



Water in the Productive Processes

Have you ever wondered how many things could be produced without water? The answer is, very few indeed! Water is not only necessary for food production, but for industrial production too. That is to say, not just rice and potatoes, but also clothes, plastic, telephones, TVs, computers, cars and...

None of these products could exist without water! Water is fundamental not only for drinking, washing and cooking purposes, but also for all the productive cycles of agriculture and industry.

The uses of water

Only 1% of water used by humans (compared to the global sum of all withdrawals) is for drinking, washing and cooking. An additional 10% is calculated for all other domestic uses (toilet flushing etc). Industry uses 19% and the rest, a massive 70%, is used by agriculture for irrigation, drawing water from rivers, lakes and underground water strata.

Global sum of all withdrawals

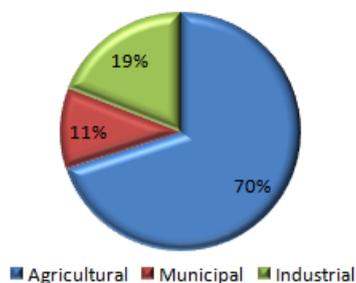


Illustration 1: © FAO Food and Agriculture Organization of the United Nations - Global Sum of all withdrawals.

This is obviously only general world data, which may disguise quite considerable differences from country to country. In Europe, for example, agriculture, industry and civil use account for 64%, 24% and 12% respectively of all use made

by humans. If however we look only at the Mediterranean part of Europe, the water used in agriculture can sometimes account for more than 80%!



Illustration 2: © Allianz
Use of water in agriculture.



Illustration 3: © EatDrinkBetter
Water for irrigation.



Illustration 4: © European Environmental Agency
Use of water in industry.



Illustration 5: © UNESCO
An industry in Grangemouth, Scotland.

AGRICULTURAL USE

Water is an irreplaceable good for the production of food and foodstuffs. To face the increasing world population growth and request for food, a massive rise in use of water for agriculture is envisaged. It is therefore our duty to learn to use water with less wastage, in agriculture too!

Researchers have attempted to calculate how much the most widespread of the earth's cultivations account for global water consumption. Of these, in descending order, we find wheat, rice and maize, accounting for 15%, 13% and 10% respectively. And here too there are considerable variations in the amount of water required per quantity of product. To produce 100kg of wheat about 80,000 litres of water are needed, and for maize it is at least double: almost 160,000 litres per 100kg!

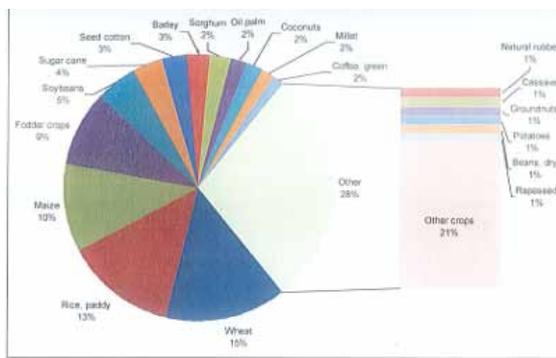


Illustration 6: © Water Footprint Network, University of Twente (The Netherlands)
Total water footprint of crop production.

It is possible to save on water for agriculture!

Do you know what the trick is to save on water in agriculture? Easy! Cultivate plants that don't need much water to grow! It's a bit like deciding to build golf courses only in countries where it rains a lot and not in areas which suffer droughts. In our daily diet too we can choose foods that require less water, for example wheat or potatoes rather than maize. The cultivation of a field of potatoes as opposed to a field of maize uses up a lot

less water: 1kg of maize requires 3 times more water than 1kg of potatoes. (See also the section "How much water do we eat?")



Illustration 7: © Centro Civiltà dell'Acqua
Collect rain water for the flowers of your garden!

Agriculture which pollutes

We also have to consider that not all the water used in agriculture returns in a clean state to the environment. In "conventional" agriculture a great deal of chemical substances are used, like pesticides, fertilizers and weed-killers. These substances are not wholly absorbed by the plants but inevitably end up polluting rivers and underground water strata.

Among the most dangerous substances for human health produced by agricultural pollution are nitrates.

Good practices for the reduction of pollution in agriculture

Some recent projects in fluvial re-evaluation have attempted to reduce the quantity of dangerous substances produced by agriculture and poured into rivers, such as nitrogen and phosphorous. One project which addressed this problem was carried out near Venice, Italy, on the river Zero. A "wooded buffer area" of about 30 acres was created which is capable of removing over 2.5 tons of nitrogen (about 60% of the total poured into the river whose mouth is the Venetian lagoon) every year. This was made possible by turning land previously used for agriculture into a buffer zone consisting of a particular range of trees and bushes which absorb the pollutants. The project area was subdivided into different areas about 15 metres wide, each with 3-4 rows of trees divided in the centre by a small drainage canal and at the sides by 2 external canals which convey the polluted water of the river. Taking advantage of the slightly sloping land, the polluted water runs down deep until it reaches

the central canal, by this time greatly purified. On its underground journey it is indeed intercepted as it were by the roots of the trees and bushes which activate a natural process of nitrogen removal. The most important is the denitrification carried out by bacteria under the ground in an environment that is anaerobic (without oxygen).

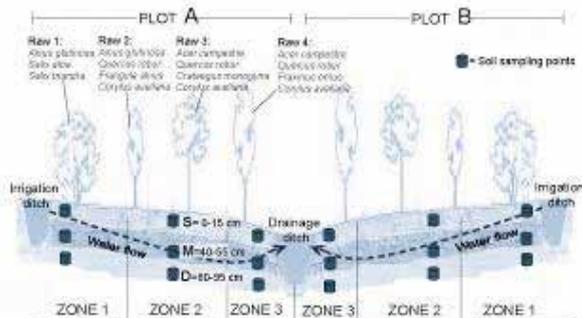


Illustration 8: © Consorzio di Bonifica Acque Risorgive, Venice, Italy - Section of an experimental site to remove nitrogen from rivers' water. Two irrigation ditches (left and right) bring polluted water to the wooded buffer area. The sub-superficial flow of water is purified naturally and at last reaches the central drainage ditch.

INDUSTRIAL USES

Industry uses 19% of the total amount of water drawn from rivers, lakes and water strata in the world. It is foreseen that in 2025 this percentage will reach 24%. In 1995 the global consumption of water in the industrial sector was 752km³/ year: a truly astonishing amount!

Why is so much water used in the industrial sector?

Water in industry is mainly used for the various work phases as well as being a component of the finished product. Thanks to water's ability to heat up and cool down slowly ("specific heat"), water is mainly employed in industry for cooling the machinery used in the productive cycles, in the same way a radiator works for a car engine. Water is also needed for cleaning machinery and the finished products. In the food industry, water becomes a part of the finished product itself. Everybody knows that fruit juice contains a very high percentage of water!

How many litres are necessary to produce . . .

Using the "Water footprint" method it is possible to calculate the quantity of water used to obtain a certain product. The results from this method really give us food for thought!. It has been calculated that to produce a cotton t-shirt for example, 2,700 litres of water are

necessary, and a pair of jeans requires about 4,560. Even computers, telephones and TVs require lots of water to be produced!

The statistics here below describe how much water is needed to produce a given quantity of product. The industrial sectors which use most water are heavy industries, the chemical industry and the paper industry. Here are some statistics:

- 1 ton of paper: about 350.000 litres of water
- 1 ton of glass: about 70.000 litres of water
- 1 ton of steel: about 25.000 litres of water

Table 7.4: Water use per tonne of product produced, selected Industries

(cubic metres per tonne)

Product	Water use ^a
Paper	80-2,000
Sugar	3-400
Steel	2-350
Petrol	0.1-40
Soap	1-35
Beer	8-25

a. Amount varies with process used.

Source: Margat and Andréassian 2008.

Illustration 9: © UNESCO

Water use per tonne of product produced

It is possible to save water in industry!

At this point we should ask what products we can choose not to buy (and therefore limit water wastage) in as much as they are not strictly necessary, or which can be substituted with other goods that use less water? Today people speak a lot about alternative fuel that is more ecological than petrol, but have you any idea how much water is needed to produce a litre of bio-ethanol? About 4,500 litres! In the face of this statistic we really wonder whether it is worth the effort to use bio-ethanol and bio-diesel (obtained from soya and other plants) as an alternative to petrol which itself doesn't need such large amounts of water!

New technologies for saving water

Fortunately today, good practices are becoming more widespread in the attempt to consume less water, through recycling or from alternative sources.

To fight drought in Australia, for example, people drink water from the sewers, obviously after it has been depurated and made fully fit for drinking! In Spain, Kuwait and other Arabic countries, people use sea water for washing, cooking and for some industrial processes, after eliminating the salt by means of desalinization plants. In Israel, the same water is used several times over in

agriculture, while in Germany rain water is used for the toilet flush. So today science and technology assist enormously in the depuration of water from chemical pollution and bacteria at ever lower costs, making it more easy to reuse. Why not take advantage of this?

Good practices for saving water in industry

In terms of greater productivity from water in the industrial sector (industrial water productivity), one nation stands out from the others, Denmark. It might be of interest to share and let others know about other good examples like this. For example, the water used in certain productive cycles can be reused a number of times before it is released back into the environment. Do you know of any good practices in your own country? Let us know by writing to: info@civiltacqua.org

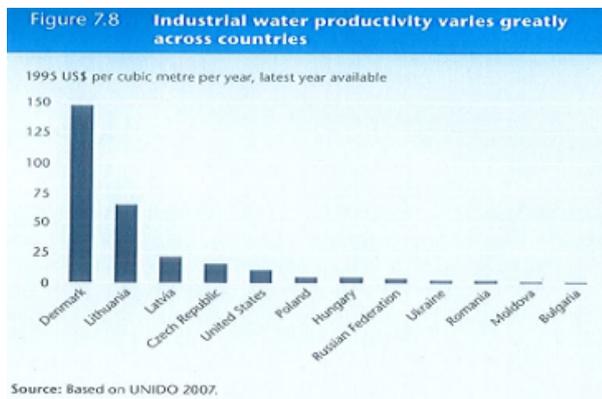


Illustration 10: © UNESCO
Industrial water productivity.

The pollution of water from industrial use

The water of rivers and water strata used for industrial purposes, for cooling or heating machinery, for transporting substances or producing energy, becomes polluted after it has been used.

The problem arises when substances that are difficult or even impossible to dispose of are released in the water, like heavy metals. The natural environment suffers the consequences and becomes poisoned. If the water in a river is polluted, all the flora and fauna of that river will suffer too. In the more developed countries, water used for industrial purposes has a different process of depuration from the water of domestic use, because it has a different grade of pollution and requires a special process of purification.

WATER AS ENERGY

Water is an important energy source which can be exploited in a number of ways. The energy that is produced today using the force of water is called hydro-

electrical energy. Ancient populations too knew how to take advantage of the force of water to produce energy, using, for example, wheels and simple machines. Think of watermills! In the past, a number of mills were always located along rivers.

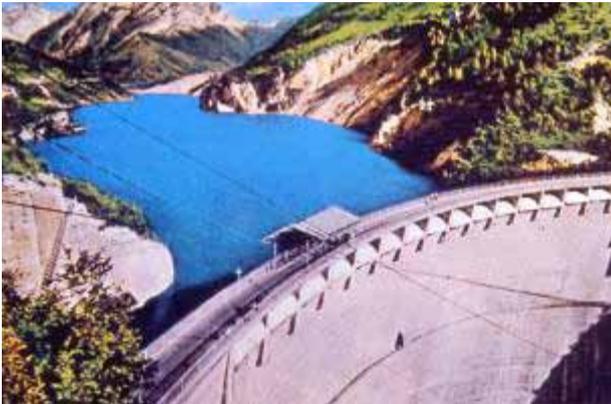
Why? The force of water moved the wheels of the mill which in turn, transmitted the rotation movement to other wheels which started up the action of other, quite complex machines that ground the grains of wheat or maize to make flour. Using the same principal, (hydraulic wheel moved by the force of water which in turn sets other wooden or iron wheels into action) it was possible to activate wooden pestles to work fabrics, or enormous hammers for the elaboration of objects in metal like swords, hoes or shovels. Today technology has evolved and water is no longer used to set the wheels of a mill in action. Today there are turbines which transform the power of water into electricity for houses, offices and industries.



Illustration 11: © Centro Civiltà dell'Acqua
A water wheel: traditional exploitation of water energy.

Types of plants that produce energy from water

The unevenness of the land and the flow speed of water can be exploited to produce hydro-electrical energy. Today there are two types of plants for the production of hydro-electrical energy. The first, Large Hydropower, involves the construction of imposing dams which however radically change the course of a river. The second type of plant, Small Hydropower, which has appeared thanks to more recent technology, is a smaller structure which draws water from rivers with a lesser impact on the environment.



*Illustration 12: © Centro Civiltà dell'Acqua
Historic picture of the Vajont Dam in the Alps, Belluno (Italy):
in 1963 it caused the death of more than 2.000 people.*



*Illustration 13: © Lesotho Highland Development Authority
Katse Dam in Lesotho..*

How is hydro-electrical energy produced?

In the first type of plant, the Large Hydropower plant, river water is blocked at a certain point in its course by a dam. Once the river's course comes to a halt, it is transformed into an artificial lake. The water in this artificial basin is released gradually into a pipe which allows it to flow down to a lower point until it reaches the hydro-electrical power station. On its downward path, the force of the water activates the turbines which transform the water energy into electrical energy. After it has moved the turbines, the water (usually, but not always) is released into the river, in the valley section of the dam. With the more modern Small Hydropower plants, the river's course is altered less, without the creation of dams or artificial basins. A means of drawing water is set

up at a certain point on the river and a part of this water is deviated and taken to a small electric power station, and immediately afterwards it is released back into the river again.



*Illustration 14: © Centro Civiltà dell'Acqua
Historic power plant once used in the Italian Alps
(beginning of XX century).*

Is hydro-electrical energy really a “non polluting” energy source?

Hydro-electrical energy is generally held to be a source of “clean” energy that doesn't have much impact on the environment because it doesn't emit dangerous substances into the atmosphere which induce climate change. Unlike carbon and petrol, hydro-electrical energy does not pollute the quality of the air. However damage is still done to the environment, in the form of heavy, sometimes irreversible modification of rivers and waterways, with all the consequences on flora and fauna.

In the case of dams, the negative consequences on rivers and aquatic ecosystems (which are interrupted or temporarily deprived of water) are now so clear that the European Water Directive classifies these parts of rivers as Heavily Modified Water Bodies. Although small hydropower plants have less environmental impact, they still negatively influence the natural course of water and aquatic ecosystems. Today small plants are preferred to large ones both because they are considered less dangerous for the environment and because most of the best places for building dams in the world have already been used up.

The environmental and social impact of hydro-electrical plants.

Although they do not pollute the atmosphere, the problem with all structures built to produce

hydro-electrical energy is that they have both an environmental and a social impact, however big or small.

In order to build a dam, the natural environment has to be tampered with, upsetting the hydrological capacity of a river irreversibly. We must therefore start to come up with different solutions that are not only ecological in nature: it is extremely dangerous, for example, to build a dam above a town because the dam may collapse or the surrounding land may "drink" too much water and generate unforeseeable disasters. That is precisely what happened in the disaster of Vajont, Italy, one of the gravest of its kind. In 1963, more than 2000 people died in just a few minutes, not because the dam collapsed but because the mountain walls on which the dam was founded gave way. The mountain fell into the artificial basin and created a huge wave more than one hundred metres high which swept entire towns and communities away.

The impact of small hydro-electrical plants

Although the small plants have less impact on the environment, it is also true that they produce less energy. In order to generate a substantial quantity of energy, it is necessary to build a larger number of them along rivers, and this means to further endanger the precious natural environment that have already been endangered by dams, as is amply demonstrated in Europe in the case of the Alps. Do you know of any problematic situations in your own country? Tell us by writing to: info@civiltacqua.org

The World Commission on Dams

The World Commission on Dams (WDC) established in 2000 an innovative framework for planning water and energy projects in order to protect dam-affected people and the environment, and ensure that the benefits from dams are more equitably distributed. The Commission, initiated in 1997 in response to growing opposition to large dam projects, had a mandate to review the development effectiveness of large dams and propose internationally acceptable guidelines for the planning, construction and operation of dams. The Commission found that while "dams have made an important and significant contribution to human development... in too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment."

Forms of pollution of air and water

In the drawing here below we can see the principal causes of pollution of the air and water provoked by civil, agricultural and industrial use. Air pollution also impacts on water quality because rains bring atmospheric pollutants right down into the rivers, lakes and underground water strata.

Dossier compiled by:

Civiltà dell'Acqua

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Water Civilization International Centre, Venice:

www.civiltacqua.org

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