How rich are we .... in blue gold?

Water footprint, water availability and use on a planetary scale

The blue planet: water availability in the world

24 December 1968, a date of historical importance. The Earth was photographed as it rose in the lunar sky. The astronauts of the Apollo 8 mission were the lucky ones to see this fascinating sight and to offer the world a small glimpse of it through the famous photograph, *Earthrise*. For the first time it was possible to see the entire Earth globe, with its land, clouds and especially its enormous masses of blue water. The blue colour is so predominant in the photograph that it justifies the name *blue planet*, which is still used.

Fig. 1 *The first image of the Earth photographed from the Moon by astronauts of the Apollo 8 mission in 1968. Credits: NASA*

Unfortunately, despite the marvellous image, our beloved planet is not as blue as it may seem. We have a lot of water and it is abundant, but some recent factors are compromising the quantity and quality of the Earth's water reserves.
In the special report on the **water footprint,** we have already mentioned how water is a precious resource, how scarce it is in some areas of the planet and how important it is to preserve it.
If water has always been considered an abundant resource, then how have we come to situations of water scarcity in some areas? All this has happened because before the twenty-first century human beings used little water compared to the water that was available as a result of the natural hydrogeological cycles. Some factors have changed this situation. Population growth and food requirements, industrialization and a demand for goods and services that are connected to water, have led to a soaring increase in the demand for blue gold, which has endangered the delicate balance of the natural ecosystems. Unfortunately, with the passing of time, the situation has been worsening, because the increase in the demand for clean water is accompanied by an increase in the pollution of this resource. And not only: there is increased competition for the use of water, and so it is going to be particularly challenging to satisfy the demand for water for nutrition, and the demand for water for domestic and industrial purposes.

In figures, would you be able to say how much water is available, overall, on our planet? Apparently a lot, a total amount of 1.4 billion cubic km of water! A quantity that is really difficult to imagine! This means that we would need 560,000,000,000,000 Olympic swimming pools to contain all this water. “So, then, where is the problem?” you must be wondering. There are two important problems: first of all as you will easily realise, this water is not distributed in a uniform manner on the Earth and, primarily, not all this water can be used by man. Actually most of the water is salty and only 2.5% of the water is fresh water, and it is mainly found in the polar ice caps and glaciers (about 79%) or in underground aquifers (20%). Less than 1% of fresh water is in rivers, lakes, basins and swamps, and this water is not always usable, because it is too costly or the quality is insufficient. Therefore how much water remains for mankind? Little, the estimate is about 0.001% of the total!
So now do you understand why water is so precious?

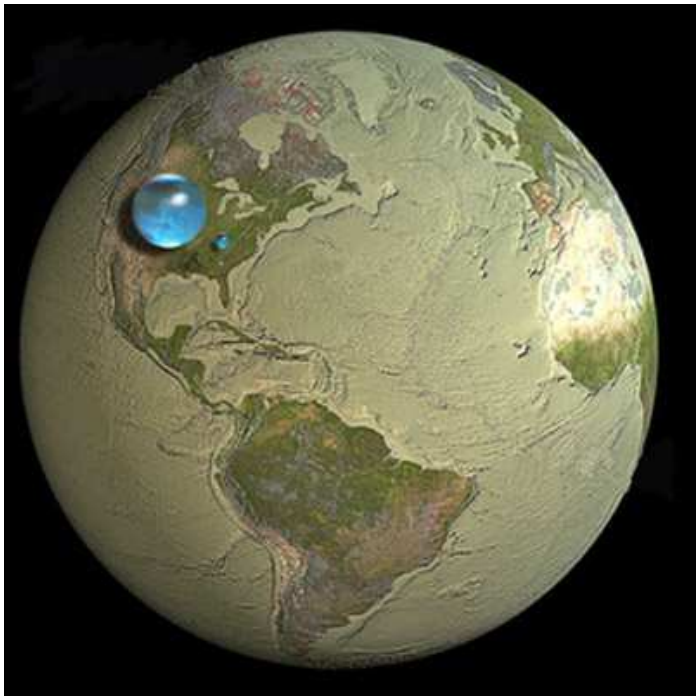

Fig.2 *The availability of water resources of the planet: the large blue sphere represents all the Earth’s water, the second blue sphere represents the world’s liquid fresh water (groundwater, rivers, lakes, and swamps).*
Credits: Howard Perlman, USGS; globe illustration by Jack Cook, Woods Hole Oceanographic Institution (©); Adam Nieman.

Distribution and use, and the planet’s water footprint

Clear sweet, fresh water ... The Italian poet Petrarch began one of his most famous poems with these words. But, had he been Indian or Jordanian, would he have been able to sing the praises of the river valley in this way? Probably not., because as you have read in the Special Report on the water footprint, water is not distributed in a uniform manner around our planet, and it is not always economically accessible.
Where else would Petrarch have easily been inspired and have composed his verses?
If we analyse the localization of water, we discover that it is concentrated mainly in just a few countries, i.e. approximately 64% of the water resources are to be found in just 13 countries. Brazil is the country with the greatest riches in water - alone, Brazil has 15%, followed by Russia (8%), Canada (6%), the United States, Indonesia and China (approximately 5%). On the other hand there is an increasing number of countries where there is water scarcity or even emergency, with a pro capita availability of water that is less than 1000 m^3 per year.

When we refer to scarcity, what do we mean exactly? From a physical and environmental point of view, water is defined scarce when the water that is withdrawn for agricultural, industrial and domestic purposes exceeds 75% of the supply, and therefore it is no longer sustainable. If up to 60% of the resources of water are drawn, it is considered approaching physical water scarcity. There is a situation of economic water scarcity when, even though water is actually available, less than 25% can be drawn because of human, institutional, and financial capital limit access to water.

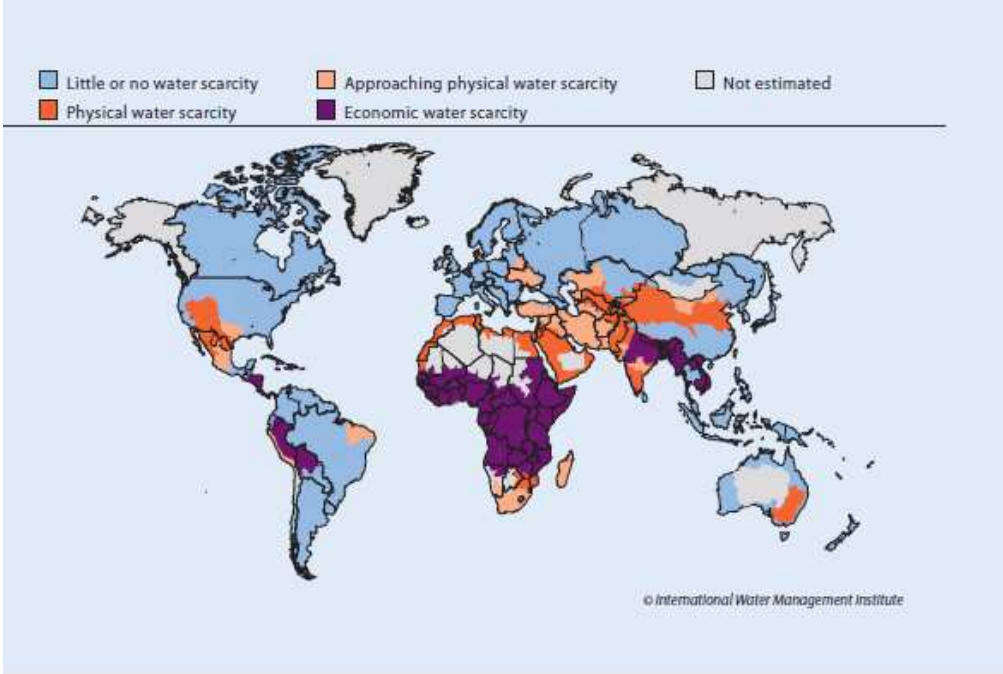

Fig.3 *Map of the world water scarcity. Light blue areas - Little or no water scarcity; Pink - Approaching physical water scarcity; Red - Physical water scarcity; Purple - Economic water scarcity; Grey - Not estimated. Credits: International Water Management Institute*

As already mentioned, most of the water resources are used for agriculture, with an average withdrawal, on a global scale, equal to 70%, followed by industry (22%) and domestic use (8%). The more we move towards countries with a lower income, the more the percentage of water destined to crops increases, up to an average of 82% which reaches a 90% peak in India and in Greece. Countries with a high income, instead, use less water for agriculture (an average of 30%, with a minimum amount in Sweden and Germany, equal to 9% and 3% respectively), but they use more water in the industrial sector and for domestic use, an average of 59% and 11%.

If we analyse average per capita consumption, we discover that this varies greatly in many countries: according to the United Nations, an American in the United States uses 575 litres of water a day, an Italian uses 385 litres, while an Indian and a Chinese use 135 litres and 85 litres respectively.

Lastly, let us once again take into account the water footprint which we have already introduced, but we will take one step forward, to stretch our view to the entire planet. We said that the water footprint is the **virtual water** content of the goods and services we use, it is generally expressed in litres or cubic metres, it can be split into the three components: blue, green and grey, it can be both renewable and non-renewable, coming from drought-risk areas or areas rich in water resources. At this stage we can add other two components: the production water footprint and the consumption water footprint. What does this mean? It means that can we can calculate the water footprint of a product, of an activity, and also of a defined group of consumers (an individual, a family, the inhabitants of a city, an entire nation) or of producers (private companies, public organizations, economic sectors).

What is the water footprint equivalent to in terms of consumption? It is equal to 7452 billion cubic m of fresh water a year, i.e. 1243 cubic m a year per capita. To give you an example, consider that the Amazon, the longest river in the world with the largest drainage basin in the world, has a mean annual flow rate of about 5520 billion cubic metres of water.
And on a national scale, which are the countries which have the largest water footprint? The leaders, in absolute terms, are India (987 billion cubic m.) followed by China (883) and the United States (696). However if we also consider the population of these countries, then we discover that actually the citizens of the United States are the least virtuous, with a mean water footprint equal to 2483 cubic m, followed by Italians with 2232 cubic m and Thai people with 2223 cubic m.
When, instead, we refer to the water footprint of production, we measure the total volume of water used in a country for the goods and services that are produced within that country's borders. However, if the good is exported, a part of the water that was used, will travel to another country, abandoning the country of origin, in the form of virtual water stored in the exported goods and services. Later, we will discover that in this case we refer to the trade of virtual water.

Water availability in Italy, Italy's water footprint

What is the situation like in Italy? How much water do we use and how much is actually available? Our everyday experience may suggest that we are not running such a big risk, but is that really so? In Italy, per capita water consumption is 152 cubic m per year, a consumption that only accounts for the direct use of the resource, such as for bathing, cooking, etc. – it does not take into account the indirect consumption we mentioned. The total water footprint instead is much higher: equal to 132 billion cubic m per year and 6309 litres per day. This is a much higher number than that of direct consumption. Where is all this hidden water? As you can imagine, 89% is incorporated in agricultural products, in particular: wheat, olive oil, coffee, beef, milk and pork; alone, these products account for 50%. If we split the three components of the water footprint, we discover that 75% of the water that is used is green, 8% is blue and the remaining part, 17% is grey.
If we refer to the water footprint for production alone, we discover that this amounts to 70 billion cubic m per year, with 85% of the responsibility attributable to agriculture, humans and animals, and farming: which is a very large amount! Unfortunately, if we split consumption into the three components, we notice that the most sustainable segment, the green water, decreases (69%) in favour of grey water (22%) and blue water (9%), which highlights how production implies greater water pollution. The remaining 15% is subdivided between industrial production (8%) and domestic use (7%).
Compared to the rest of Europe and the world, we Italians are one of the least virtuous countries as our annual water footprint is 25% more than the mean per capita water footprint in Europe (equal to 1836 cubic m) and 66% more than the mean per capita water footprint on a world scale (1385 cubic m) . In other words we are one of the countries that use most water per capita, after the United States, Canada and Australia.
But is all the water Italian? With regard to our water footprint, are we independent, or does most of the water footprint include water from foreign sources? Unfortunately we are far from being independent for our water, and most of the incorporated water comes from abroad. The incorporated water amounts to 60.7%, and this value classifies Italy as the third largest importer of virtual water, after Japan and Mexico. So, then, where does "our" water come from? Mainly from Europe (72%) , in particular from France, Spain and Germany, and from the Mediterranean area also Turkey and Tunisia.

Virtual water trade

As you must have noted, many goods that we need to live, are not produced in Italy, but come from abroad. What does this mean in terms of the water footprint? These traded goods do not only determine a flow of materials from one country to another, but also a flow of energy and water, water that we do not see, and that we have defined virtual water. Therefore virtual water will produce a correlated trade which, in fact, is the **virtual water trade**. In the water footprint we find two other components: **the internal and the external water footprint**. The internal water footprint includes the

virtual water consumption to satisfy the demand of goods that are produced and consumed in Italy (in our case) while the external water footprint groups all the virtual water flows of goods produced abroad, and consumed in Italy.
Theoretically, virtual water trade could also be a positive characteristic, because countries whose water resources are scarce, from a physical point of view or from an economic point of view, would have the possibility of optimizing the management of their water, using this “alternative” source that comes from abroad. On a global scale it would be possible to save water resources when a country with a large availability of water exports to a country with scarce water resources. On the other hand this implies a potential dependence of a country on its imports of virtual water. Italy is an emblematic example of this. As we have seen in the paragraph above, we Italians depend greatly on foreign countries for our virtual supply of water that is necessary to produce our goods and services, and this makes us particularly dependent, and therefore vulnerable. To use water from other countries for the production of products that are consumed within the boundaries of one’s country, also determines the influence of indirect and negative effects of exploiting the water resources in the exporting country, with critical situations referred to as **water colonialism** by the experts.
Lastly, water is increasingly the reason of conflicts, because of the competition between its different possible uses or competition between States with regard to exploiting and managing bodies of water that they share.

What does the future have in store for us? Some possible scenarios

The ability to foresee the future has always been one of our greatest desires, but since we do not have a magic crystal ball, how can we face these challenges, and successfully satisfy the human population’s thirst for water ?
When scientists have to make forecasts they do not look at the coffee grounds left at the bottom of a cup, they use very sophisticated and complicated instruments that often require many years of studies and work: the forecast models. These models try to simulate reality as precisely as possible, with the help of a series of mathematical equations and variables. The more complicated the model, the more precise it will be.
In the case of availability and accessibility of water resources, the variables that have been identified and which will have an influence in the long term are:

- population growth and urbanization process
- increased wellbeing of the population with a consequent change in its eating habits
- climate change
- socio-economic development and the production of biofuels

Current estimates foresee that the world population will grow to over 8 billion in 2030 and will reach 9 billion in 2050. With the increase in population, there also will be an increase in water requirement, which at present is estimated to be 50% more for the developing countries and 18% more for the developed countries. The food demand, correlated to the increase in population and the increase in income is estimated to be 50% in 2030 and 70% by 2050. With an increase in incomes there will also be a correlated increase in the demand for animal proteins which, as we know, need a quantity of water that is much greater than vegetable proteins.
All these growth factors are unfortunately accompanied by a decrease in available water resources due to climate change. In the Mediterranean area a decrease in the rainfall is foreseen, which in Italy is estimated to be 14%, and a 2°C increase in the mean temperature. This will involve an increase in crop evapotranspiration which will require an increased amount of water, estimated around 10%. All these variables lead to an estimated 19% decrease in the water available for agriculture and an economic damage, for our country, equal to approximately 1.8% of the Italian National Income. Besides these problems, there is also the increase in water pollution and the increased demand for energy, from hydroelectric sources and biofuels, whose cultivation and production will compete more and more with the demand for farming land and water for drinking.
Lastly we must consider that we are not the only ones who need water – many ecosystems need a certain amount of water for survival, the environmental flow requirements.
Future scenarios are not rosy, however we can make changes happen, by starting to be aware of the situation, by spreading information, and by making some small changes in our habits.

Do not waste water! The water we save today will be available in the future.

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Author: Nadia Mirabella, eniscuola editorial office