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# CHAPTER 11
# ECONOMICS OF DRINKING WATER


**Abstract**

This chapter provides a foundation to the understanding of key concepts and theories used in water economics. In accordance with this approach, firstly explained from an economic perspective conception of water and different characteristics from other goods. Then it considered demand and supply of water used for domestic purposes. Unique characteristics of water affect the water supply and demand and hence conditions in the domestic water market equilibrium. Therefore, focused on how supply and demand effect the prices in the water economy and generally, why prices do not reflect market prices. It then goes on to describe the key issues related to the economic efficiency of water market.


## 11.1. Introduction

Until the latter part of the 20th Century, nature as a factor of production was considered of less significance in many economy books. Water was not in the area of interest of economists. Throughout history, Adam Smith, David Ricardo and Malthus, along with other classical economics, have recognized land as a production factor (meaning all natural resources). However, it is possible to say that the argument between limited resources and development began with Thomas Malthus (1766-1834). The Law of Diminishing Returns theory was strongly advocated by Malthus. According to the theory, as more capital and labor inputs were applied to a fixed amount of land, the marginal product of capital and labor combined eventually would decrease and so would output per capita. As different from other classical economists, Malthus concentrated on the short term instead of the long term and land was the constant. The Neo-classical economists mainly concentrated on labor and capital. In fact, in the past, indirectly renewable natural resources was easily included in the production process and assumed to be inexhaustible and infinite in accordance with the current demand. For example according to Marx, natural resources can be used as free goods. He supposed that after removing private ownership, the future society can produce the products of nature with only the real production costs, i.e. (Krautkraemer 2005).

However, the conditions of today have changed considerably. The population has grown nearly 7.5 fold since the industrial revolution. The world's population is growing by roughly 80 million people each year. The urban population of the world is forecast to grow to 6.3 billion people in 2050 from 3.4 billion in 2009, representing both population growth and net migration from countryside to city (WWDR, 2015). With such issues as global climate change and atmospheric pollution, natural resource depletion, industrialization, the environment has become one of the scarcest factors. Economics, as the science investigating how scarce resources can meet the unlimited needs of man, is not indifferent to these developments; leading to the emergence of the new field of environmental economics. As one of the fields under the umbrella of the science of economy, environmental economy investigates the problems of the environment in relation to the economy and the contribution of conservation of environment and natural resources on the economy, and it encompasses many sub-fields such as Economics of Energy, Economics of Water Pollution, Economics of Water, Water Resources and Economics.

Today, one of the most problematic areas of natural resources has become water. In general, water is used in agricultural irrigation, meeting industrial needs and for domestic purposes. Changes in lifestyles and eating habits in recent years are requiring more water consumption per capita. As mentioned above, rapid population growth, urbanization, industrialization, global climate change and atmospheric pollution, or leakages from the distribution system, remain factors which limit the demand of safe water. Moreover, many underground water reserves are already running low, while rainfall patterns are predicted to become more erratic with climate change. By 2050, global water demand is projected to increase by 55%, mainly due to growing demands from manufacturing, thermal electricity generation, and domestic use. According to the United Nations World Water Development Report 2015 “unless the balance between demand and finite supplies is restored, the world will face an increasingly severe global water deficit” (WWDR 2015).

### 11.2. The Importance of the Economy to the Water Sector

Water, as a naturel source a fundamental component of human life. Clean drinking water and adequate sanitation are fundamental to the well-being of individuals and society as a whole. Water’s special character of being essential to health as well as a key component in social and economic activities, has resulted in a special cultural status and consequently a special position in public policy. Freshwater resources have traditionally been regarded as something to which all members of the human community have rights to access However, water is a basic human need and access to minimum quantities of safe water (20 liters per person per day) should be everyone’s right. Access to clean water –and sanitation - is considered by many current international agendas and platforms as a basic human right, indispensable for leading a healthy and dignified human life (URL 1).

In fact, in the past, applications of water resource management for access to clean water and sanitation were considered to be related more so to the technical and engineering fields. Today, this approach is considered as one which is more directed to demand and there has been a shift to a more integrated approach. Water is the main factor, which established the network of relationships between energy, food safety and the environment. A holistic approach must be taken for defining of the problem and the also the solution process in this complex structure. Thus, it has become even more important to efficiently and effectively manage water sources, which are increasingly becoming more polluted and depleted. Today, access the clean water is highly capital – intensive, and capital is also scarce (Green, 2003). Water supply and sanitation require a huge amount of capital investment in infrastructure such as pipe networks, pumping stations and water treatment works. It is estimated that OECD nations need to invest at least USD 200 billion per year to replace aging water infrastructure to guarantee supply, reduce leakage rates and protect water quality (URL 2). The process of  to clean water (capturing the water as runoff or in the form of groundwater, storing the water -surface or groundwater- conveying it to the point of use) provides a scientific approach, playing a critical role in establishing multi-dimensional relationships between water sources and economy. The financial and economic dimensions affecting the use of water resources be it water extraction, pollution or allocation, across different economic sectors like agriculture, energy, industry and urban water supply as well as between local, regional and transboundary river basins. Water Resources and Economics aims to contribute to the development of advanced integrated hydro-economic modeling at river basin, national and international scale, water resources valuation, the design and evaluation of water policy instruments, including water markets, and the economics of public water supply, sanitation and waste water treatment in developed and developing regions (Brouwer 2015**).** ) Further, water plays an important role for national economies, as water is the main input for many sectors. A country's overall development strategy and use of macro-economic policies -including fiscal, monetary and trade policies - directly and indirectly affect demand and investment in water-related activities (Sanctuary, 2005).

### 11.3. Economic Characteristics of Water

There are challenges to categorizing water, or attempting to define it in an economic sense; because water can be considered in a multitude of dimensions in terms of the sources of the water and its use. Water provides goods (e.g. drinking-water, irrigation water) and services (e.g. hydroelectricity generation, recreation and amenity) that are utilized by agriculture, industry and households. Provision of many of these goods and services is interrelated, determined by the quantity and quality of available water. Management and allocation of water entails consideration of its unique characteristics as a resource (URL3). While defined as a free good in the past, its definition has changed as it has become scarce. Today, water is considered an economic good, by means as to how it is considered in our current day. Economic goods are those which are subject to a production activity; thus, they are good which require labor, time, technology and allocation of resources. Water was suggested to be considered and managed as an economic good for the first time in 1992 during the “International Conference on Water and Environment” held in Dublin. According to the Dublin Principles accepted at the Conference, water is considered to be a value such that it contributes to economic activity and, in this context, has economic value in all various fields of its utilization. However, here it should be especially noted that, although water is defined as an economic good, it does not mean that all its costs can be charged. The fourth Dublin Principle defines water as an economic good, by keeping in mind the right to access to safe water by persons in poverty, and emphasizes its social dimension[1.] There is consensus on this matter, be it in local economies or at the international level.

In addition, good and services divided into private and public goods and services. In a market economy the allocation of scarce natural resources (such as coal, oil, fish, crops, and timber) is typically determined by trade in markets. However, water resources have a number of unique characteristics which mean that traditional market mechanisms can lead to inefficient and inequitable allocations. This creates questions over whether water should be considered a public or a private good (White, 2015). Private goods involve two properties: rivalry and exclusion. Rivalry essentially means that if I consume the good you cannot. Exclusion means that if I consume the good you are excluded from any effects from that consumption: there are no

[1]According to *The Fourth Dublin Principles* “Water has an economic value and should be recognized as an economic good, taking into account affordability and equity criteria” ICWE (1992).

‘externalities’ (Shaw 2005). One of the most familiar uses of water is at the household level of drinking, gardening, etc. These kind of uses can be described as rival in that an individual drinking of glass of water can prevent other from drinking it, and excludable in that when it has been consumes nobody else can use it (White 2015). Also, bottled water is a private good because of is consumed by someone then disposed of. Property rights can lead to creation of a private good. Private property, such as a home, is protected via property rights established by laws. However, water rights are not typically defined in the same way as the property rights for one’s home. Often, water rights are legal rights to use the water – the volume of water itself is not owned by the individual (Shaw, 2005). Public goods are non-rival goods: one unit of your consumption does not lead to me not getting to consume that unit. Public goods may also involve externalities. That is, benefits and costs are not fully reflected to market prices. Because of non- excludable and non-rival a water sanitation is public good. Also, flood control services are public nature. Nonrivalry is linked to the high exclusion costs of water. And this brings to free-riding, i.e. to the enjoyment of water by those who have not helped pay for its cost of production (Farolfi 2011). Dirty water would be a public good, but clean fresh water is definitely rival but not necessarily excludible is it is a lake or aquifer. Also, recreation on lakes and the ocean would be considered a public good (URL 4).

There are mixed products in terms of rivalry and excludible features. Of these, club goods (for example, shared irrigation) are excludable, but non-rival. In contrast, common–pool goods, e.g. water in aquifer, are non-excludable and are rival. On the other hand, other types of economic commodity values associated with water may not require it to leave the hydrologic system. These are for instance the waterways transportation and hydroelectric power generation. These are therefore called *instream* uses and because they involve very little consumption of water, they are called nonconsumptive uses. These uses have some aspects of rivalry of private goods. (Farolfi 2011). To conclude, the use of water (in the course of its utilization) is considered both a private and public good according to the source of the water.

The other characteristic features of water can be summarized as follows:
Water is a 'bulky' resource: Although water is essential for almost any economic activity, there are not many examples of water being transported over any considerable distance, particularly not against the force of gravity (Zaag 2006). This means that its economic value per unit weight or volume tends to be relatively low. Therefore, its conveyance entails a high cost per unit of volume and is often not economically viable over long distances unless a high marginal value can be obtained (URL 5).

The essentialness of water: The concept can be applied either to something that is an input to production or to something that is directly enjoyed by people as a consumption commodity. In the case of an input, if an item has the property that no production is possible when this input is lacking, the item is said to be an essential input. In the case of a final good, if it has the property that no amount of any other final good can compensate for having a zero level of consumption of this commodity, then it is said to be an essential commodity (Hanemann 2006).

Water is non-substitutable: There is no alternative for water. Economic theory is based on the existence of choice. But what alternatives are there for water? There is no alternative, there is no choice. The only exception is coastal cities that could afford to produce fresh water from seawater through desalinization. Being essential and non-substitutable, water is considered a special economic good (Zaag 2006).

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### 11.3.1 Supply of fresh water - The quantity of fresh water

In the last 50 years, although the amount of water has remained the same, the water withdrawals has increased three-fold (WWAP, 2012). In many regions, the ground water withdrawal is more than the feedback or sustainable amounts. Water sources are significantly affected by global changes. There are very few ground water or surface water systems, which have not been affected by human activity. Therefore, the amount (quantity) and characteristics (quality) of the supply of water has become an important component. In other words, the water to be used should be of adequate quality and quantity. Thus, the research, investigation and discussions related to water focus on the components of quality and quantity.

Although three quarters of the surface of the earth is covered with water, the amount of fresh water suitable for use by mankind is considerably limited. The total amount of water of earth is 1.4 billion cubic kilometers. As can be seen in Table 1, 97% of this water is oceans and seas, while only 3% make up fresh water sources. However, of this, 2.5% are frozen and locked up in Antarctica, the Arctic and glaciers, and not available to man. Thus, humanity must rely on this 0.5% for all of man's and ecosystem's fresh water needs (WBCSD 2006). The below graph shows the available fresh water sources (Figure 11.1).

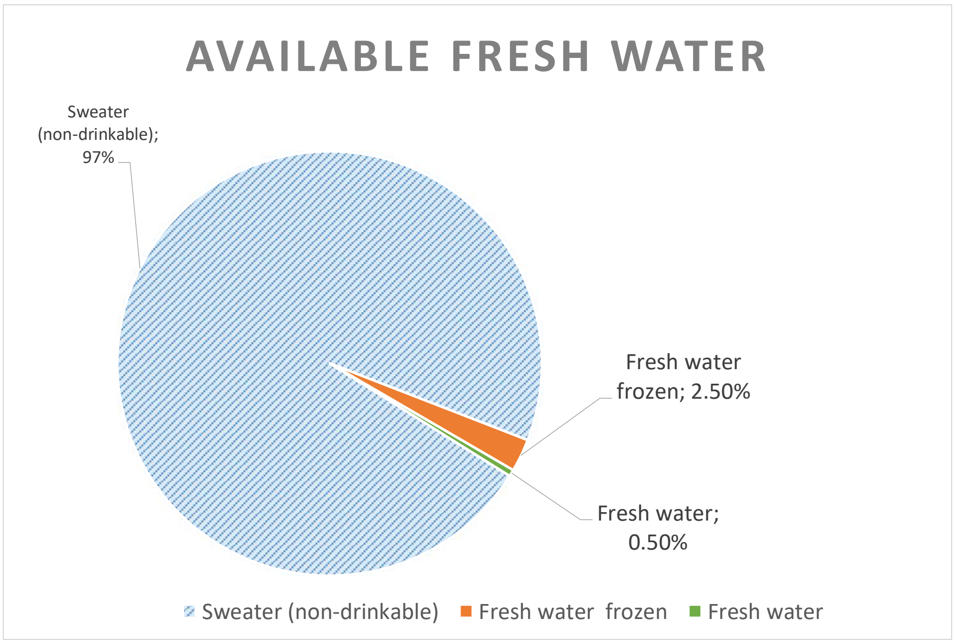


**Figure 11.1.** Available Fresh Water Resources **(**WBCSD, 2006)

#### 11.3.1.1 The quality of fresh water supply and its effects

As mentioned above, together with the rise in living standards, social and economic development increases the need for drinking water per person. In addition, the seasonal decrease in water resources, leakage in the distribution and supply networks, depletion of aquifers and steadily decreasing, led to a growing imbalance between water supply and demand. One of the most important factors causing this imbalance is water pollution. Government authorities and public and private institutions have striven to find solutions to reduce this problem. The main objective is to deliver good quality drinking water to consumers. The Millennium Development Goals aimed at halving by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation. Access to an improved water source refers to the percentage of the population using an improved drinking water source. The improved drinking water source includes piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection) (WDI 2015). Important progress has been made towards this goal in the World. The number of countries reaching the target are shown as follows (Figure 11.2).

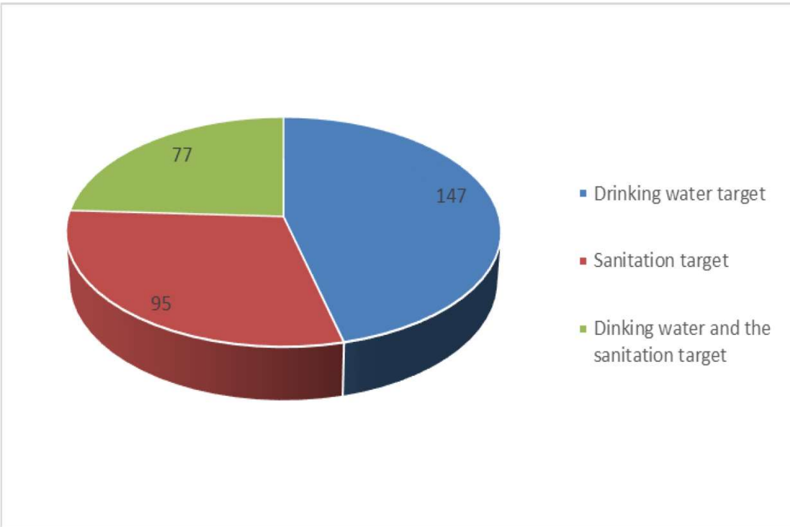


**Figure 11.2.** MDG Drinking Water Target and Countries (World Development Indicators, 2015)

According to the 2015 Millennium Development Report as of 2015 147 countries have met the MDG drinking water target 95 countries have met the MDG sanitation target 77 countries have met both the drinking water and the sanitation target. Thus, 2.1 billion people have gained access to an improved sanitation facility since 1990. Thus 68 % of the global population now uses an improved sanitation facility. However, Eight out of ten people still without improved drinking water sources live in rural areas. One in ten (663 million) people still lack improved drinking water sources. The world has missed the MDG target for sanitation by almost 700 million people. These differences between countries are shown as follows (Figure 11.3).

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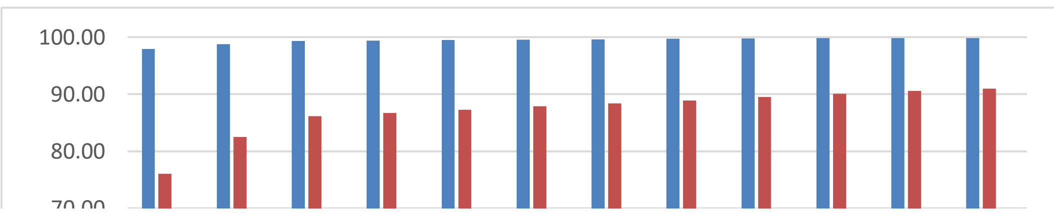

**Figure 11.3.** Improved water source (% of population with access) (database from World Development Indicators, 2015)

### 11.3.2. Economic benefits of water and sanitation improvements

There are many and diverse potential benefits associated with improved water and sanitation. However, there is an economic and social cost to accessing and treating safe drinking water. The following section outlines each of the benefits and costs.

The quantity of water delivered and used for households is an important aspect of domestic water supplies, which influences hygiene and therefore public health. First of all access to basic sanitation and adequate drinking water makes people healthier and more economically and socially productive" (URL 6). For example The United Nations (UN) reports that for every $1 invested in water and sanitation, there are around $8 gained through averted costs (for healthcare, illness etc.) and increased productivity. However, environmental pollution and water sources as a receiving environment for waste in recent years has meant that the quality of water is degraded in many water sources (ground water or surface water). This situation adversely affects the use (and the potential use) of water. To prevent pollution, the control of sources of pollution and treatment is necessary. Social and economic benefits of such investments to ensure this are of importance. Because lack of water supply, sanitation and hygiene takes a huge toll on health and well-being and comes at a large financial cost, including a sizable loss of economic activity in order to achieve universal access (WWDR 2015). According to Hutton and Heller (2004), who investigated the economic gain of increasing the quality of water, water and sanitation interventions is high when all benefits are included, standing at around between $5 and $11 economic benefit per $1 invested for most developing world sub-regions and for most interventions.

According to the authors, the total societal economic benefits can be listed as such:

(1) Health sector benefit due to avoided illness
(2) Patient expenses avoided due to avoided illness

(3) Value of deaths avoided
(4) Value of time savings due to access to water and sanitation
(5) Value of productive days gained of those with avoided illness
(6) Value of days of school attendance gained of those with avoided illness
(7) Value of child days gained of those with avoided illness

Table 11.1 shows possible these economic benefits related to water and sanitation improvements. As stated above these are classified in their own as Health benefits, Indirect economic benefits related to health improvement Non-health benefits related to water and sanitation improvement.

**Table 11.1**. Economic benefits arising from water and sanitation improvements (Hutton&Haller, 2004)

| **BENEFICIARY** | **Direct economic benefits of avoiding diarrhoeal disease** | **Indirect economic benefits related to health improvement** | **Non-health benefits related to water and sanitation improvement** |
|---|---|---|---|
| **Health sector** | Less expenditure on treatment of diarrhoeal disease | Value of less health workers falling sick with diarrhoea | More efficiently managed water resources and effects on vector |
| **Patients** | Less expenditure on treatment of diarrhoeal disease and less related costs<br>Less expenditure on transport in seeking treatment<br>Less time lost due to treatment seeking | Value of avoided days lost at work or at school<br>Value of avoided time lost of parent/ caretaker of sick children<br>Value of loss of death avoided | More efficiently managed water resources and effects on vector bionomics |
| **Consumers** | | | Time savings related to water collection or accessing sanitary facilities<br>Labour-saving devices in household<br>Switch away from more expensive water sources<br>Property value rise<br>Leisure activities and non- |
| **Agricultural and industrial sectors** | Less expenditure on treatment of employees with diarrhoeal disease | Less impact on productivity of ill-health of workers | Benefits to agriculture and industry of improved water supply, more efficient management of water resources-time-saving or income-generating technologies and land use changes |

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As seen as Table 1 there are many and diverse potential benefits associated with improved water and sanitation, ranging from the easily identifiable, quantifiable to the intangible and difficult to measure. For various sectors and individuals, these benefits include both (a) reductions in costs and (b) additional benefits resulting from the interventions (Hutton & Haller 2004).

### 11.3.3. Water quality in an economic context

Social monetary expenditure directly aimed at improving the quality of water or controlling pollution is known as pollution control costs. There is a need for high-cost technologies and additional investments to sustain a higher quality of water in the face of increasing pollution. Therefore, marginal pollution control costs increase as the level of pollution decreases. Water purification costs, including treatment and inspection, have taken a significant weight on municipal budgets. As water supply and demand are in urbanized regions, this externality is difficult to overcome. Securing reliable and uncontaminated sources for large cities requires heavy investment in infrastructure (dams, pumping stations, waterworks, treatment plants, etc.). Last but not least, accidental spills by tankers (petroleum products) are always expensive events to cleanup (URL 7). Figure 11.4 below illustrates this:

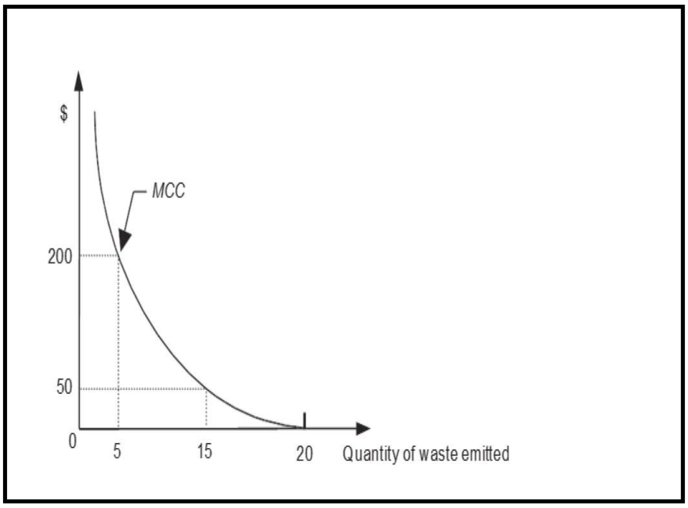


**Figure 11.4.** The marginal control cost (MCC) **(**Hussen, 2004)

According to Hussen (2004) if a higher level of water quality is desired, an additional expenditure on secondary or tertiary treatment may be required. Such additional treatments would require implementation of new and costly technologies designed to apply either chemical and/or biological treatments to the water. Figure 4 represents the marginal pollution control cost in graphical form. The marginal cost of controlling or treating the fifth unit of waste is seen to be $50. However, the marginal cost increases to $200, a fourfold rise, to treat the fifteenth unit of waste. Note that given that the benchmark is 20 units, the treatment of the fifteenth unit is equivalent to leaving 5 units of waste untreated – which is what is shown in Figure 2. As seen as, the marginal pollution control cost increases at an increasing rate as a higher level of cleanup or environmental quality (a movement towards the origin).

### 11.3.4. Demand of fresh water

The worldwide demand on water is primarily for purposes of domestic, industrial and agricultural use. Table 2 below outlines the water demand according to purpose of use.

As can be seen in Table 11.2 above, domestic water usage in homes, hotels, restaurants and Laundromats are for drinking, food preparation, sanitation, lawn and garden watering and service production and makes up for a smaller portion out of the total water usage in many countries. Trade related and industrial water usage is the consumption of water in factories, offices for trade or industrial purposes. The quantities of usage differ among regions according to whether there are large industrial facilities in cities or whether these facilities use water from the city mains water supply. 16% of the world's agricultural areas are irrigated and 84% are irrigated by rain water.

**Table 11.2** Water Demands According to Purpose of Use

| **Domestic** | **Industrial** | **Agricultural** |
|---|---|---|
| Drinking water<br>Food preparation<br>Sanitation<br>Personal hygiene<br>Cultural asset<br>Gardening, Car wash | Production of goods and energy<br>Transportation of goods<br>Process water | Irrigation<br>Livestock farming |

70% of the world's water sources are used for agricultural purposes. This is followed by industrial use with 22% and domestic usage with 8%. Although water usage for industrial purposes is less than for agricultural purposes, there is still a need for water sources which are accessible, regular and environmentally sustainable. Domestic use of water is calculated based on water consumption per day per person. The average daily consumption of water per person in developed countries (500-800$m^3$) is approximately 10 times more than that of developing countries. In regions of drought, this daily consumption amount can be as low as 20-60$m^3$ (UNESCO 2000). Figure 11.5 shows the consumption of water according to sector by taking into account the level of development of countries according to WBCSD (2009) data.

Demand for water increasing dramatically in all major use sectors. According to The United Nations World Water Development Report 2015; over the past century, the development of water resources has been largely driven by the demands of expanding populations for food, fibre and energy strong income growth and rising living standards of a growing middle class have led to sharp increases in water use. By 2050, agriculture will need to produce 60% more food globally, and 100% more in developing countries. Global water demand for the manufacturing industry is expected to increase by 400% from 2000 to 2050, leading all other sectors, with the bulk of this increase occurring in emerging economies and developing countries.

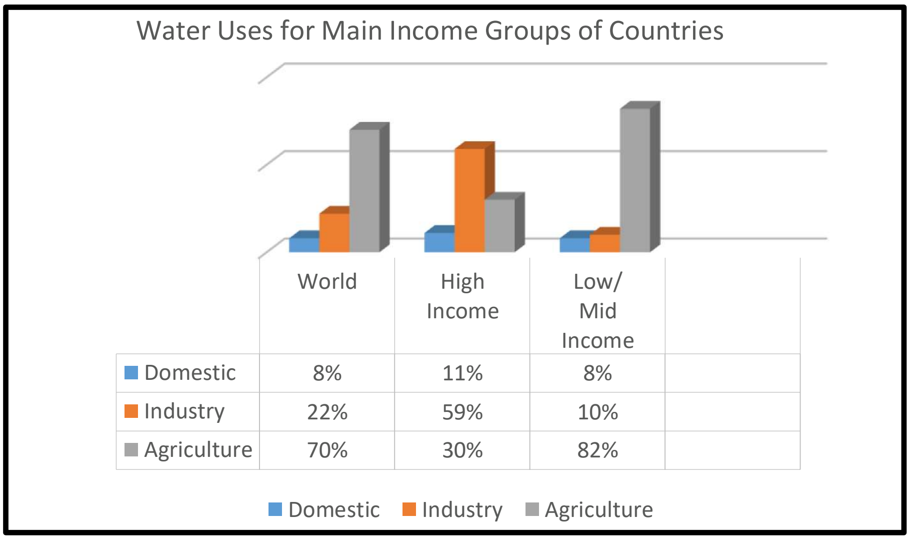


**Figure 11.5** Composition of water use in different countries (WBCSD, 2009)

On the other hand, as seen as Figure 11.6, according to OECD (2012), water demand will increase by 55% globally between 2000 and 2050. The increase in demand will come mainly from manufacturing (+400%), electricity (+140%) and domestic use (+130%). In the face of these competing demands, there will be little scope for increasing water for irrigation.

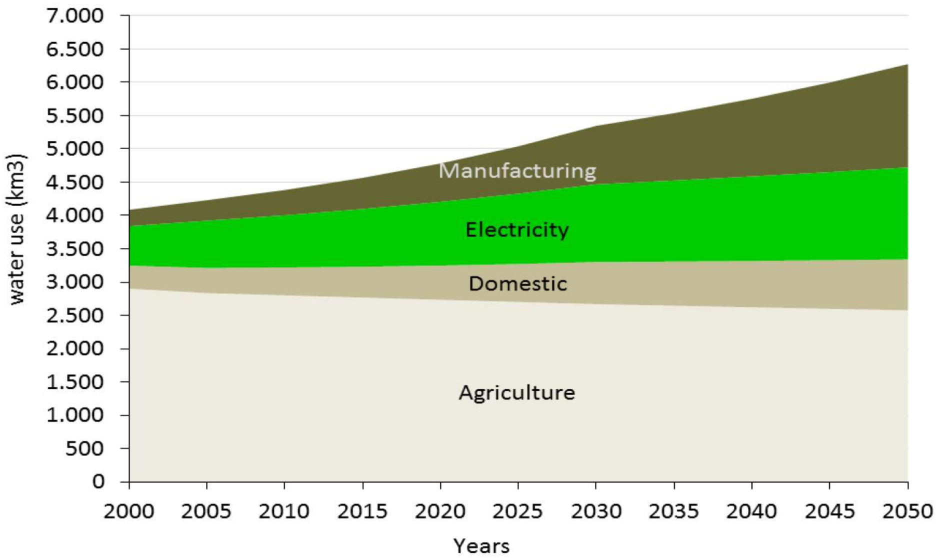


**Figure 11.6.** Water use by 2050 (OECD Environmental Outlook Baseline, 2010)

### 11.3.4.1 Estimation of fresh water demand

In nearly all markets for goods and services, scarce resources are allocated through prices, which transmit information about relative scarcity and value in use. However, in the case of water, as with many other scarce natural resources, true markets are rare. Prices for water are administratively determined, through mechanisms that are often political and rarely take economic value into account. Water prices, therefore, do not respond automatically to short-term and long-term changes in supply. Prices set by public officials are one potential lever for managing water demand when resources are scarce. Good estimates of the price elasticity of water demand are critical (Olmstead 2010).

The responsiveness of demand to a change in price is measured by price elasticity of demand, which is defined as the percentage change in demand divided by the percentage change in price. The price elasticity of drinking water demand by urban households is typically low. In European countries it ranges between -0.1 and -0.25, i.e. the demand for water decreases by 0.1% to 0.25% for every 1% increase in tariffs. In Australia and the United States price elasticity is somewhat higher in the range of -0.1 and -0.4 (Farolfi 2011). This means that the demand change will be proportionately smaller than the price change. Because for householders, tap water is a necessity, with no alternatives. If the water company increase the cost of water bills, people would keep buying the service. It would have to rise to a very high price before people disconnected their water supply. This is why tap water is regulated (URL 8).

The inelastic demand for tap water has implications on the tap water management: if a municipality is responsible for providing households with tap water and attempts to at least cover its costs, then there is a maximum volume of tap water it can sell. In other words, a minimum threshold for tap-water price exists below. However, the low price for domestic use will not affect the total demand amount to a high degree and will lead to a relatively small additional consumption amount. But it is not possible to say the same of medical/health services; because the price is relatively more elastic in comparison with the elasticity of the water demand. If a price is equal to the marginal cost in the short term, this would lead to an extreme level of wide spread consumption due to the demand on health care services. This is shown in Figure 11.7.

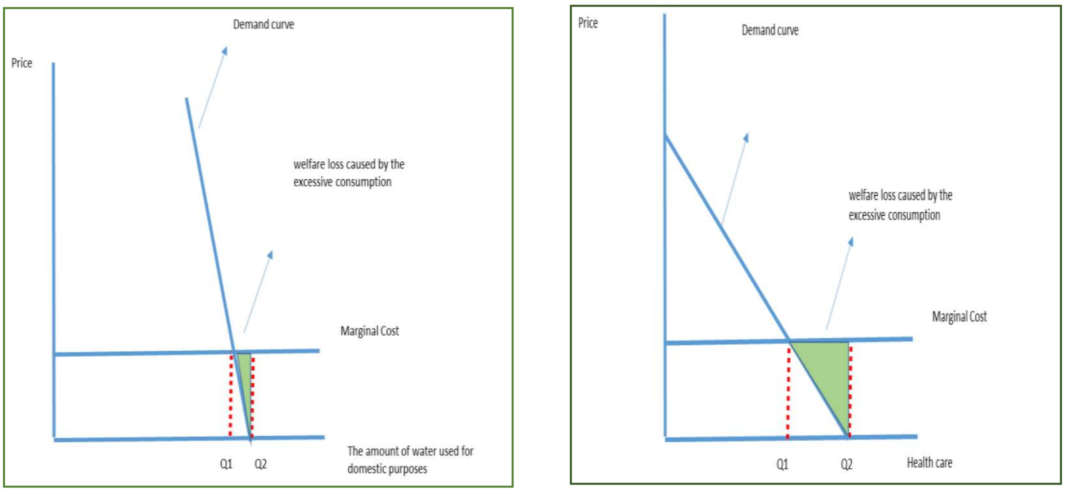


**Figure 11.7.** Tap Water: Demand Elasticity-Marginal Cost Pricing

As can be seen in Figure 11.4 and 11.5, the demand elasticity of water is low. In this case, the marginal cost pricing will not increase the consumption of water for domestic purposes to a high degree. However, the price elasticity of demand on health care services is higher in comparison. The marginal cost pricing for this sector will place a higher demand on health care services.

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**Can Water be Free?** A pricing system ensures the maximized distribution between scarce resources and alterative utilization area. In 2014, Ireland began to charge for tap water, which was once free of change. This situation leads to a significant amount of protesting. The argument at hand was as such: whether wealthy or poor, water is an essential good of vital importance for all; thus, it is wrong for the public to pay for an essential good. Therefore, the state should supply water free of charge. This way of thought is considerably common. This is largely because water has been regarded as a communal resource to which access was free, apart from the costs of capture, storage and distribution. In fact, prices of water for drinking water (also irrigation) are in many countries well below the full cost of the infrastructure and personnel needed to provide that water, which comprises the capital charges involved, the operation and maintenance (O&M) cost. What would happen if it was supplied for free, instead of at an affordable price? There is a significant difference between the amount of water consumed at a low price compared with if it were free of charge. As can be seen in Figure 11.8 below, when a price of p0 is charged, the amount consumed by the consumer is q0. However, when the price is reduced to 0, then the consumption amount increases up to q1. In this case, the marginal benefit of the majority of consumed water when it has no charge is considerably low. When there is additional consumption, then it will move towards the area of significantly low marginal benefit. For example, more water will be used when washing the car or the necessary care will not be taken concerning water leaks in the garden. It is costly to supply the amount of additional water and it will be necessary to use scarce resources in the production of other good with the supply of water free of charge.

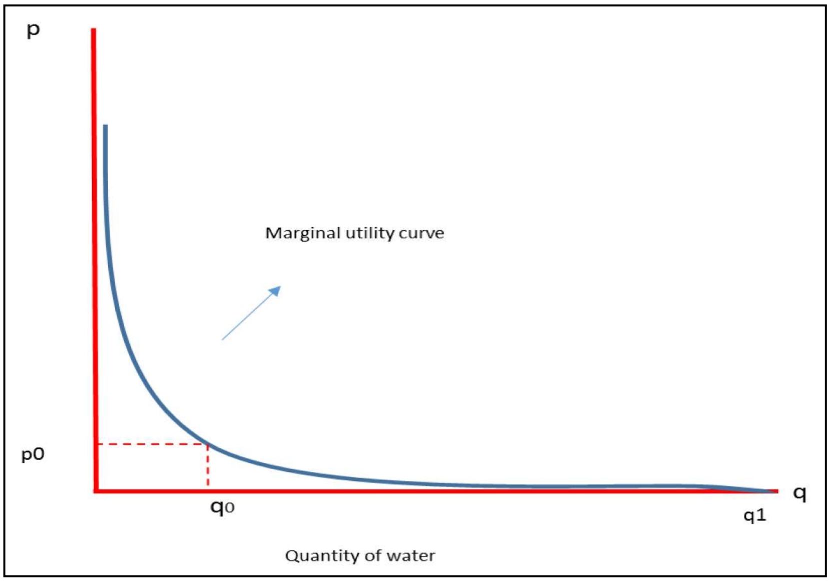


**Figure 11.8.** Marginal utility of tap water

### 11.4. Water Market-Economic Efficiency

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The water "market" is not homogeneous. Different sub-sectors (agriculture, industry, power, transport, flood protection) have different characteristics (Zaag, 2006). However, this study undertakes the use of water for domestic purposes.

Economic efficiency is defined as the maximization of social welfare also requires the efficient use of resources. Allocative efficiency means that resources are used for the production of goods and services most wanted by society. Productive efficiency implies that the least costly production techniques are used to produce any mix of goods and services. Allocative efficiency requires that there be productive efficiency. The principle condition for the optimum distribution of resources is to ensure MC=MB equality, because the consumer aiming to maximize the benefit will make a demand on the goods and services which ensure the most satisfaction. The producer, aiming to maximize their profit shall continue to produce until the point where the marginal cost is equal to the market price. Thus in the absence of externalities and other market failures the market demand and supply curves where the marginal benefit equals the marginal cost. This is also the point where total surplus (consumer surplus plus producer surplus) is maximized. There is no way to rearrange production or reallocate goods so that someone is made better off without making someone else worse off — a condition known as Pareto optimality. These conditions are undertaken and discussed in regard to the water market by Winpenny (2005), as can be seen in Figure 11.9.

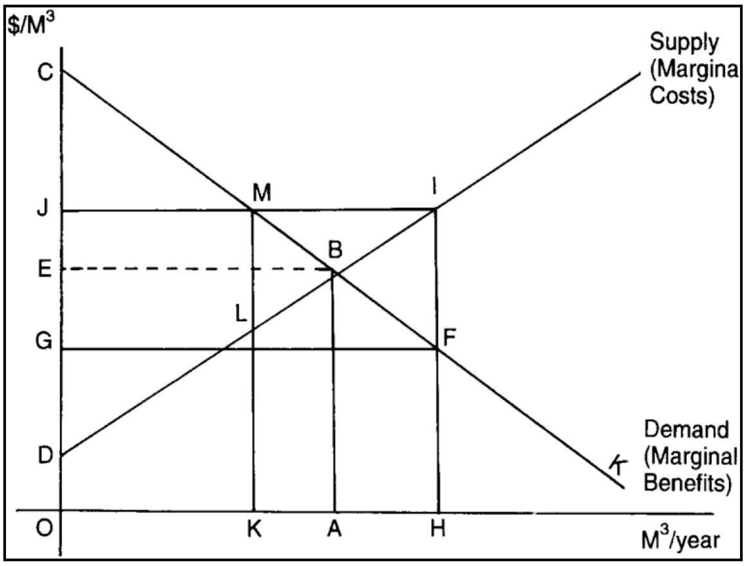


**Figure 11.9.** Market Equilibrium(Winpenny, 2005)

In Figure 11.9, the demand curve relates the consumer's willingness to pay to the amount of water consumed. This would normally be downward-sloping from left to right, reflecting the diminishing marginal valuation of successive increments of water. The supply curve slopes upwards, reflecting the fact that increments of demand can normally be met only at rising cost to the water system. From the point of view of fixing prices, the cost schedule is best interpreted in the sense of long-run marginal costs of expanding the system to meet a permanent increment of demand. These basic notions are equally applicable to water 'mining', such as the excessive drawdown of aquifers, where the benefit of reduced consumption is the avoided cost of alternative future supplies. As shown Figure 11.9, net benefits are maximized when OA units of water are produced with a price of OE. Net benefits, the excess of the area under the demand curve over that under the supply curve, are represented by the area CBD. If consumption is higher than this, say OH, the costs ABIH of supplying the increment AH exceed benefits ABFH by BIF. Conversely, if consumption is restricted to OK, for instance by excessive prices or over-zealous restrictions, the loss of consumer benefits KMBA exceeds the supply cost savings KLBA, and this solution is also sub-optimal (Winpenny, 2005).

In fact, it is difficult to make mention of a balance regarding the water market in the traditional sense. The application of price- based instruments, once an appropriate value system has been agreed, is particularly difficult in the case of water, because the flow of water through a basin is complex, and provides wide scope for externalities, market failure, and high transaction costs (Franks at al. 1997). Nevertheless, in the market, decisions are based on the private costs and private benefits to market participants. If the consumption or production of goods and services poses an external cost or benefit on those not participating in the market, however, then the market demand and supply curves no longer reflect the true marginal social benefit and marginal social cost. Hence, the market equilibrium will no longer be the socially (Pareto) efficient outcome.

### 11.4.1 Externalities

Externalities are the direct benefits or costs of producers and consumers to other producers and consumers as a result of their actions. As externalities cannot be priced, the social benefit and cost of production and consumption differ from each other and this is considered by the market as failure. That is, when the pricing mechanism and the cost and benefit in question are not equal to the production and consumption amounts as desired by the individual and society, then there is a loss in social welfare/benefit.

By following the argument of Hussen (2004), this situation can be explained as follows:

(a) In a situation where a *positive* externality is present

Social benefits = Private benefits + External benefits and

External benefits > 0 Therefore,

Social benefits > Private benefits

(b) In a case where *negative* externality prevails

Social costs = Private costs + External costs and

External costs > 0 Therefore,

Social costs > Private costs

**11.4.2 Externalities in water market**

In the water sector, positive externalities are associated with improved water and sanitation. Numerous benefits of using quality water were examined above.[2] Use of water by one user commonly has negative effects (externalities) on other users. The most important negative externality is impairment of water body quality as a result of industrial activities in the long term. This is titles as negative externality in macro economics. There are many negative externalities in the short- to medium-term. For example, pollution from a town can mean that downstream users have to incur additional treatment costs. Similarly, drainage water from irrigation fields often carries high levels of salts, nutrients and pesticides, leading to losses of aquatic habitats (Kay at al. 2005). In recent years, the importance of externality has come again to the forefront for the water sector due to population pressure and a demand on water more than ever before. On the other hand, the construction of a new dam, the extension of a water supply network, the repairing of a water treatment plant, or the renovation of a small scale irrigation scheme all require a significant amount of investment and cost-benefit analysis. Also, the unique characteristics of water use should be taken into account. Not taking into consideration the negative externalities before taking decisions, not conducting an careful analysis or including it in cost expenditure analysis, will adversely affect the effectiveness and efficiency of these such investments.

On the other hand, as aforementioned, in a competitive market, for example, the efficient allocation of goods is reached at the point where the market price balances supply against demand. At this point each water abstractor uses a level of water where the additional or marginal benefit to withdrawing an additional unit of water is equal to the cost of withdrawing it. However, unlike in the case of many goods, the use of water can have wider impacts which are not typically reflected in the costs to the user (White, 2015).

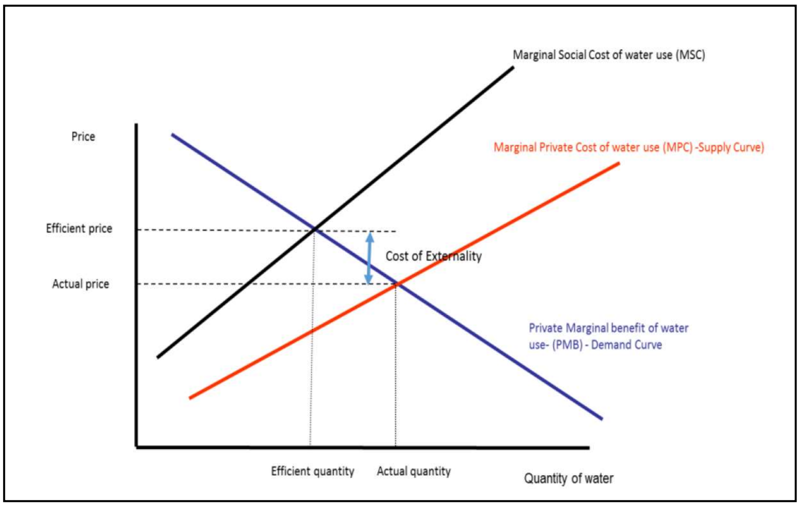


**Figure 11.10.** Cost of the externalities in water use (Grafton et al., 2013)

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[2] The economic benefits of improved water and sanitation effect households, businesses and industries need piped water for many kinds of activities. Welfare impacts on countries trough decreases poor health may in part cause this cognitive dysfunction, decreases in water-related mortality rates etc.

As shown in Figure 11.10, the demand curve shows the marginal benefit incurred by an individual with one unit of water production. The supply curve reflects the marginal cost for the production of the extra one unit of water. In the case where there are no externalities, the market balance is fully efficient. The marginal social cost is equal to the marginal benefit. The marginal social cost is larger than the price. Now, let's consider that there are externalities. For example, If a user withdraws large amounts of water from the environment they are likely to have to pay for the cost of transporting the water. However, this may create costs for other water users which they do not have to pay; such as if less water is available for crop production, fisheries, recreation, or biodiversity. These external impacts of water use are not typically reflected in market prices. As a result, they are not included in the costs faced by users, so users do not take them into account when deciding how much water to withdraw. These effects are described as negative externalities and they create a 'wedge' between the private and social marginal cost of using a resource. In the case of actual quantity, the marginal social cost curve has surpassed the price paid by consumers (White 2015). Due to these negative externalities, water resources are often undervalued and overused relative to the efficient allocation which includes both private and external costs.

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**QUESTIONS AND ANSWERS FOR BOOK CHAPTER 11**

**Q1- The price elasticity of drinking water demand is typically low**

**a)** True **b)** False

**Q2-Which of the following is not a reason for water market failure?**

a) the complexity of the flow of water through the basin
b) wide scope for externalities,
c) higher transportation costs
d) scarcity of water

**Q3- Water pollution of steel plants are examples of**

a) external economies.
b) negative externalities.
c) internal spillover.
d) social distortion.

**Q4- From an economic standpoint according to the various uses water is a;**

a) public good
b) common–pool goods
c) private good
d) all of the above are correct.

**Q5**- **Water was suggested to be considered as an economic good for the first time;**

a) in 1992 during the "International Conference on Water and Environment" held in Dublin.
b) in 2000 during the United Nations Millennium Development Goals (MDGs) meeting held at the UN headquarters in New York
c) in 2015 during the 7th World Water Forum held in Daegu & Gyeongbuk
d) in 2013 during the World Water Week Conference held in Stockholm

**Q6**- **The water pollution is an example of market failure because;**

a) the equilibrium price is higher than the efficient price
b) the equilibrium price is equal to the efficient price
c) the equilibrium price is less than the efficient price
d) the equilibrium price is equal to the marginal cost

**Q7**- **The costs of cheap fresh water are far too high because;**

a) water use are typically reflected in market prices and its costly
b) urban water utilities have not been charging enough to cover long-term maintenance costs
c) charging decreasing rates the less water is consumed then to ensure access by poor people to these services
d) marginal cost increases