



## Module 4: Let's Get to Work: Water, Energy, and Waste

### Introduction

We have heard it time and time again, in movies, newspapers, books, and on television: As humans we are part of an interconnected system to which every living and inert thing on the planet belongs. But, what does this mean? How do we translate this to our day-to-day lives? And, what relevance does saving energy and materials have? How can this be related to the idea of climate change? This chapter will attempt to answer these questions by making a direct connection between our day-to-day actions and the repercussions that these have in the processes and natural cycles of the planet.

### Objectives

By the end of this module, the teacher will be able to:

- Understand 4 basic ecological concepts
- Know the interrelation between the processes and natural cycles of the planet and human activities.
- Identify the impact that our modern lifestyle has on nature.
- Understand the life cycle of productive processes: (history; where they come from and where the goods

that we consume every day go)

### Themes

1. *Key Ecological Concepts*
2. *Energy*
3. *Water*
4. *Waste*
5. *Where Things Come From and Where They Go*

### **1. Four Basic Ecological Concepts**

In the framework of Education for the Earth (a current environmental education concept initiated 30 years ago, which aims to prepare more conscious individuals for their place on Earth), there are four basic ecological concepts (these are: *Energy Flow, Material Cycle, Interdependence, and Change* (Van Matre, 1993)).

Let's continue by describing the concepts and explaining their connection to our daily life.

### **Energy Flow**

Is the process that makes life on earth possible. The First Law of Thermodynamics (also known as the Law of Conservation of Energy) says that *energy cannot be created nor destroyed; it can only change from one form to another*. This means that in the universe there is a specific



quantity of energy, which is constantly changing form.

We can follow this trajectory of transformation from energy in the Earth to the sun, which generates radiant energy from the atomic energy released in the fusion of hydrogen atoms in the sun's nucleus. This radiant and thermal energy from the sun is absorbed by plants and transformed to chemical energy in a process known as photosynthesis. This energy passes from the plants to herbivorous animals and later to carnivorous ones in what we know as a "food chain." Everything is part of the flow of energy. This chemical energy that the plants "produce" and that we ingest as food is transformed to mechanical energy when we move, work, run, and play. The Sun is the energy source that gives life to the Earth and through this flow, provides energy to practically everything that inhabits it.

### **Material Cycle**

With the exception of meteorites and other particles that continually reach Earth, all the materials that we use have been here since the beginning of the planet and everything has been cycled and continues cycling continuously. The water cycle is an excellent example of this: the clouds drop water, it accumulates in rivers, lakes, and later stored in the ground, and eventually, it is evaporated and

the cycle starts all over again in the clouds.

The nutrients that animals consume from plants return to the earth after digestion so they can be absorbed again by the plants. As humans we are also part of these cycles and for a long time we were regulated by this process, but with the development of technologies for the use of natural resources, we interrupted these cycles and on occasion we took more than the system could bear and gave back contaminants.

Another example is industrial agriculture, where the indiscriminate use of the ground renders it infertile. Furthermore, we add pesticides that enter the subsoil and contaminate water tables. The production systems that dominate the global economy are linear, with raw materials taken from one or various regions of the planet (natural resources) used to generate products that are distributed and used in other parts, generating waste (trash), which we have to deposit in other regions. This model doesn't fit in the material cycle model that sustains the planet.

This concept attempts to directly explain how the system in which we live - Planet Earth - operates and all the subsystems that exist within it. All these systems are interrelated and what happens in one part of the system is always going to affect the rest of it. So, the well-being and



balance of every part of the system depends on the others.

Interdependence can take the form of competency – between plants competing for light or between animals competing for territory or food – or of collaboration, as in the symbiotic relationship between some animals. Humans have created systems – cultural, social, political, or economic – intertwined among themselves, but also interdependent on the natural systems.

Our human systems wouldn't work for very long if the natural system became dysfunctional. We must remember that everything we use and consume comes from nature and returns to nature. According to the philosophy of Education for Earth, no isolated actions exist, or, that is to say, everything that we do has an impact on the other subsystems on Earth. A concrete example of these impacts from our lifestyle is the accumulation of Greenhouse Gases in the atmosphere that provoke climate change.

### **Change**

Change is something that we always can hope occurs naturally on the planet, it is an essential part of the processes that maintain the balance and health of the system. From slow and imperceptible changes like the movement of the continental plates to the periodic changes of the seasons or from day to night. Thanks to change, manifested

through natural selection, biodiversity of species exists on the planet.

Even if change is something that occurs naturally, human beings, through the development of technologies, and especially since the Industrial Era, have accelerated change in the land and have occasionally brought it out of balance. Following with the example of the accumulation of Greenhouse Gases, the scientific community recognizes that cycles of gas accumulation that cause the Greenhouse Effect naturally occur in the atmosphere and also cause climate change on Earth. However, these cycles also indicate that our activities are responsible for the accelerating effects of climate change.

### **In Conclusion**

What does all this mean in the real world? What is its relevance and how can we apply it to the reality in which we live in the schools? Yes, it is valuable to teach students the importance of turning off lights and electronic equipment when they aren't using them in order to save energy, or to turn off the faucet when they aren't using it, in order to save water, or to take advantage of school materials in order to save resources. All of this is common knowledge in our society because it brings us economic benefits, but it is important to think past just saving money and see the complete picture.



As part of the activities in *Sustainable School*, the teacher as the leader of the group promotes the understanding of interdependence, emphasizing that to be part of a natural system everything that we do has an impact on nature. Promoting a long-term vision in the students is a skill for putting sustainability into practice.

As an exercise, ask the students to analyze, in groups, where the things that we use in the classroom come from:

- Where does the notebook come from? The pencils and the other materials that we use in school?
- How many resources and how much energy does it take to produce them?
- Where do they go when we throw them away?
- What is the environmental impact upon finding a place to throw them away? What can we do to diminish this impact?

To close this exercise, ask that they write a reflection about what they have learned. Share with students the importance of doing these reflections. Remind them that while interesting, the reflections may be challenging, because often times the answers might be overwhelming and that they might find themselves mentally blocked.

As educators we have the responsibility of presenting this information in a way that is

manageable and useful for them, and so that it generates a challenge and enthusiasm in the individual, in place of a sensation of desolation and impotence. The ecological concepts presented here can be applied directly to sustainable activities that help diminish the environmental impact in relation to the use of energy, water, and waste.

## 2. *Energy*

We have already handled the theme of energy flow as an ecological concept, but, what about electric energy? And gasoline and other fossil fuels? These energy sources have been developed by humans, right? Correct. The technologies for the use of these forms of energy have been developed by humans, but the energy in it has come from the Earth, thanks to the Sun.

Remember the law of conservation of energy. Electricity is only one form of energy and it is very clean, but to generate it, turning to other forms, like chemical energy and the potential of fossil fuels (petroleum, carbon, etcetera), which should be burned (or transformed into thermal energy) to move a turbine that produces electricity, creates enormous quantities of carbon dioxide (CO<sub>2</sub>), the principal Greenhouse Gas. So although it seems that in turning on a light or starting up our computer we aren't contaminating anything, the reality is quite the opposite.



Other energy sources exist, like wind, river currents, and the direct rays of the sun, that are renewable and much cleaner and little by little are being used around the world, but actually, fossil fuel energy continues to be the most used.

The energy sources that cannot be replaced or quickly regenerated are called *non-renewable*. These are the least desirable, since their consumption generates Greenhouse Gases and limited reserves.

Examples:

- Petroleum
- Carbon
- Natural Gas
- Nuclear

Energy sources originating from natural resources that can be naturally regenerated and in a short amount of time are called *renewable*. These are more desirable since they tend to be cleaner and sustainable.

Examples:

- Wind
- Hydroelectric
- Solar
- Raw materials (biocombustibles)

It is important to remember that when we are utilizing any of these resources for generating electricity or any other type of utilizable energy, we are not using the energy itself, since it is only changing form (let's remember the law of the conservation of energy). What we

are doing is using the limited natural resources from where we obtain it and changing the state of things, interrupting the natural equilibrium of things. Because of this, we shouldn't just use more sustainable energies. This means we should reduce the amount of energy that we use, changing our daily routines to use only what we really need.

### 3. *Water*

Almost three-quarters of the surface of our planet is composed of water. Water is continually changing form, but the total quantity of water remains the same. Water exists in three states: solid (ice), liquid (lakes, oceans, rain, etc.), and gas (water vapor, clouds). Oceans account for approximately 97% of the total water supply. The polar ice caps and glaciers account for 2%, the rivers and lakes make up less than .02%, and groundwater makes up about .6%. The rest is in the form of water vapor or soil moisture in the ground (<http://www.outreach-scheduling.org/tucsontoolkit.php>).

The water cycle is commonly described as a series of processes occurring in a predictable pattern: It begins with the evaporation of water from the ocean's surface. As it rises, the humid air freezes and the water vapor is transformed into water. This is the process of condensation. After, the droplets bond and form a cloud so that they can later fall by their own weight as precipitation. When the temperature in the



atmosphere is very low, the water falls as snow or hail. If it's higher, the drops will fall as rain. A part of the water that reaches Earth is taken advantage of by human beings; another part drains into rivers, lakes, or oceans. This is known as runoff. Another part is filtered through the ground, forming subterranean water layers through the process of percolation. Sooner or later all this water will return to the atmosphere again, due mostly to evaporation.

During evaporation, the water leaves behind all the elements that contaminated it or that make it impossible for drinking (mineral salts, chemicals, wastes). Also through the plant's perspiration the water is purified. The plant's roots absorb the water, which is then moved through the stems or trunks, taking with it the elements that the plant needs to feed itself. To get to the leaves and the flowers, it is evaporated in the form of water vapor. This phenomenon is called perspiration. Although the plants help clean the water, there is a limit to its capacity and on many occasions humans have surpassed that limit.

Water, although a renewable resource, is limited. It is renewable because the same amount of water is found perpetually passing through a global cycle called the Water Cycle or the Hydrologic Cycle. It is also a limited resource because the availability of "fresh water" and

liquid varies largely over the plant and is not distributed equally over the globe. When we modify the channels and the processes of the hydrologic cycle, we put the same source of fresh water in danger. Because of this, it is important to look after the quality of water and use it only as we need, to interrupt the cycle as little as possible.

#### **4. Waste**

What are solid wastes? More commonly known as "trash," solid wastes are the materials that someone doesn't want anymore and that are not liquid or gas. These lessons focus on solid wastes in cities, which include what is thrown away in the homes, businesses, and institutions, but which doesn't include wastes from activities such as mining, agriculture, forestry management, destruction, or semi-solid materials (mud). The word "waste" has interesting connotations: it can refer to a surplus or residuals, and also to something that is wasted by inappropriate use. Many things that are considered "wastes," in reality, can be taken advantage of in other ways. Solid wastes are a serious point in the United States, since at the global level, the U.S. is the highest generator of solid waste per capita.

Compared to other industrialized nations, such as European countries or Japan, every American generates individually, on average, double the amount of solid waste that these



countries use. The typical U.S. citizen wastes, daily, about 4.4 pounds (2 Kg.). In 1960, this number was 2.6 pounds (1.2 Kg.). If we don't change our daily habits, this could lead to 4.8 pounds (2.2 Kg.) by the year 2010. In the last 20 years recycling has continually grown: from 1980 to 1990, the United States nearly duplicated its recycling, from 9% to 17%.

The Three R's: In the context of waste reduction, this refers to Reduce, Reuse, Recycle. These are the three basic habits and are most important for reducing wastes, conserving natural resources, and diminishing our impact on nature. Furthermore, Reduce, Reuse, Recycle also saves money. It is essential to remember that this order – Reduce, Reuse, Recycle – is not arbitrary. Some people think that recycling is the central point of attention, and that to reduce and reuse are less relevant, but this interpretation is incorrect. In reality, reducing is, in fact, the most efficient habit for conserving resources. Reusing is the second-most efficient. Recycling is certainly important, but not as efficient as reducing or reusing. Of course, recycling is understood as a cycle. So that recycling is successful,

we have to complete, or, close this cycle, buying manufactured items made from recycled materials. Although it could seem confusing, in reality, it is very easy to recognize the “Made from recycled materials” logo, that is a triangle of arrows around a darker-colored circular one; from the “recyclable” logo, that is only a triangle of arrows, in some cases with the identification of materials that are used. A product or object “made from recycled materials” really contains materials that have been previously used.

##### ***5. Where things come from and where they go***

Inside the conceptual framework that defines the four ecological concepts mentioned here (Energy Flow, Material Cycle, Interdependence, Change), and to understand how good habits related to waste regulation, energy use, and taking care of water can make a difference in the health of the planet, there are various resources that help develop an integrated vision and with it, the understanding of this model of sustainable development. One of these resources is the documentary called “The History of Things” presented by Annie Leonard.