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# Water – the Essence of Growth

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*Water has played an important role in human history and civilization. The aim of this article is to demonstrate that water – with its specific features – is essential in economic development. In the first place it is deduce how water found its place among economic goods. Secondly, the demand and supply of our days is detailed with an outlook to imminent changes related to the growth of population and climate change. Finally, the role of water in development will be evolved considering the challenges and the means of a favourable outcome.*

*Keywords: water, economic growth, sustainability, climate change*

## Introduction

The wide spread of crisis in water management is well known among economists and water professionals. Though it has been recognized many decades ago, still the ultimate solution has yet to be found. This rises urging concerns as the role of water in economic development is becoming more and more evident.

Scientists, politicians, engineers try to determine different aspects of the problem with approaches from their field of proficiency. But the special features of water makes their work challenging: its ever changing availability, shrinking quantity and degrading quality transforms economic definitions and approaches.

# 1 The economic concept of water

Water is one of the most common natural resource that can be found on Earth. Still, it has been hindered to establish its concrete place in economics for many centuries. To understand the complexity of the problem, one must look in detail into the concept of value and the many ways water is used. Obviously water as a commodity played an important role not only in the clarifying of the economic concept of value, but also in developing the necessary operational processes for measuring it.

## 1.1 Interpreting value in economics

To start with, it must be understood, that value has two separate meanings in economics: one is the value in use and the other is the value in exchange – with bearing in mind the comparison made by Smith between diamonds and water. According to Plato „only what is rare is valueable and water, which is the best of all things, is also the cheapest". Both definitions tried to express that the market price of an item needs necessary not reflect its true value. Looking further, Dupuit and Marshall pointed out that even items having no market price at all can have a positive economic value – a remark that has been accepted in modern economics only in the second half of the XX. century when the method of non-market valuation emerged [1]

In particular, water has a very specific feature, notably its marginal value declines sharply: people would pay very high prices for drinking water, as they need it to survive but tend to appreciate it much less when water is abundant. Therefore drinking water is a good with generally high consumer surplus.

## 1.2 Water: an economic good

A broader understanding of economic goods can be interpreted in the following: people may value a natural resource out of considerations unrelated to their own immediate and direct use of it, they may wish to preserve a future option of satisfaction or would like to protect it for future generations. [1]. In the following an overview will show, how economics arrived to this concept.

Ward and Michelsen equate the economic value of water with its market price. They state, that „the economic values of water, defined by its price, serve as a guide to allocate water among alternative uses, potentially directing water and its complementary resources into uses in which they yield the greatest total economic return" [2].

A new approach was the extension of the economic concept of value to a broader class of items than just market commodities: anything could actually be a market

good from which people derive satisfaction. This was formally demonstrated by Maler [3] when he showed that the modern formulation of the problem in terms of duality theory, carry over from the valuation of market goods to non-market items. His findings lead to the following conclusion: the natural environment is a common property.

At the 1992 International Conference on Water and the Environment the four Dublin Principles were declared. One of them holds that water has an economic value in all its competing uses and should be recognized as an economic good. The spectre of this sentence seemed to be wide: from "water is no different from any other economic good" [4] to "the Earth's freshwater belongs to the Earth and all species [5]. Baumann and Boland is correct when they point out that water is a necessity. However, water is perceived as having a special significance that most other commodities do not possess: its special economic features.

Furthermore, water is both a private and a public good. By contrast, most of the other commodities associated with food, shelter and clothing are purely private goods and have no public goods aspect. The public good nature of water influenced its legal status: in Roman Law and to an extent of Civil Law systems, flowing waters are treated as common to everyone (res communis omnium) and are not capable of being owned. These waters can only be object of rights of use [6].

The specific features of water highlights, why the road presented above was so rocky. The mobility of water and the opportunity for sequential use and re-use make water relatively distinctive as commodity. By consequence, it is essential to find the tools to internalize the externality associated with the mobility and return flows.

The variability of water supply in terms of space, time, use and often quality had a major impact on the global prise of the good: the uneven distribution on the globe, the distribution of precipitation for a given region and the use for example in agriculture, where irrigation is needed only in well-defined periods of the year.

# 2 Uncertain supply

The challenges the world will face in adapting to water issues are enormous. According to many projections [6], as the water cycle is a closed dynamic system, the total volume of runoff will be relatively stable and the amount of global surface water remains fairly fixed. The problem roots in more complex aspects: these are the extremities that will cause major concerns. More frequent natural disasters are imminent: droughts, floods, uneven precipitation escalating in torrential rainfalls, higher water temperatures and all the consequences that are

related to these tendencies. The changing environment obviously affects the water supply making it more unpredictable.

## 2.1 High and dry

Those countries which experience already considerable amount of water stress will become even more water scarce: the MENA region, Central Asia and Central America. Notably, much of the decline in runoff is projected in the least developed countries. When drought hits a region that is already water stressed, migration to the cities is induced: economic migrants head to the urbanized area, instead of seeking other alternatives for adaptation strategies. Drying events are thought to have fueled transboundary invasions back in the ancient times: China and Egypt experienced these threats that lead to political instability. Today, due to the delicate nature of war – where the process is generally costly and outcome is rather uncertain – even in transboundary water conflicts, disputes are mediated and peaceful resolution is facilitated on an international level. However, water conflicts within a country are much more widespread: water shocks are usually followed by spikes of violence leading to regime change in developing countries. No surprise, these are the areas, where population living on the edge reacts sensitively to the slightest decrease in income.[6] Hungary has a very privileged situation with its many affluents. However it must be considered that the amount of water entering the country is decreasing: according to the Hydroinfo databasis the average Danube level decreased by 1cm in average in the last 100 years.

## 2.2 When it's too much

Floods cause a more visible and perhaps an even more rapidly growing toll. A recent study used meteorological data to reconstruct every country's exposure to tropical cyclones during 1950-2008 [6]. It found that national incomes decline after a disaster an do not recover within 20 years. The results suggest that future cyclone activity would result in costs of about $10 trillion larger than previous estimates. What aggravates the situation even more is that the process of urbanization is the most dramatic in low- and middle-income countries: the number of dwellers is projected to grow by 2.5 billion people [6] mainly in flood-prone areas, deprived of municipal water, sanitation and flood protection.

In case of Hungary unprecedented floods raise major concerns: in 2013 historical flood records were registered along the Danube without severe consequences, for this time. But it is essential to bear in mind, that more than one quarter of Hungary's population is served by piped water produced by river bank filtration – therefore flood protection should become a priority in water management in the country.

The economic effects of water shocks are diverse. It can cause nutritional deficits or health impacts in young children, or income shocks that prevent families from investing in their education. The fetal origins hypothesis demonstrates – and mounting evidence shows – the important role that early-life conditions can have on future life success [7]. A less competent population with hindered economic background obviously decelerates or even detain growth.

## 2.3 Treasure underfoot

Aquifers contain about 30 percent of the available freshwater of Earth and act as a natural buffer against climate variability [6]. If protected and managed along with surface water, groundwater can do much in adapting to climate change. It loses negligible amount of water through evaporation and transpiration. Long retention time and slow response make it more buffered against environmental changes. However, the quality of ground water is influenced by climate change too: rising sealevels push seawater inland, resulting in quality issues.

To conclude the above presented it is essential to see, that in the present situation an improved water supply for the nearly one billion people around the globe is needed. But it should be considered too, that the world's population is still increasing in those areas where water security is still a major issue to be resolved. Hungary is renowned internationally for being rich in groundwater. However recently it has been proved that the groundwater level is decreasing and the natural habitats in many parts of the country are becoming endangered.

# 3 Thirsty demand

The total amount of water demand has been challenging to define. The World Bank created a new perspective to determine the drivers of demand: farms, cities, energy and environment – called the expanded water nexus, represented in Figure 1. According to their concept in the coming three decades the global food system will require 40-50% more water, municipal and industrial water usage will increase by 50-70%, the energy sector is projected to experience a boost of 85% while the environment will receive even less and worse of water [6].

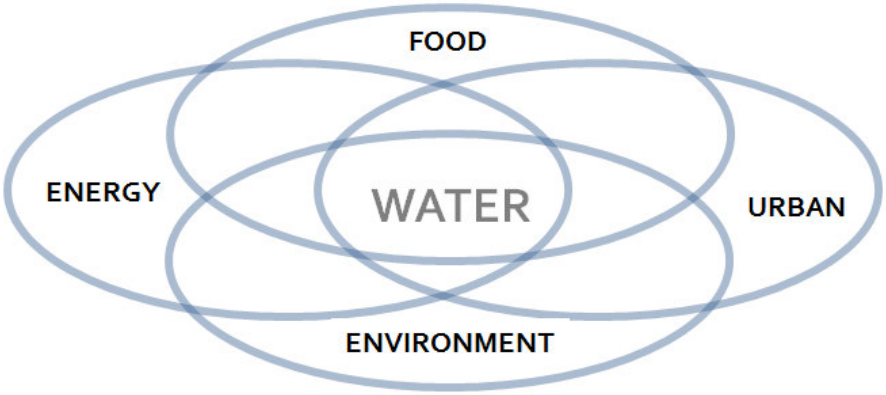


Figure 1.
The expanded water nexus [6]

## 3.1 Meeting food security challenges

Water fits the definition of essential final good: no life is possible without water. Biologically human life is not possible without at least 5-10L/day per person of water. The UN and the WHO determined the limit 20L/day per person, while Gleick [8] argued that this limit was too low and advocated that the basic human need should be at least 50L/day per person. However, if we compare this necessary minimum, with the average water consumption in the developed world - about two magnitude of difference - it can be declared, that water demand grows sharply as life circumstances improve.

On the other hand it is important to see, that as life is impossible without any access to water, the problem for those, affected by water security issues are more related to quality. These two observations highlight the need to adopt a behavioural approach, where the focus is not on the need but rather on the amount of water that is covered by the willingness to be paid. World Bank has experience of studying the phenomenon. It proved that households spend considerably more on water – mainly to purchase water from vendors – than the expected 3-5% of income. The question therefore is how much people value piped, public water supply relative to the existing alternatives. Compared to electricity – another influential service - water is lagging behind [6].

Sustainably feeding 9 billion people by 2050 is one of the greatest challenges: food production needs to duplicate over this period while methods must be found that do not degrade natural resources [6]. The agriculture consumes already 70% of the available freshwater – being the single largest anthropogenic water user. Little additional surface water is available in many parts of the world. The increasing number of closed basins is becoming an urgent problem: groundwater

aquifers are heavily exploited and groundwater abstraction requires approximately 30 percent more energy than surface water irrigation. This results in significantly higher greenhouse emissions: 4 to 6 percent of India's total carbon emissions. Not to mention the water quality related problem of fertilizers: in the most developed parts of the globe phosphorus and nitrogen concentrations have already reached unsafe levels [6].

## 3.2 Changing cities and changing climate

Over half of the world's population lives in cities that generate about 80 percent of global GDP. And the world keeps on to become even more urbanized: in the next three decades water demand is expected to increase by 50 to 70 percent. One in four cities worldwide experiences water insecurity. Flooding, heat waves and rising seas can degrade the quality of surface and ground water that can indirectly disrupt the urban economy. In Jakarta flood related financial losses reached $900 million in 2007, when a major flood occurred reaching 25% of the city. And things will get worse: the city confronts a sea-level rise of 60 cm or more over this century – the Northern parts of Jakarta are predicted to be 4 to 5m below sea level within 20 years [6].

## 3.3 Water for energy

Cleaner energy sources consume surprisingly high amount of water causing distinct trade-offs between the use of water and energy.

Surprisingly, the thirstiest business among the renewable energy sector is solar energy production. Desalination and water recycling are not economically feasible options for lower value added uses: desalinated water costs about 4 to 5 times more than treated surface water. Wind turbines are the best choice, if one considers water performance [6].

## 3.4 Environmental water requirements

Environment is the residual claimant of water resources: receiving what is left behind by the previous uses and much of this is polluted. It is estimated, that 20 to 50 percent of the total available water in each basin is required to maintain plant and animal life and sustain critical ecosystem services like water purification, while temperature changes will likely increase the needs of these ecosystems. It is especially challenging, how to determine the environmental water requirements – as each and every waterway has unique circumstances. The Australian experience is a very good example of environmental stewardship as smart water resource management can partly mitigate the environmental impacts [9].

# 4 The fuel of economic growth

It is known that many of the world's major cities owe their origin to their location along coasts or rivers where water-borne transportation was facilitated. However evidence is less obvious and more negative as of today while it is surprisingly difficult to measure the concrete benefits associated with an increment in water availability; these difficulties are clearly evident in the literature on water and economic development.

In 2015 the UN has determined seventeen Sustainable Development Goals with clean water and sanitation listed as the sixth. Considering the expanded water nexus presented in connection with demand, it can be deduced how all sectors of society are interlinked through the common currency of water. This is an essential cornerstone to start from while defining the relation between water availability and economic growth [10].

However, water shortages are becoming more obvious, much of the world's water is used inefficiently by industry, cities and agriculture even in arid areas; and much of it is wasted without economic benefit, often with negative economic impacts. It seems that having an adequate supply of water might be a necessary but not a sufficient condition for economic growth: with areas lacking an adequate amount of water will not flourish economically. When water is in short supply, there will be changes in what is produced, where it is produced and the efficiency of production.

But vulnerability discourages major investments – especially water infrastructure related projects. This tendency affects the Poor, as their circumstances will not be ameliorated: poor households are less robust and more vulnerable and also tend to be located in higher risk areas, that are prone to be more affected to water related threats.

The third threat being climate change has important consequences as well. The expected global damages are small relative to the expected global GDP in 2050, ranging between 0,37-0,49, while significant variations exist between regions[6]. Western Europe and North America, where much global GDP is produced, experience negligible damages in most scenarios. The bulk of losses are in the Middle East, the Sahel and Central and East Asia and the magnitude of losses is largely driven by the level of the water deficit. The economic consequences are highly unequal with the worst effects in the driest regions.

# 5 Balancing water

Water is a complex natural resource. About 1.6 billion people live in countries with physical water scarcity – a number that will double in only two decades. This results in an ever increasing constraint: demand for water is ever increasing, but supply remains fixed and more variable.

According to Karl-Göran Maler the basic cause of environmental degradation is the failure of the markets to deal adequatly with public goods [11]. It is therefore essential to find the way to allocate water to sectors and uses where demand and value added is greatest.

While in the World Bank report [6] it is stated that the problem of water is not one of economics but politics, not one of physical shortage but governance – where the generic problem of water is one of matching demand with supply, of ensuring that there is water of a suitable quality at the right location and the right time.

When governments respond to water shortages by boosting efficiency and allocating water to more highly-valued uses, losses decline dramatically and may even vanish. Improved water stewardship thus pays high economic dividends. Prudent water-management policies can do much to secure growth. This requires using market forces and prices to guide water allocation decisions. The benefits to managing water resources as a valuable economic resource are considerable. Water that is provided free, promotes and condones overuse and waste. More efficient water pricing, coupled with policies that safeguard the most marginal members of society, can therefore ensure that sufficient water is conserved and guarantee enough water to meet basic needs.

The prices paid by industry, agriculture and residential users are often unrelated. Furthermore the price of water that most users pay for water reflects its physical supply cost –capital and operating costs - and not its scarcity value. However, some countries – including Hungary – levy an abstraction charge for water these charges tend to cover rather administrative fees and are not based on an assessment of the economic value of the water being withdrawn.

# Conclusions

According to those that have been summarized in this article, it can be understood that water is an economic good and that it has an obvious effect on economic growth. However, it is not a direct connection: it manifests through water availability and uncertainty that is becoming an ever increasing issue. Efficient allocation across water sources and uses are essentials for long term achievements while growing populations, rising incomes, and changing climate all three increase

the competition for a limited resource. To alleviate the problem solution must be found by the means of economic models and effective policy programs must be established on a global level.

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