers would have used 2.0 m^3 per kilogram. In addition, cereal trade also saves irrigation water because major cereal exporters produce under highly productive rainfed conditions, while the main importers would have relied on irrigation. Without cereal trade, irrigation water depletion would have been higher by 112 km^3—or 11 percent.

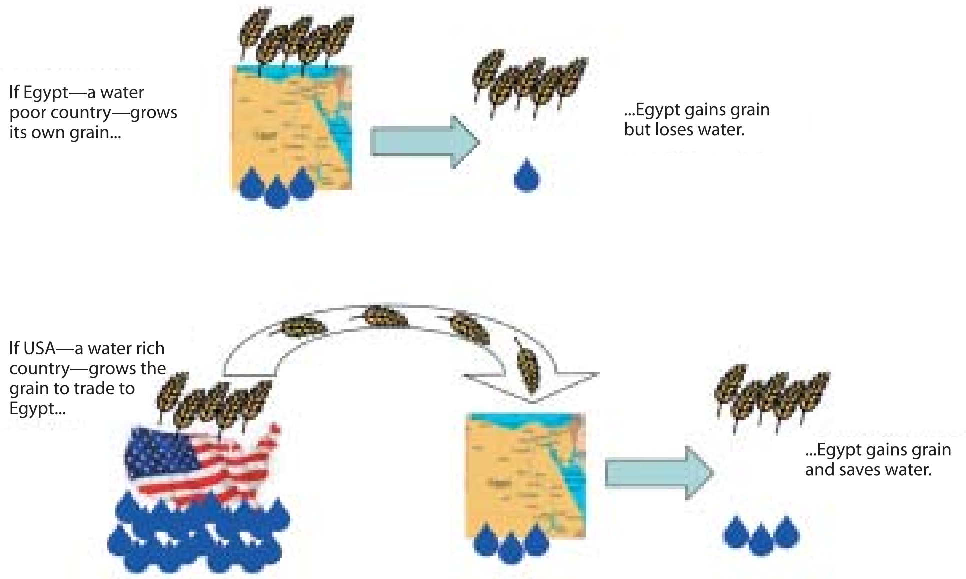
A steady increase in cereal trade does not necessarily translate into an increase in virtual water flows. Over the period 1980-2000 cereal trade volume grew by one third while the volume of virtual water traded remained at the same level and "savings" through trade increased only slightly. Figure 3 explains why. The growth in water embedded trade volumes was offset by improvements in crop water productivities in both importing and exporting countries.

Not all water 'saved' by trade are real savings

Trade in food and virtual water results in 'real' water savings when the water saved can be reallocated to other uses, such as environmental uses. Many traded crops are grown under rainfed conditions. Rainwater usually cannot be allocated to other uses besides alternative rainfed crops. Reductions in irrigation water depletion result in 'real' water savings. For example, importing paddy rather than growing it can result in irrigation water savings, though not necessarily. In Asia, during the monsoon, the combination of abundant rain, floods and limited storage capacity means that there is no alternative use for the water 'saved' by importing paddy rather than growing it.

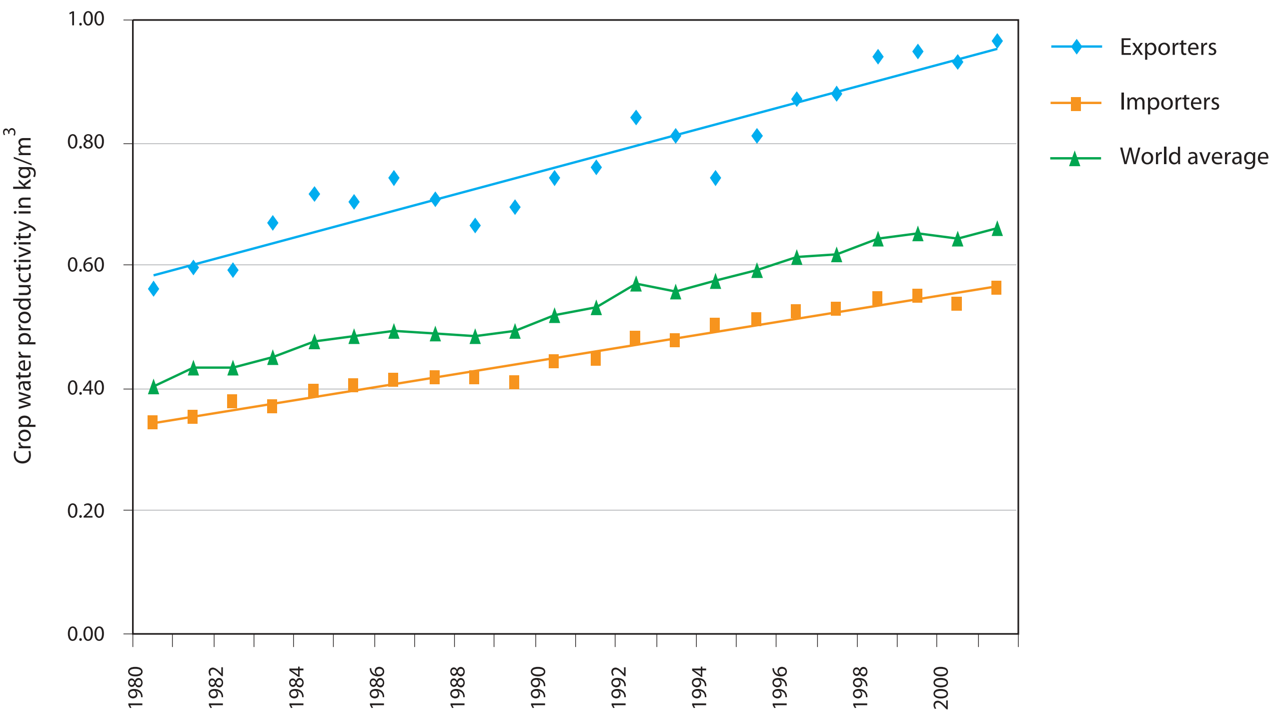
Figure 2. Egypt and USA—traders of cereals and water

Egypt imports 8.5 billion m^3 of water per year through cereal trade



In 1995, **EGYPT**—a highly water-stressed country—imported 8 million tons of grain from the USA, where most grain is grown under rainfed conditions. By importing grain, Egypt saved over 8.5 billion cubic metres of irrigation water—a sixth of the annual releases from the High Aswan Dam.

Figure 3. Water productivities of exporters and importers, 1980-2000



Some countries where water resources are very scarce often have no option but to import. Egypt for example cannot grow all cereal that it currently imports because it does not have the necessary water resources at its disposal. Thus, it is misleading to hold up Egypt as an example of water 'savings' through global trade since, to begin with, it has little or no water to save.

How important is trade in mitigating water scarcity?

Though the potential of trade to reduce water use is large, agricultural trade does not, at present, play an important role in global water scarcity mitigation. Water scarcity is just one among multiple drivers of food trade. Most trade occurs for reasons unrelated to water—less than a quarter of cereal trade occurs from water abundant to water scarce areas (for example from Europe to North Africa and the Middle East). Three quarters of the cereal trade takes place between water abundant countries, and major water importers are not necessarily water scarce. In some countries land rather than water is the binding constraint. For example, Japan—the largest importer—requires "virtual land" that comes with cereal trade, rather than "virtual water". Fast growing and industrialized economies sometimes have labor rather than water shortages. Water savings through trade are related to productivity differences between importers and exporters and are merely a by-product of trade. Saving water is not generally a factor taken into consideration in formulating agricultural trade policies.

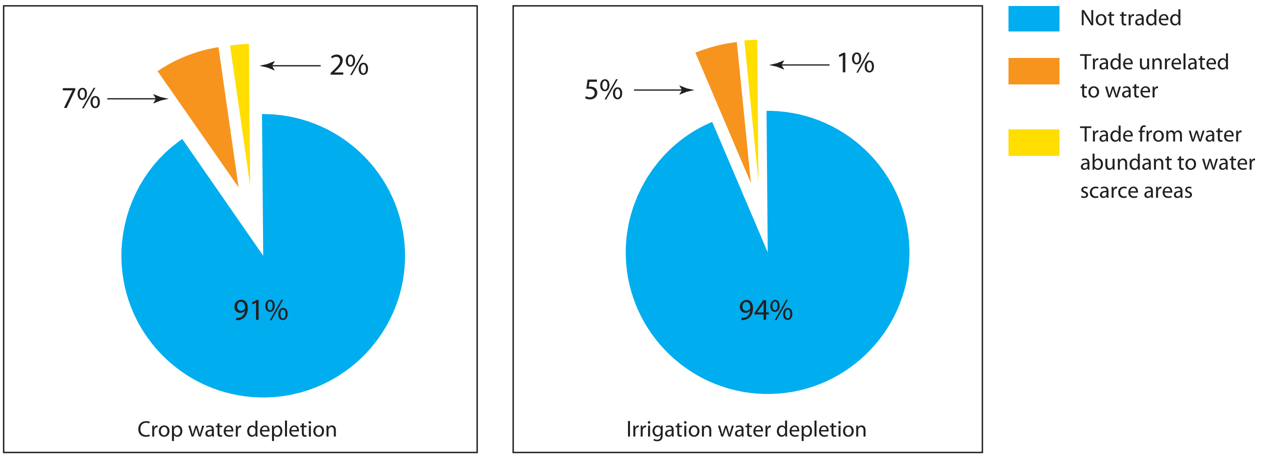
Food trade can have positive as well as negative implications for water use and ecosystems. On the one hand, expanding trade in countries where agriculture is mainly rainfed might come at the expense of ecosystems in those countries where more land needs to be put under production. Wetlands and other fresh water ecosystems as well as forests are the target of these expansions and may be irredeemably damaged. On the other hand, the export of a seasonal crop such as rice—grown in Asia when water is abundant—can be beneficial as the paddy fields play a buffer role for floods and enhance groundwater recharge.

Will the role of virtual water trade change in the near future?

Trade forecasts by Rosegrant et al (2002) indicate that trade volumes are expected to grow and thus volumes of virtual water traded will also increase. By 2025 cereal trade may reduce irrigation water depletion by 191 km^3 or 19%. Today nearly one quarter of food trade occurs from water abundant to water short areas. With global water shortages increasing, this percentage may rise by 38% in the year 2025. Trade has and will continue to have important implications for national and global water use (table 1)

But improved productivity in irrigated and rainfed areas may play a more prominent role in future water conservation than cereal trade. The same projections by Rosegrant et al (2002) indicate that water productivity improvements may reduce global water use by 1,205 km^3 between 1995 and 2025. This is in contrast to the 355 km^3 which would be saved as a

Figure 4. Water depletion in global cereal production



More than 90% of the crop water depletion occurs in crop production for domestic use. In 1995 only 9% of crop water depletion was used to produce traded crops. Of the traded amount only an estimated 25% was water related, while three quarters of the trade occurred between water abundant countries.

Table 1. Cereal production and global water use, summary table

1995	Million tons	km^3 of ET	km^3 of irrigation
Global cereal production	1,724	2,875	979
Total traded*	215		
Depleted by exporters		269	67
'Saved' by importers		433	179
'Savings' because of trade		164	112
Trade related to water scarcity	52	64	15
2025 projection based on Rosegrant et al. (2002)			
Global cereal production	2,615	2,981	1,013
Total traded*	343		
Depleted by exporters		337	64
'Saved' by importers		695	256
'Savings' because of trade		358	191
Trade related to water scarcity	130	128	24

result of trade. Where productivity is low, water-short importing countries will increasingly face the choice between growing imports or the pressure to use water resources more productively. In most importing countries there is still scope to conserve water by increasing "crop per drop".

Can trade be used as a policy tool to mitigate water scarcity?

International trade provides water short countries an option for responding to increasing water scarcity but the importance of this option depends on many factors, including international trade agreements, the costs of engaging in trade, and the nature of domestic economic objectives and political considerations.

Increasing international trade comes at a substantial cost, especially to developing countries. Foreign exchange is required to pay for food imports, and for many poor countries this is earned only through exports, grants or loans. However, the costs may not be immediately apparent because these countries receive large amounts of assistance from donors either in terms of hard currency or through subsidized exports from the United States and Europe. Many developing countries, particularly in sub-Saharan Africa, do not export enough to be able to pay for imports. Moreover, countries whose economies depend on one or few export products are vulnerable to changes in terms of trade which affect their purchasing power. Trade also requires a considerable amount of energy for transporting goods, which adds to the environmental costs.

For poor countries struggling with issues of food security, depending on imports from trade to meet basic food needs is risky. Such a strategy is viewed as one that increases their vulnerability to global fluctuations in market prices as well as to geopolitics. Reaching a level of food security is still an important policy goal and, despite emerging water problems, many countries view the development of water resources as a more secure option to meet food supply goals and promoting income growth, particularly for poor rural communities. It is also uncertain that water-scarce countries who cannot afford sufficient investments in water infrastructure can afford to import large amounts of agricultural commodities. As recent negotiation under the umbrella of the World Trade Organization illustrate, the economic and political interests associated with agricultural trade are likely to dominate water scarcity and environmental concerns in a considerable number of these countries.

High potential but many issues

The idea of food trade as an answer to water shortages is appealing. But firmly established political, social and economic interests in agricultural trade will limit the potential of this option. Under the prevailing political and economic climate, it is unlikely that food trade alone will solve problems of water scarcity in the near term.

Iran is struggling to improve agricultural productivity. The country is among the top ten cereal and virtual water importers. Photo Credit: Jonathan Woolley

Water Policy Briefing Series

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IWMI is a non-profit scientific organization funded by the Consultative Group on International Agricultural Research (CGIAR). IWMI's research agenda is organized around four priority themes covering key issues relating to land, water, livelihoods, health and environment:

Theme 1: Basin Water Management: *understanding water productivity*
Theme 2: Land, Water and Livelihoods: *improving livelihoods for the rural poor*
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The Institute concentrates on water and related land management challenges faced by poor rural communities in Africa and Asia. The challenges are those that affect their nutrition, income and health, as well as the integrity of environmental services on which food and livelihood security depends. IWMI works through collaborative research with partners in the North and South to develop tools and practices to help developing countries eradicate poverty and better manage their water and land resources. The immediate target groups of IWMI's research include the scientific community, policy makers, project implementers and individual farmers.

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