The first image that comes to mind when we think of a river is that of water running continuously from mountain to valley. This may sound obvious, but it is precisely this aspect that allows us to understand what a river is and how it functions.

A river is a course of water that originates in the mountains and flows downwards until it reaches the sea. On its perpetual journey, river water crosses land, hills and plains. Starting in the mountains, the water is at first torrential because of rainfall and the melting of ice. Sometimes land levels shift and change abruptly, causing the formation of waterfalls where the water picks up speed and strength. Then, as it reaches the plains, it flows more slowly and if it encounters any obstacles it will flow around them, forming twists and bends (like those of roads) called “meanders”.

Illustration 1: © NGRBA National Ganga River Basin Authority - The Ganga river

Illustration 2: © George Steinmetz, National Geographic - The Nile river

Illustration 3: © IAN Integration and Application Network - University of Maryland - The Danube river

Rivers, blood of the earth
Along its entire route, a river is a fundamental resource not only for human life but for fauna and flora too. Each and every river is crucial to the equilibrium of the environment and biodiversity. That is why rivers must be considered a most precious good, to be guarded and protected from all forms of pollution or excessive exploitation.

In some cultures, like the U’wa Indians of Colombia, quite unlike western culture, the river itself is seen as a “living organism”: it is the blood that nourishes the earth.

Droughts and floods
When there is too much or too little water, rivers suffer the consequences. Today we are frequently taken aback at how frequently droughts and floods occur in certain parts of the world. A riverbed can carry only so much water and when there is too much it literally bursts its banks and floods the surrounding land. History is full of episodes related to calamities and floods like this. In the past, these events were certainly regarded negatively but they did have some positive outcomes as in the case of the Nile river, venerated by the ancient Egyptians as a god because of its amazing fertilizing powers. This example is a reminder that if floods are managed wisely there are advantages to be reaped.
Where do rivers originate? The source
Rivers originate in the mountains, very often in glaciers, vast reserves of permanent ice which derive from the snow deposited at high altitudes or in the polar regions. While snowflakes fall to earth a small quantity of air in miniscule particles remains frozen and trapped inside the snow crystals. These particles can remain trapped for a few days, a season, or even thousands of years until the snow melts and turns to water. In other cases, the source of water may be underground. Indeed there are many rivers which spring from plains precisely because the water flows beneath the earth’s surface. When underground water encounters clay soils it then comes up towards the surface, thus creating swamps and in some cases actual courses of water, so called resurgent rivers. It can take some underground water courses thousands of years before they eventually rise up to the surface.

Illustration 4: © Centro Civiltà dell’Acqua
The river’s source in a mountain glacier.

The ages of a river
We can divide each river up into three ages, comparable to the life phases of human beings: youth, maturity and old age. These three phases roughly correspond to the regions the river runs through. The river’s course is its life, its entire journey from source to mouth where it sheds its banks and merges with the water of the sea.

Youth
When it first starts out, a river is still small and narrow, a mountain spring whose waters run quickly downwards towards the valley. The land here is sloping, often steep, and does not allow the river to create an alternative course. It is often torrential, that is to say its rate of flow depends on the amount of rainfall. Even if there isn’t much water initially, the speed with which it flows downwards erodes the surrounding rock, and in this way the water absorbs many mineral salts and elements from stones, soils, vegetation and wood.

Maturity
Once out of the mountainous stretch, the river flows through hills and valleys – known as valley bottom, or piedmont regions, where the land is more gentle than in the mountains and where the water meets up and joins with other rivers and torrents. The land slopes less and the river flows more slowly. Material brought down by the current begins to deposit, first the large pieces of debris get left behind, then the smaller pieces, right down to mud and sand.

Old age
The river flows from the hills down into the plains. The flow speed slows down yet again, debris becomes finer, and the riverbed, the basin in which the water flows, gets wider. The flatness of the land allows the water to freely "explore" its surrounding territory and change its form as it moves around whatever it meets. Sometimes little islands form in this way along rivers, known as fluvial islets.

The mouth
At the end of its journey the river flows out into the sea. The place where fresh and salt water meet is known as the river mouth or outlet, and this can either take the form of an estuary, or a delta. An estuary is a simple outlet where the water from the river reaches the sea directly. There are no islets or amassments of debris which deviate the last lap of the river because the sea currents are so strong that they all get swept away. A delta outlet is the opposite of an estuary. Here the river can fork off into complex branches, and this is made possible because the sea currents are weak and unable to sweep away the debris that has been formed by the river. Islets may form which make the river fork off into intricate directions.

Illustration 5: © United States Department of Agriculture
The ages of a river: youth, maturity, old age.
Which are the longest rivers in the world?
The longest river in the world is the Nile. It is 6700 kilometres (4132 miles) long and flows throughout Africa in a northerly direction, its mouth being in the Mediterranean Sea. The second longest river is the Amazon in South America (6500 kilometres / 4000 miles long) which flows out into the Atlantic Ocean. In third place comes the Blue River, or the Yangtze, which is just under 6500 kilometres long. A curious fact is that of the ten longest rivers in the world, four of them cross Russia (Amur, Ob-Irtysh, Lena, Enisej) and China (the Blue River or Yangtze, the Yellow River or Hunag He, Amur, Ob-Irtysh).

From mountain to valley, a continuous habitat mosaic
The confines between the different zones (or ages) and the habitat of rivers are not clear cut. Rather, the movement from mountain to valley is often gradual or shall we say it is hard to distinguish one section from another.
Where the structural characteristics of the river (i.e. slope, substratum, current speed) change, there are corresponding changes in the flora and fauna in as much as they are typical specimens of a specific environment. A river is thus an ecological continuum, a succession of rich and vital environments which slowly merge one into the other. By ecological continuum we mean that the river gives continuity to the fluvial ecosystems that follow one after the other from mountain to valley. All rivers may therefore be seen as long passageways which allow for the transport of different types of organic material throughout its course as well as the migration of many different species of animals.
From riverbank to riverbank: a transversal perspective

Rivers should not only be viewed longitudinally (from mountain to valley) but also transversally (from bank to bank). The unique beauty of a river is precisely this, the perpetual interchange that exists between river and land, from source to mouth and from one bank to the other! The cross section, or river ecotone, which runs transversally to the current, also consists of a succession of microhabitats of great environmental importance. If we look at one section of the river’s course we discover that there are zones of varying depth and current speed, such that they create a series of microhabitats which are all very different to each other. The river ecotone, a transitional area of vegetation, presents a series of gradual transformations. From the area closest to the land to the deepest part of the riverbed, we encounter many different types of plants (trees, bushes, grass and aquatic plants). The first area we meet closest to the water is the river’s pebbly shore with its typical herbaceous vegetation, though the continual movement of the current does not allow a stable herbaceous community to grow. Where the current is at its weakest, near the riverbank, cane thickets and other bushes grow. Beyond this area we find the sturdier and more important types of vegetation which can withstand submersion in water.

The concepts of habitat and ecology

We have seen that the river habitat, the natural environment around the water, does not just develop along the river’s length but also between its banks. But before we can really begin to understand the purpose of these habitats and how they work, we should first clarify what ecology means. In everyday language, we speak about ecology in terms of everything that is somehow compatible with the environment: ecological washing powders, ecological fuel, ecological paper, etc. But actually, ecology (from the Greek oikos meaning “home” or “environment”, and logos meaning study) is a scientific discipline which studies the distribution of living creatures and the interaction of organisms with their environment. The term ecology itself was coined by the German biologist Ernst Haeckel in 1866.

What is an aquatic ecosystem?

An ecosystem is the entire spectrum of plants and animals in any one area which depend on each other for their continued survival. The sum of all their interactions is known as an ecosystem. An aquatic ecosystem therefore refers to those interactions which develop among the living creatures of a given climatic, geological and morphological context along a course of water. We find many different aquatic ecosystems along a river’s course, and any interruption or alteration to their composition can cause serious problems indeed. As an example, let’s try to imagine what might happen if we introduce a completely new animal or plant to an ecosystem. This newcomer will compete with the pre-existing organisms for its share of resources, sometimes pushing the other organisms out and perhaps even leading them to extinction. The effect of this might be that serious damage will be caused to those organisms which depended on the extinct organism for food, and so on. The fruits of the exchange between the different levels in an ecosystem might be considered nature’s “services” to us: water, food, energy and resources (from water for agriculture to water for domestic, civil and industrial use; from fishing to medicines, from wood to a multitude of other natural resources).

The many functions of a river

A river is an extremely complex environment which carries out fundamental processes in order to maintain environmental equilibrium, with benefits for both the natural world and the human world. Of these benefits, we should begin by stressing the crucial role that aquatic ecosystems play in the depuration of water. But we should also point out that the capacity a river has for self-depuration is strictly linked to its integrity. Only a healthily functioning river can effectively combat pollution without compromising its quality at the same time. So, for rivers to keep up their natural capacity for self-depuration, it is vital to protect and strengthen their natural conditions against excessive forms of exploitation and pollution. Now let’s take a look at some of the major tasks rivers perform in more detail.

The best water depurators in the world

Not many people know that rivers have a huge capacity for self-cleansing or depuration, and are actually the best water depurators in existence! A series of chemical and biological processes take place in rivers which can fight various forms of pollution, both of natural or human origin.
Polluting substances are “eaten” by small organisms like bacteria and fungi which in turn are a source of food for the microscopic communities of organisms that live on the river’s pebbles and stones. These communities are called the periphyton, that subtle, slippery film which plays the initial role in the river’s self-depuration system. The second system is composed of a community of larger organisms called macro-invertebrates or macro-benthos (made up of living creatures that are a few millimeters in size such as insect larvae, water beetles and also small crustaceans and mollusks). The macro-benthos comprises all levels of the food chain. They are both herbivores and carnivores with many specialized functions which allow them to scrape, grind and absorb all the alimentary resources of a river. A further contribution to self-depuration comes from superior organisms such as fish, amphibians, birds and mammals that feed on the macro-invertebrates.

The energy base of the food chain
Vegetation in the river leads organic material to become caught and trapped. The outcome of this process is that an extensive quantity of organic material (like branches and leaves) is, as it were, stored up, and this is the energy base for the food chain of all creatures living along rivers.

The river as an ecological highway
Rivers might well be seen as “green highways” which link up a succession of natural zones. Even where human action and presence is marked, the river and its ecotones are still vital areas, used both by plants and animals for movement and reproduction. The migration of birds, for example, generally follows paths marked by rivers, and some trees, especially in the ecotones, use the flowing water to disperse their seeds. Rivers are thus extremely important interlinking passageways in a wider network, the ecological network itself.

The filter function of the river ecotone
The river ecotone, or the vegetation that grows in a transitional environment between land and water, also plays an important part in water depuration. Here below are some of the main functions the ecotone carries out:
- Filter zone for nitrogen and phosphorous from agriculture (through radical absorption, action of microorganisms and microbiological processes)
- Anti-erosive effect of river banks (due to the radical apparatus of the ecotone vegetation)
- Flood control (as a zone of natural overflow)
- Mitigation of sudden temperature change of the water (due to the shade of plants)
In addition to all the foregoing, the ecotone is important in terms of the landscape and recreation, in that it breaks up and gives life to the monotony of a territory.

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References


