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ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

Youth Capacity Building and Exchange Program towards Sustainable Development and Conservation of Ifugao Rice Terraces

Ifugao Rice Terraces as Satoyama Landscape Book Series

ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

Mark Anthony F. Rabena, Romeo A. Gomez Jr., Ph.D, Elpidio Basilio Jr., Ph.D., Melanie S. Subilla and Thaddeus P. Lawas, Ph.D.

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UPOU Headquarters
Los Baños, Laguna 4031, Philippines
Tel/Fax: (6349) 536 6010
Email: fmds@upou.edu.ph

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Editors: Primo G. Garcia, Ph.D. & Joane V. Serrano, Ph.D.
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Photos:	Jan Pauline Borce, Fulgencio G. Oliveros, Jr., Christian Guevarra & Ruth Veluz
Layout & Book Cover Design:	Noreen Dianne S. Alazada
Contributors:	Janele Ann C. Belegal, Von Kevin Alag Jan Pauline Borce& Fulgencio G. Oliveros, Jr.

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FOREWORD

This book is part of the Ifugao Rice Terraces as Satoyama Landscape Book Series, and is in support of the two United Nations 2015 Sustainable Development Goals (SDG):

- SDG 13: Take urgent action to combat climate change and its impacts; and
- SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Satoyama, a Japanese term that has taken global significance, is a framework that highlights human-nature interaction. In a satoyama landscape, human-nature interaction is expected to be at its best because there is harmony, there is no destruction, there is sustainability, and there is resiliency (Buot, 2017). This interaction is evident in the daily living of people relying heavily on the goods and services provided by the environment. Studying and understanding the individual components of communities and determining their connections and relationships with their environment are important for satoyama initiatives to operate synergistically and sustainably. An evidence-based presentation of connections and relationships will allow stakeholders to acquire a broader perspective on the "domino effect" of their actions on the landscape.

With this definition, the Ifugao Rice Terraces is a clear example of a Satoyama landscape with its inherent human-nature interactions and the various social, political, cultural, and economic issues present in the world heritage site.

#Y4IRT Team

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OBJECTIVES

At the end of this book you should be able to:

1. Describe ecosystems, ecosystem structure, ecosystem functions, and ecological succession; and,
2. Explain the impacts of human activities on ecosystem services.



ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

CHAPTER 1: ECOSYSTEM STRUCTURE

OBJECTIVES

At the end of this chapter, you should be able to:

1. Describe the biotic and abiotic components of an ecosystem;
2. Explain the interaction between living and nonliving components of the ecosystem; and,
3. Differentiate predation, herbivory, competition, and symbiosis.

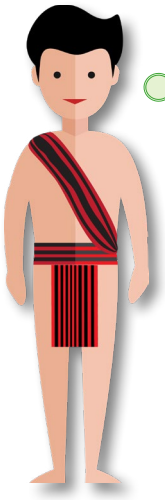
Hello. My name is Bugan, and together with Wigan, we welcome you to our book. We will be assisting you in learning the topics at hand, and we hope you enjoy learning the topics included here.

This book will introduce to you different ecosystems and ecosystem structures, functions, and services.

Before all of that, familiarize yourself first with the concept of *satoyama*.

Hi. I'm Wigan. Do you know what *satoyama* is?

Satoyama is a Japanese term comprised of two words: "*Sato*" meaning home or native place, and "*Yama*" meaning mountain or woodland. In simple terms, *satoyama* describes a village and its populace and their relationships with the mountain or woodland.



'sato' + 'yama'

Based on this definition of satoyama, it is clear that the Ifugao Rice Terraces is a satoyama landscape. The Ifugao Rice Terraces (IRT) is a collective of five rice terraces located in four municipalities in Ifugao (Banaue, Hungduan, Kiangan, and Mayoyao). The IRT was inscribed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1995 as a World Heritage Site and was pilotly declared as the only Globally Important Agricultural Heritage Systems (GIAHS) site in the Philippines by the Food and Agriculture Organization (FAO) in 2005.

This book focuses on the ecosystem services and structure of the IRT as a satoyama landscape. You will further learn about the elements and processes in an ecosystem; ecological succession; ecosystem services; and impacts of human activities on ecosystem services.

You must know by now what satoyama means and what you will learn in this book. You can proceed to the topic discussion and the activities.

TOPIC 1

THE BIOTIC AND ABIOTIC COMPONENTS OF AN ECOSYSTEM

To start, the IRT as a satoyama landscape is made up of different living (biotic) and nonliving (abiotic) components that interact with one another. The interactions between living components and their physical environment make up the different ecosystems in the IRT. Examples of distinct ecosystems in the IRT include muyong (forest), payoh (rice terraces), umah (swidden fields), and wa'el (streams) (see Fig. 1).

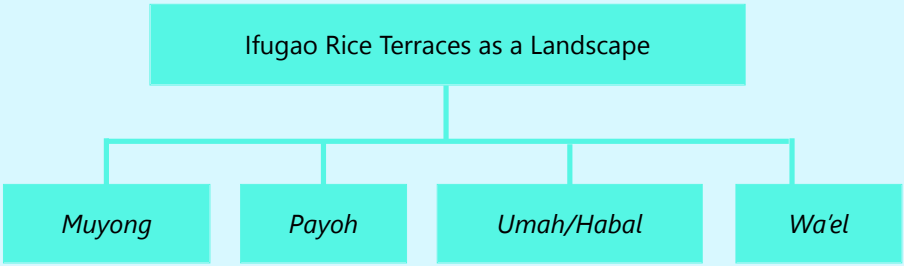


Figure 1. Different ecosystems within the IRT landscape.

These interacting ecosystems are described in terms of their structure and function. In general, structure refers to the components while function refers to the interactions that maintain it as an integrated whole.

To achieve a holistic conservation of the IRT, it is vital for you to understand the structure and function of the different ecosystems within it. This means that conservation efforts, aside from the rice terraces itself, should also encompass the surrounding forests, swidden fields, and the streams and rivers of the IRT landscape. These ecosystems work together to ensure sustainability of the whole IRT landscape.

In this chapter, you will be learning about ecosystem structure. This chapter will further discuss what is an ecosystem, what makes an environment an ecosystem, what are the different types of ecosystem, and what are the different interactions between ecosystem components.

Rice plants and a rice terrace wall. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

The picture above represents an ecosystem.

It has all the factors or components that make an ecosystem.

Do you know what these factors are?

The first topic will begin with an introduction to the basic concept of an ecosystem. Read the transcription of a video about ecosystems. The video was adopted from FuseSchool-Global Education (Youtube channel). And to further examine the concept of ecosystem structure. In the transcription, an ecosystem is described as a composition of living (biotic) and nonliving (abiotic) components.

The first topic will begin with an introduction to the basic concept of an ecosystem. Read the transcription below of a video about ecosystems. The video was adopted from FuseSchool-Global Education (Youtube channel).

The Batad Rice Terraces in Barangay Batad, Banaue, Ifugao. Photo by the Youth for Ifugao Rice Terraces Project.

An **ecosystem** is a community of living organisms and their interactions with their abiotic environment. Ecosystems can be small, such as a small garden; or large, such as the IRT. In the small garden, the living organisms are the plants and the bacteria in the soil.

They interact with the soil, air, water, nutrients and sunlight to grow. For the IRT, the rice, grass, plants, trees and animals living inside the forest and the rice paddies are continuously interacting with water, air, soil and sunlight.

Ecosystems have three broad categories, based on their environment. Within these categories, there exist individual types based on the organisms present and the type of environmental habitat: fresh water, ocean water, terrestrial ecosystems, tropical rainforest, savanna, deciduous forest, desert, coniferous forest and tundra.

The Ifugao Rice Terraces belongs to the terrestrial category with the type being a tropical rainforest because it exists in the tropical region characterized by constant temperature and high volume of rainfall.

Let us further examine the concept of ecosystem structure. In the transcription, an ecosystem is described as a composition of living (biotic) and nonliving (abiotic) components. To learn more about these components, read the transcription of the video about these. The video was adopted from Khan Academy (Youtube channel).

Rice panicles. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

Ecosystems need energy to function, and this energy is regulated by three levels of organisms—producers, consumers and decomposers. These organisms comprise the biotic components of the ecosystem.

Producers are commonly plants in terrestrial ecosystems. They are also called autotrophs. These organisms absorb energy from the sunlight and use it to produce food, a process called photosynthesis.

Consumers are living organisms that cannot produce their own food, so they get their energy by eating other organisms like animals and plants. These are represented by the animals in the forest and rice paddies of the Ifugao Rice Terraces. This group is also called heterotrophs.

Decomposers are the fungi and bacteria that act upon the dead bodies of plants and animals to liberate the energy stored in those bodies. Decomposers are also part of the heterotrophs.

Ecosystems also need abiotic factors for the growth and maintenance of the living organisms in the environment. Examples are wind, water, temperature, soil, and sunlight. The biotic and abiotic components of the ecosystem are interdependent. Changing one component of the ecosystem, whether living or nonliving, will create a significant impact to the ecosystem. An example would be cutting or removing trees from the forest. It will cause:

1. Soil erosion because of losing the ability to hold the soil which is a function of tree roots;
2. Reduced infiltration that recharges groundwater supplies;
3. Increased risk of flooding;

4. Increased temperature due to lesser shade for protection from the sun and lesser absorption of carbon dioxide which will then increase its atmospheric concentration, trapping the heat in the atmosphere in effect; and,
5. Loss of biodiversity due to loss of home for some organisms that rely on trees to live. These are just some of the examples of negative effects of cutting down trees irresponsibly.

Likewise, removing an abiotic component will also disrupt an ecosystem. For example, removing water in an ecosystem such as rice paddy will cause rice to not be able to grow even if there is an abundance of other abiotic factors such as soil, sunlight, air and nutrients. It is important to keep the integrity of an ecosystem so that it will continue to exist. Ensuring that biotic and abiotic components of the ecosystem are not changed or disturbed is of vital importance to mitigate negative effects of a changing environment.

LEARNING ACTIVITY 1

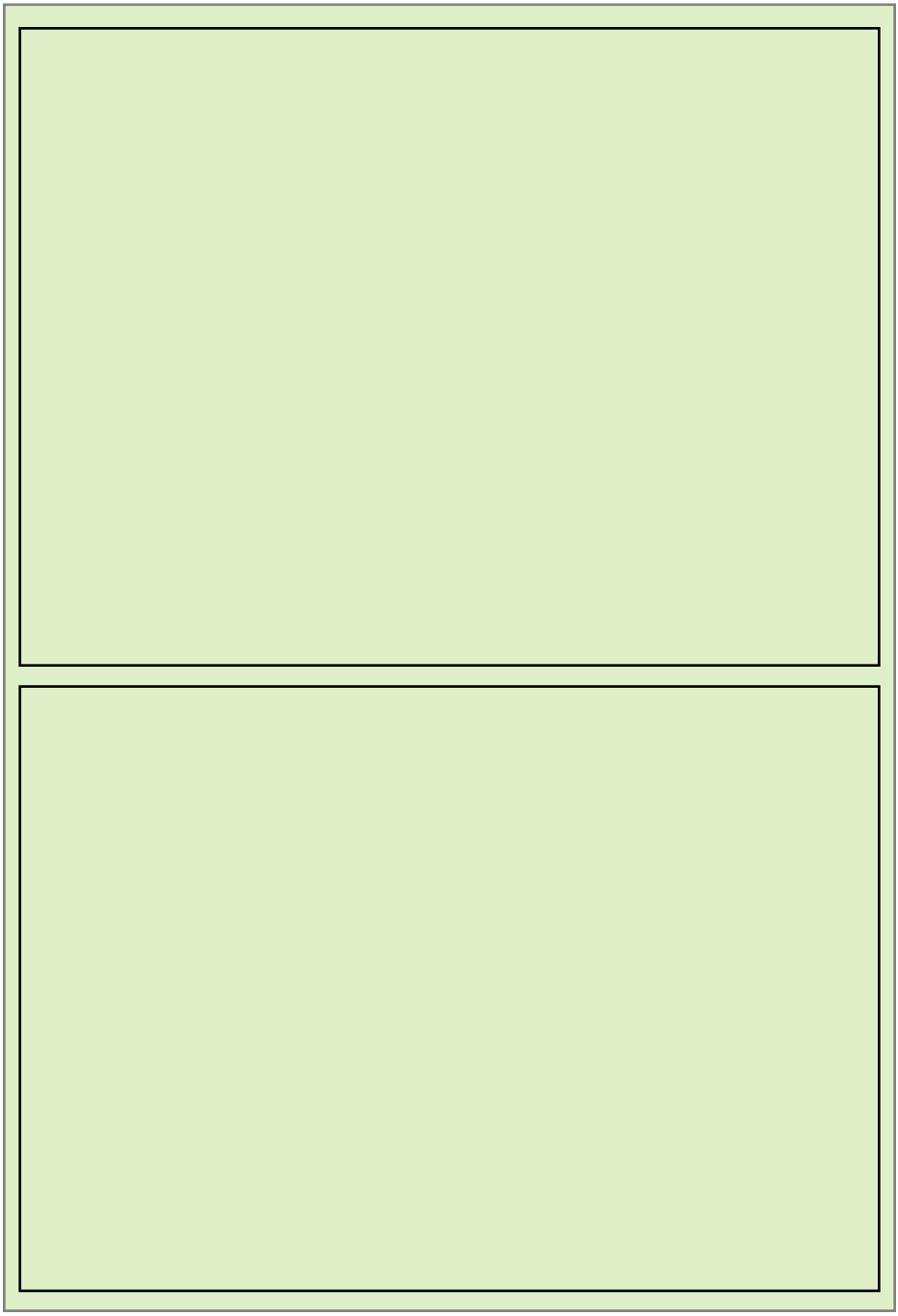
You must have learned by now the ecosystem and its components. Conduct a field observation of the different ecosystems in your community.

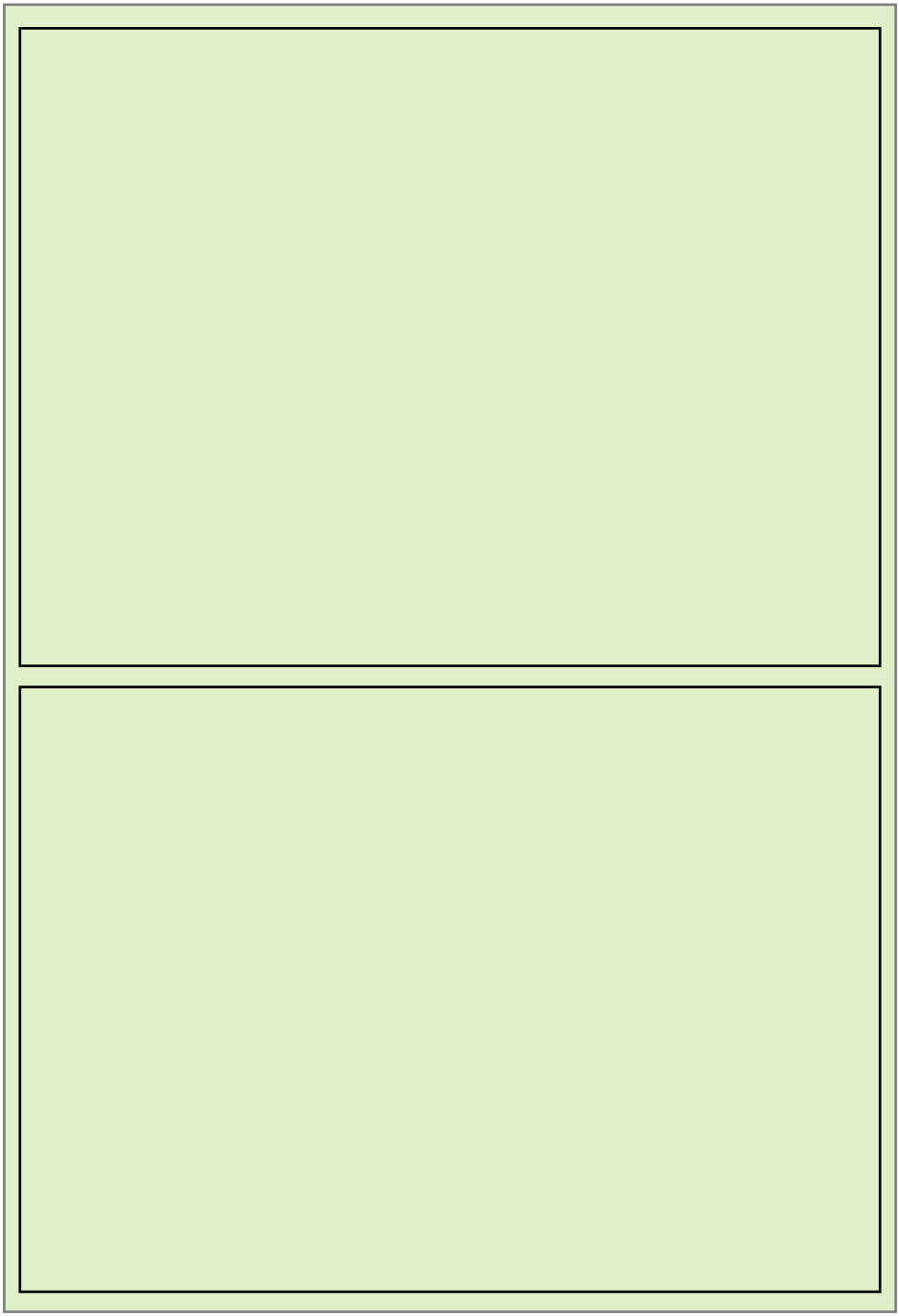
Go to each ecosystem (muyong/forest, payoh/rice field, umah/swidden farming, and wa'el/stream), but ask for permission first from concerned authorities for your safety and security. You might also want to consider wearing proper field work attire, and bring a camera for photo documentation.

Visit the ecosystems near you, and once you arrive at the site, take a photo of a producer, consumer, and decomposer. Take note of the following descriptions: local names, specific location where they thrive (e.g. leaves, soil, branches, rocks) and abiotic factors affecting them. Collate these pictures in the following pages and write descriptions for each picture.

You have learned what the living and nonliving components in the ecosystem are and how these components interact with each other.

Once you have accomplished this task, you may proceed to the second learning activity on determining how living components interact with the nonliving components and vice versa.





LEARNING ACTIVITY 2

First, please take a look at the pictures below.

The Batad Rice Terraces in Barangay Batad, Banaue, Ifugao. Photo by the Youth for Ifugao Rice Terraces Project.

Farmers harvesting in the Batad Rice Terraces. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

Determine what are the existing interactions between the biotic and abiotic components found in the pictures. List down your ideas.

_____

_____

_____

_____

_____

_____

_____

_____

SELF ASSESSMENT QUESTIONS:

Fill in the blanks:

1. **Ecosystem is an assemblage of _____ and _____ elements contained within a _____ such that these elements have functional relationships with each other.**

2. **_____ are the organisms that make their own food, and the last in the order are the _____ that consume the dead bodies of plants and animals.**

TOPIC 2

BIOTIC INTERACTIONS

In this topic, you will explore how biotic components interact with each other. Read the transcription of the video about biotic interactions to learn more. The video was adopted from Khan Academy (Youtube channel).

A community is a group of interacting species living in the same habitat. A balance of species needs to be maintained in a community. The number of animals per species is kept by the interrelationships of these species. A change in one will affect all the other species. To sustain balance, biotic factors such as plants and animals should constantly interact with each other. These interactions are called biotic relationships.

There are six biotic relationships found in a community, and there are four effects that are brought upon by these relationships, with three relationships sharing the same effect but with minor differences between them.

An Ifugao native chicken. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

Let us discuss predation first. Predation is a relationship where one organism benefit from another organism, which is harmed or killed in the process. The stronger animal, the predator, benefits from feeding on another smaller or weaker animal - the prey. An example of this is a chicken feeding on an earthworm. The chicken benefits by gaining energy and nutrients from the earthworm, while the earthworm dies in the process. The predator is commonly a carnivorous animal.

Body lice [digital image]. Photo by James Gathany. (2016, August 18). Retrieved from https://pixnio.com/science/microscopy-images/lice-infestation/body-lice-are-parasitic-insects-that-live-on-the-body-and-in-the-clothing-or-bedding-of-infested-humans.

Second is parasitism. Parasitism is a type of predation wherein the prey (host) is not killed. The predator (parasite) harms the host to a point that greatly affects its quality of life. It can even give the host sickness and when it does, it is then called as a pathogen. An example of parasitism is head lice on humans. Head lice feed on our blood for its nutrition, and in effect, it makes our head itchy.

Another type of predation is herbivory. Herbivory is when an animal (herbivore) feeds on a plant or producer. The plants are harmed as it loses its fruits, leaves or stems—in the process while providing nutrients to the herbivores. An example of this is when cows eat grass for energy and nutrition.

Goat competition [digital image]. (2017, June 14). Photo retrieved from https://pixnio.com/fauna-animals/goats/goat-horn-competition-animal.

Fourth is competition. Competition is a biotic relationship where both organisms are harmed by the other because they struggle for the same source of food, mating partner, and even territory. Say for example, two male goats competing to determine who will be the partner of a single female goat. The winner between the two will be able to mate with the female goat to produce offspring.

Frog atop a leaf [digital image]. Photo by skeeze. (2016, March 7). Retrieved from https://pixabay.com/photos/emerald-eyed-tree-frog-reptile-1233571/.

Fifth is commensalism. It is a biotic relationship where one organism benefit from the other organism, and that other organism is not harmed or benefited. This interaction is as simple as when frogs take shelter under leaves of a plant or tree, or when termites use dead trees to build its nest.

Bee pollination [digital image]. Photo by cocoparisienne. (2014, February 3). Retrieved from https://pixabay.com/photos/forget-me-not-hoverfly-fly-bloom-257176/.

The last biotic relationship is mutualism where both of the interacting organisms benefit from their interaction. An example of this relationship is between bees and flowering plants. Bees harvest nectar from the flowers for production of honey, while flowering plants benefit from the bee visitations through pollination, thereby, enhancing fruit and seed production for creating new flowering plants.

LEARNING ACTIVITY 3

Examine the pictures above and determine what kind of relationship is present in each. Write your explanations why you described it as such a relationship.

Explore ecosystems around you and look for other local examples of biotic interactions. Document the interaction using your mobile devices or camera. Collate your pictures and analyze them using the following key points:

1. Where did you observe the interaction? Indicate the type of ecosystem?
2. Identify the name/s of the organism/s present in the pictures.
3. Elaborate the interaction/s you observed.

SELF ASSESSMENT QUESTIONS:

Based on what you have learned in this topic, complete the table by indicating the appropriate symbol to show how Organism 1 interacts with Organism 2.

Write (+) for positive effect, otherwise, write (–) for negative effect.

Type of Interaction	*Organism 1*	*Organism 2*
Predation	+	-
Herbivory		
Competition		
Mutualism	+	+
Parasitism		
Commensalism		

For self assessment questions, you can check your answers using the key guide by the end of this book.

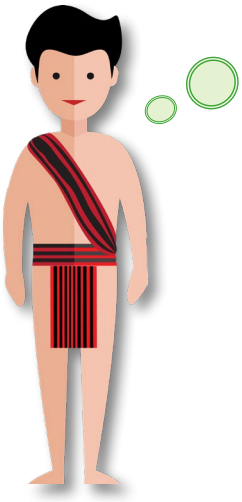
ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

CHAPTER 2: ECOSYSTEM FUNCTIONS

OBJECTIVES

At the end of this chapter, you should be able to:

1. Discuss how energy flow through ecosystems; and
2. Explain how nutrients (water, carbon, nitrogen) flow through ecosystems.



You just learned from the previous chapter the components of an ecosystem and the different interactions you can observe in it.

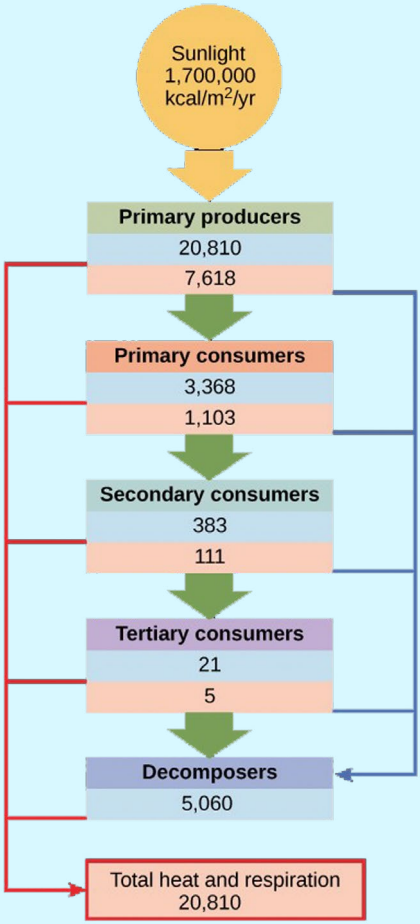
In this chapter, you will learn what functions do ecosystems play. You will get to know what are the important things that happen around us that we cannot simply observe with our naked eyes. These ecosystem functions are very important for you to learn as these affect your daily lives. Are you not curious what these are?

The function of an ecosystem consists of all the interactions among its components. These interactions result in three important functional traits of the ecosystem as a whole: (1) the rate at which energy flows through the biotic components; (2) the rate at which chemicals like phosphorus, carbon and nitrogen cycle within the ecosystem, from abiotic to biotic and back to abiotic components; and (3) the persistence of the ecosystem through time.

In this chapter, you will learn about the first two functional traits.

TOPIC 1

FLOW OF ENERGY



Energy flow in an ecosystem [digital image]. Photo by CNX OpenStax. (2016, May 27). Retrieved from https://commons.wikimedia.org/wiki/File:Figure_46_01_07.png

The picture presented is a representation of energy flow in an ecosystem. Are you familiar with the topic? Have you ever wondered where energy in our surroundings come from? What form of energy is being utilized by the muyong? Do you think you are also using energy?

To get you introduced to the topic and to answer the previous questions, review the transcription below and explore the Earth's ultimate source of energy, and know how energy flows through ecosystems and how energy reaches you. The video was adopted from Osseo Biology and Khan Academy (Youtube channels).

A rice paddy in Ifugao. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

All living things require energy. Some get their energy from the sun, such as plants and fungi (autotrophs), while some get them by eating other organisms such as plants (herbivores) or animals (carnivores), or both (omnivores). Some get their energy through the dead bodies of plants and animals (decomposers and detritivores).

As a result, energy flows in ecosystems, which can be represented by food chains or food webs. For most ecosystems, the ultimate source of energy is the sun.

As energy is transferred from one organism to another, you will move up the trophic structure. The trophic structure shows the position an organism occupies in a food chain. The trophic level of an organism is the number of steps it takes for that organism to be eaten, starting from the bottom or the start of the chain. The food chain usually starts with plants and other

autotrophs which comprises the first trophic level. Examples of autotrophs are rice plants, trees, and algae.

The second trophic level is commonly the herbivores, feeding only on plants and other autotrophs. Examples of herbivorous animals are cows, goats, butterflies and bees. They are also called primary consumers.

The third trophic level starts with the weakest carnivores, feeding on herbivores for their energy. Examples of these organisms are loaches and frogs.

The higher levels consisted of more predators, such as cats and dogs. The apex predators, which are at the top of the food chain, such as crocodiles and sharks, occupy the highest trophic level.

Lastly, there are the decomposers and detritivores. Decomposers and detritivores are organisms that act upon dead bodies of plants and animals to liberate the energy stored in those dead bodies, as well as return the nutrients back to the soil for plants to absorb. Examples of decomposers are fungi and bacteria and for detritivores, there are worms, millipedes and flies.

As consumers eat the producers, or as herbivores eat the plants, energy is released. This released energy is transferred to the next trophic level, in this case, the herbivore. However, only 10% of the released energy is retained within the body of the herbivore. This is also the case as you move up the higher trophic levels.

To simplify, let's start with an example of 10,000 calories of energy liberated by the herbivores from eating the plant. However, only 10% or 1,000 calories in this case, is absorbed by the herbivore. When that herbivore is eaten by a predator or carnivore, the energy is released but the carnivore will only be able to get 100 calories, or 10% of the 1000 calories from the herbivore. Then, the predator that eats the animal that ate the herbivorous organism will gain only 10% of the 100 calories, thus will only get 10 calories.

Most of the energy lost in this process is lost as heat, this follows the laws of thermodynamics. It states that energy cannot be created nor destroyed but can be converted from one form to another (1st law), and this energy conversion is never completely efficient (2nd law). As a result, most of the energy stored inside the bodies of organisms is lost as heat when that organism is eaten by another organism.

As discussed earlier, energy flow can be illustrated through food webs and food chains. A food chain is simply illustrated in a single line. It just shows how energy is passed from one organism to another. A food web, on the other hand, shows how every organism in an ecosystem is interconnected to each other through multiple paths. These paths, when illustrated, show a web-like picture. In a food web, one animal may have more than one food source; but may also have more than one predator. In both the food chain and food web, there will be no arrows that will show apex predators as being a source of food for other animals, and no arrows that will show producers having a source of food aside from the sun.

You may also look at the figure below, by Setelle and Martin (1998), to discern the food web in the Ifugao Rice Terraces.

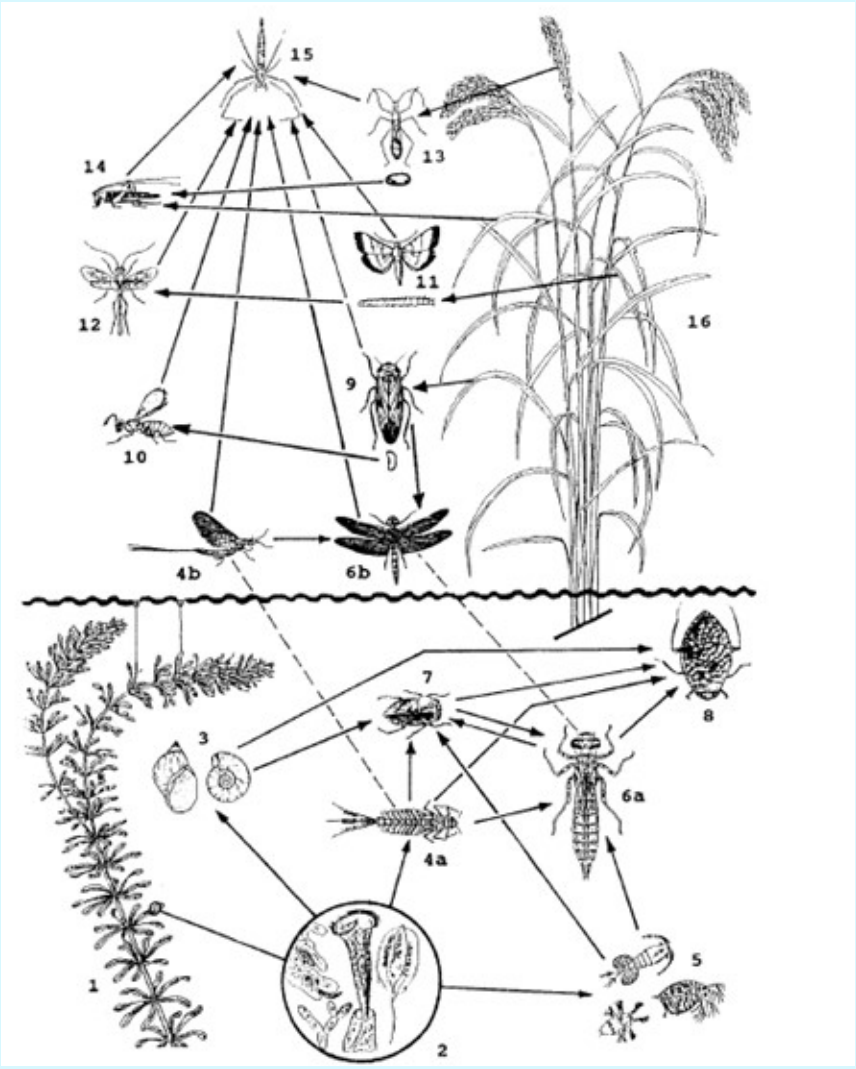


Figure 2. *Food web of an Ifugao agro-ecosystem (Setelle and Martin, 1998). 1 – Aquatic plant; 2 – algae, bacteria; 3 - snail; 4 – insect (a. larva, b. adult); 5 – zooplankton (microscopic floating algae); 6 – dragonfly (a. larva, b. adult); 7- aquatic bug; 8 – aquatic bug; 9 – leafhopper; 10 – insect (feeds on eggs); 11 – leaffolder larva and adult; 12 – insect (feeds on larva); 13 – rice bug; 14 – grasshopper; 15 – spider; 16- rice.*

LEARNING ACTIVITY 4

A food chain is the simplest way of illustrating energy flow.

As an activity, try to create a food chain by examining the food you have eaten for breakfast. First, recall what you ate this morning. After remembering what you have eaten, illustrate a food chain on a document that shows how each food item from your breakfast reached you or your dining table.

LEARNING ACTIVITY 5

For this learning activity, construct a food web using species found in the IRT (payoh). Prepare a photo (may be your own or from the internet, but properly cite the source) of a species found in the payoh.

SELF ASSESSMENT QUESTIONS:

Multiple Choice.

Choose the letter of the best answer.

1. Energy enters the payoh (rice terraces) by way of the

a. Producers **c. Herbivores**
b. Consumers **d. Decomposers**

2. A group of interconnected food chain is called a:

a. Pyramid of energy **c. Food web**
b. Complex food chain **d. Food cycle**

3. Within the ecosystem, energy is transferred from organisms to organism in the form of ____ energy.

a. Electrical **c. Chemical**
b. Mechanical **d. Solar**

4. About how much of the solar energy that falls on the leaves of muyong trees is converted to chemical energy by photosynthesis.

a. 1% **c. 30%**
b. 10% **d. 50%**

5. Tertiary consumers are the final levels in the food web.

a. True
b. False

TOPIC 2

FLOW OF MATTER

It is not only energy that flows through ecosystems. Do you have an idea on what else is there? If not, read this transcription of the video to learn about biogeochemical cycles. The video was adopted from Khan Academy (Youtube channel).

The biogeochemical cycles consist of the recycling of the following nutrients: water, carbon, nitrogen and phosphorus which are essential for life.

Water is involved in the water cycle, and in this process, water is stored in many ways. Some of this water stored cannot evaporate as water vapor, but eventually through condensation, these become clouds, then it would rain back down.

In the carbon cycle, plants fix carbon from carbon dioxide in the air when they get light energy from the sun. The nitrogen and phosphorus cycles are involved in plants as well, and these will be further discussed in the next section.

Wilted flower. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

Since this video only presented the general overview of each nutrient cycle, the next few sections will discuss each cycle more thoroughly. Before you proceed, answer this short quiz to check if you learned something about biogeochemical cycles:

1. **Enumerate the nutrients the video talked about:**

_____
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2. **What is the process that converts water vapor into clouds?**

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3. **Where do plants use the energy from the sun?**

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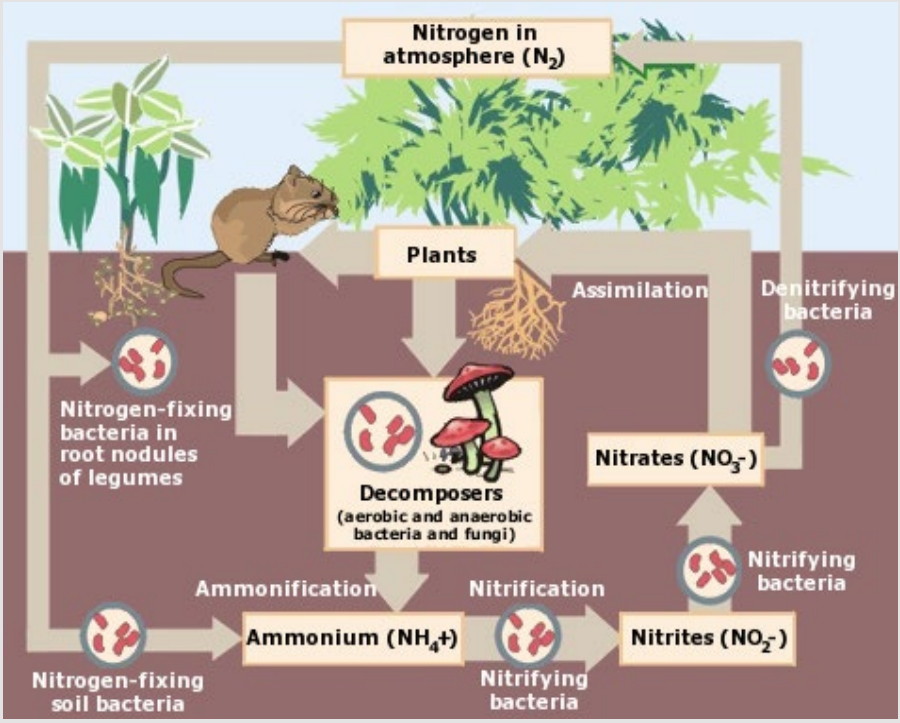
NITROGEN CYCLE

In this section, you will learn more about the nitrogen cycle and its importance to our daily lives. To get an overview, you can look at the picture above that shows a diagram of the nitrogen cycle. Do you know the whole process? Review the video transcription below to learn about the nitrogen cycle. The video was adopted from Khan Academy (Youtube channel).



Nitrogen cycle [digital image]. Photo by US Environmental Agency (2003). Retrieved from https://upload.wikimedia.org/wikipedia/commons/f/fe/Nitrogen_Cycle.svg

Nitrogen, a colorless, odorless, and tasteless gas is important for all life forms. It is used to make DNA, RNA, and proteins, and these serve as building blocks of cells, and therefore also to life. You can look up the definitions of these materials.

Nitrogen makes up 78% of the air in the atmosphere. However, plants and animals cannot use the nitrogen gases directly out of the air. It has to be processed first to its usable forms. The transformation of nitrogen to nitrogenous compounds and back to nitrogen comprises the nitrogen cycle.

Nitrogen cycle starts first with nitrogen fixation. Nitrogen is "fixated" by microorganisms, such as bacteria called nitrogen-fixing bacteria, to form ammonia. Nitrogen fixing bacteria are commonly found in the roots of leguminous plants. Nitrogen fixing can also be done by lightning, forest fires, and hot lava flows.

Ammonia is then taken by nitrifying bacteria to form nitrites, and then nitrates. Nitrates are the form of nitrogen that can be used by plants, which are taken from the soil. Plants use nitrates to form proteins.

Animals are then able to get proteins from eating plants, while carnivorous animals get their proteins from eating herbivorous animals.

Dead bodies of animals and plants, as well as excreta, contain nitrogenous compounds, which over time will decay and turn into ammonia by the process called ammonification. Ammonia is then used by nitrifying bacteria to convert to nitrates to be used by plants.

Some of the nitrates are also converted back to nitrogen gas by denitrifying bacteria, which then goes back to the atmosphere, thus maintaining the concentration of nitrogen gases. This process is called denitrification.

In lands that lack nitrogenous compounds, industries use nitrogen-based fertilizers to enrich the land, essentially increasing the nitrogenous compound available in it. However, excessive use of fertilizer is detrimental to the ecosystem as this can cause many environmental hazards, such as soil and water acidification and water pollution, which are overall negative impacts to society.

SELF ASSESSMENT QUESTIONS:

Answer the following questions about Nitrogen cycle.

1. What is the most common way that nitrogen fixation occurs?

a. lightning **b. fossil fuel combustion**
c. nitrogen fixing bacteria **d. forest fires**

2. Nitrogenous wastes found in dead plants and animal excreta are converted back to nitrogenous compounds like ammonium through the process of

a. nitrogen fixation **b. nitrification**
c. decay **d. none of the choices**

3. Which process releases dinitrogen gas (N2) back into the atmosphere?

a. denitrification **c. decay**
b. nitrogen fixation **d. nitrification**

4. Once bacteria have fixed nitrogen, it can be taken up by plants and animals, where it is used in the production of _____.

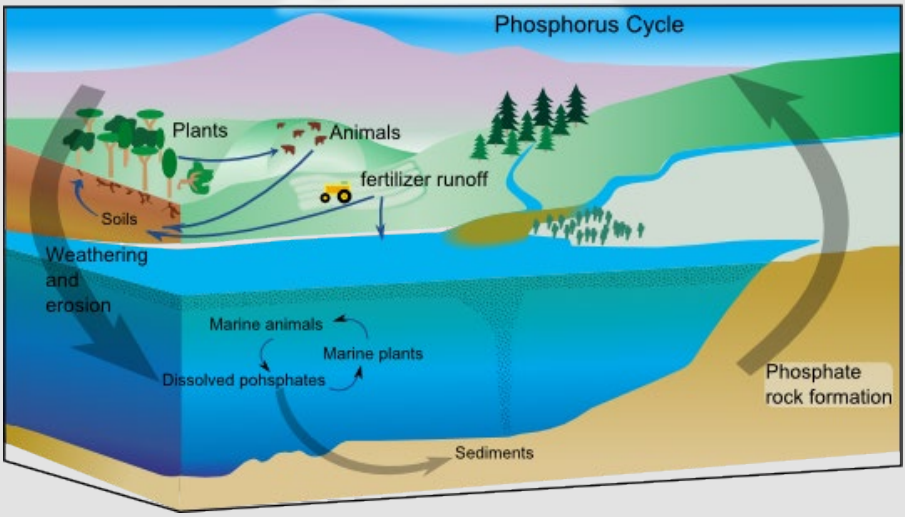
a. nitrogen oxides **c. proteins**
b. carbohydrates **d. energy**

5. Synthetic fertilizers add _____ to the soil:

a. organic nitrogen **c. nitrogen oxides**
b. fixed nitrogen (ammonium) **d. Rhizobium bacteria**

PHOSPHORUS CYCLE

The next nutrient cycle is the phosphorus cycle. The image above shows the general overview of this cycle. To learn the details, review the video transcription below. The video was adopted from Khan Academy (Youtube channel).



Phosphorus cycle [digital image]. Photo retrieved from https://upload.wikimedia.org/wikipedia/commons/5/56/Phosphorus_cycle.png

Phosphorus is an element that is important to all life forms. It plays a critical role in cell development and is a key component of molecules that store energy, which is Adenosine Triphosphate (ATP). In its phosphate form, it forms part of the structure that holds RNA and DNA together. It is also important for soil fertility; thus commercial farms apply phosphate fertilizers to ensure a good yield of their crops.

Compared to other biogeochemical cycles (nitrogen, sulfur and carbon cycles), the phosphorus cycle happens without any gaseous phase. It is also the only element not found in the atmosphere or in air. Phosphorus cycle

begins with rocks. Over time, rain and weathering cause rocks to release inorganic phosphate ions which is then distributed in soils and water.

These phosphate ions in the soil are then taken up by the plants through its roots. Herbivorous animals then get their phosphorus from eating the plants, which is then incorporated into organic molecules such as DNA.

When an animal dies, the decayed body will release the organic phosphate and is returned to the soil. To be bioavailable to the plants, organic phosphates are acted upon by microorganisms to be converted to inorganic phosphates, a process called mineralization.

Phosphorus in soil can also end up in waterways, which eventually reaches the oceans. Once there, it can be incorporated into sediments over time.

However, phosphorus is considered a pollutant in high concentrations, especially in bodies of water. It stimulates growth of plankton and plants and favors weedy species over others. Excess growth of these species causes eutrophication, a phenomenon by which there is no more dissolved oxygen available for fish and other marine animals, eventually causing death.

As important as phosphorus is, we need to keep in mind that overuse of phosphate fertilizer and improper disposal of agricultural runoffs and sewage should be avoided as this can cause significant ecological damage (e.g. pollution or contamination of the surface and underground water) due to excess amount of phosphorus.

SELF ASSESSMENT QUESTIONS:

Answer the following questions about Phophorus cycle.

1. Where does phosphorus come from?
a. atmosphere **c. soil/ rocks**
b. water **d. water**

2. Humans also obtain phosphorus from breathing the air.
a. True **b. False**

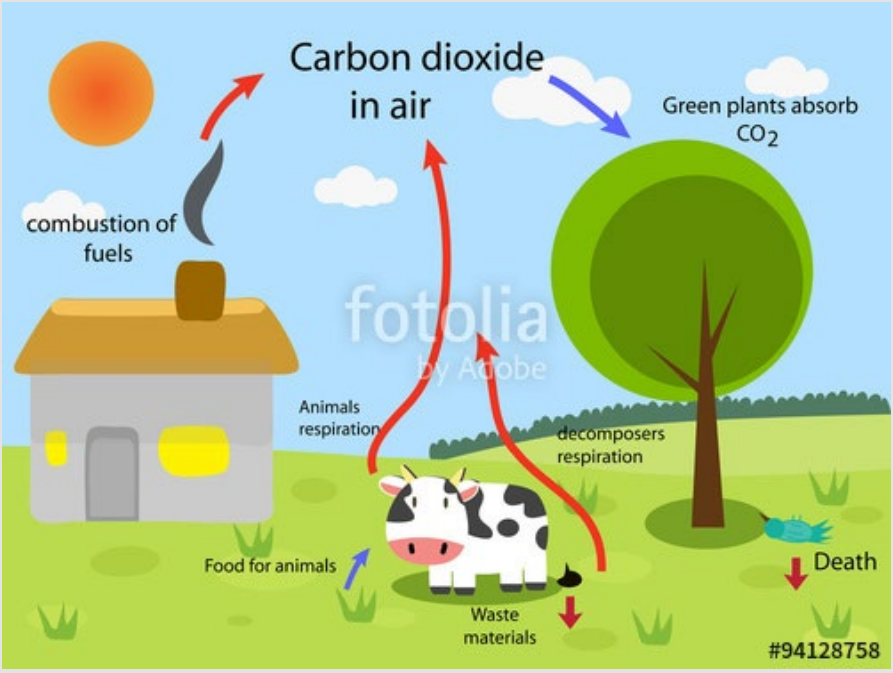
3. What part of the plant absorbs the phosphorus?
a. flowers **c. stem**
b. leaves **d. roots**

4. It is advantageous to have more phosphorus than what the ecosystem needs
a. True **b. False**

5. What do you call the excessive amount of nutrients found in bodies of water that leads to oxygen depletion?
a. Ephemeralization **c. Nutrient Pollution**
b. Eutrophication **d. Oxygen degradation**

CARBON CYCLE

Last is the carbon cycle. The image above shows the general overview of the carbon cycle. Review the transcription below of the carbon cycle video. The video was adopted from Osseo Biology (Youtube channel).



The carbon cycle [digital image]. Photo retrieved from https://co.fotolia.com/id/94128758.

Carbon is another molecule that is important to all life forms as it makes up all living organisms. Everything that contains carbon is considered organic, while those that do not contain carbon molecules are considered inorganic.

Carbon exists in the air mostly as a gas in the form of carbon dioxide. It is this molecule that is taken up by plants and used in photosynthesis to produce food in the form of glucose. It then becomes a part of the plant in food form.

Consumers get their carbon from consuming plants—in the case of herbivores; while, the carnivores and apex predators get their carbon from consuming herbivores and other animals. Animals also release carbon to the air through cellular respiration as carbon dioxide.

Decomposers, on the other hand, act upon the dead bodies of plants and animals and waste materials to liberate the stored carbon. Carbon is then released back to the atmosphere as carbon dioxide and to the soil as carbon compounds.

Excess carbon dioxide is bad for the environment. It is because of its ability to trap or hold heat, a phenomenon called the greenhouse effect. Human activities can greatly affect the concentration of carbon dioxide in the atmosphere, by which the effects we are experiencing now is called global warming. This is primarily attributed to the unregulated fossil fuel burning and extensive livestock agriculture, as well as other human activities.

SELF ASSESSMENT QUESTIONS:

True or False:

1. Carbon is called green gases because it helps in growing plants.
a. True **b. False**

2. Carbon gases can trap heat from the sun.
a. True **b. False**

3. Carbon gas is only secondary to sunlight in its importance for producing food.
a. True **b. False**

4. All compounds that have carbon molecules are called inorganic compounds
a. True **b. False**

5. Plants absorb carbon dioxide during photosynthesis.
a. True **b. False**

LEARNING ACTIVITY 6

Choose one topic between energy flow, nitrogen cycle, phosphorus cycle, and the carbon cycle.

Identify a few key components of your chosen topic that are found in your community. Illustrate and discuss your chosen topic using those components. You must relate your discussions on how your topic affects your daily life in your community.

Include problems your community may experience that are related to your chosen topic (e.g., lack of nitrogen in lands, leading to famine; excessive application of phosphorus fertilization leading to death of fish in the nearby lake)

ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

CHAPTER 3: ECOSYSTEM SUCCESSION

OBJECTIVES

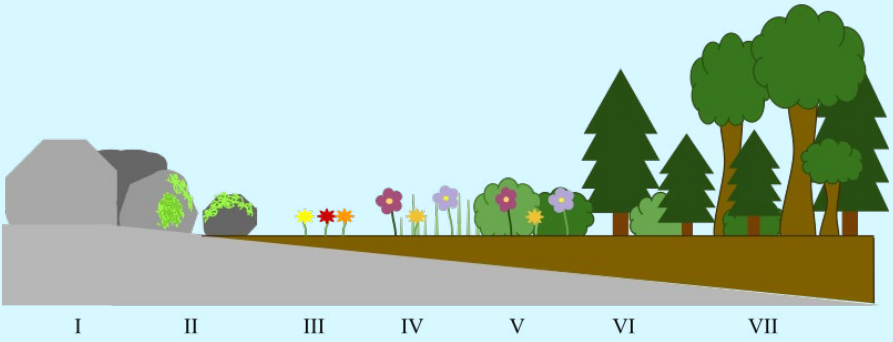
At the end of this chapter, you should be able to:

1. Differentiate the two basic types of ecological succession;
2. Discuss the succession of different kinds of plants in a given area; and,
3. Explain the significance of ecological succession as applied in the management of the IRT.

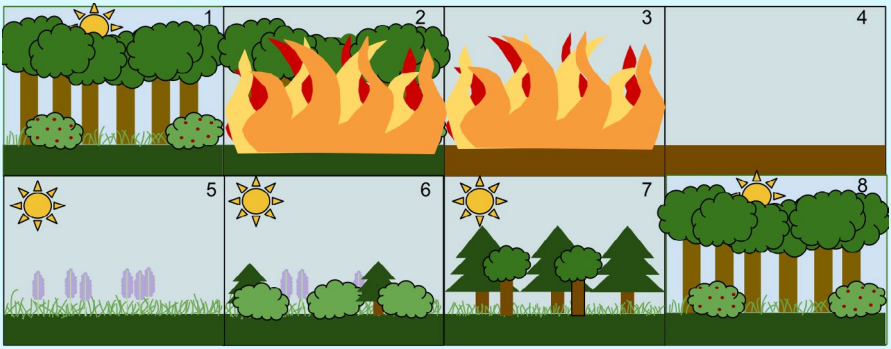
Do you know what ecological succession is?
Take a look at the pictures below:

TOPIC 1

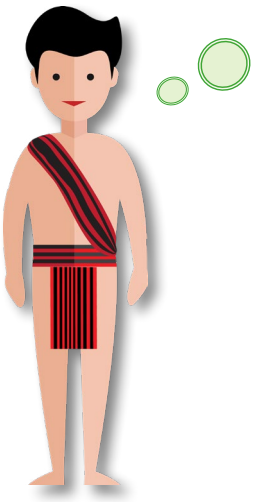
ECOLOGICAL SUCCESSION



Primary ecological succession [digital image]. Photo retrieved from https://upload.wikimedia.org/wikipedia/commons/4/4d/Primary_Succession_Diagram.svg



Secondary ecological succession [digital image]. Photo by Katelyn Murphy. (2012, May 19). Retrieved from https://upload.wikimedia.org/wikipedia/commons/4/47/Secondary_Succession.png



The pictures provided show the two types of ecological succession. But what exactly is ecological succession?

In simple terms, ecological succession refers to the change in the species composition (or different kinds of plants and animals) in a given area over a certain period of time. Ecological succession is important because it allows the regeneration of the ecosystem, or a part thereof, after the disturbance.

For this chapter, try to observe the process of ecological succession in a plant community to grasp its concept better.

LEARNING ACTIVITY 7

For our next learning activity, read transcription below of a video on ecological succession. The video was adopted from CrashCourse (Youtube channel).

A traditional house in Ifugao. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

Ecological succession is a series of progressive changes in the species present in a community over a period. There are two types of succession: primary succession and secondary succession. They differ in their starting points.

Primary succession is characterized by a newly formed or newly exposed area populated by living organisms for the first time, meaning no organisms lived in the area before. The first organisms to live in the area are called pioneer species. These species help improve the living conditions for other species to be able to grow in the area. Primary succession commonly occurs after volcanic explosions and other calamities.

Secondary succession, on the other hand, happens when a new group of organisms grow in an area that was disturbed that resulted in loss of its previous inhabitant species. It usually occurs during forest fires, man-made disturbances such as swidden farming or kaingin, and flooding. The new group of organisms that grow first in this succession are also considered as pioneer species. However, over time and as the area recovers to pre-disturbance condition, the previous inhabitants will grow dominant again, with usually the process taking up to 150 years to complete.

Make sure to learn the main differences between primary and secondary succession. Write your answers on a document using the table below.

Primary Succession	Secondary Succession

Accomplish the following exercises and submit your answers in the same document.

1. Take a walk around your community. Identify an area around the uma/habal/kaingin that underwent disturbance (being cleared) in the last 3 weeks or so. You must take a picture of the area, closely focusing on the appearance of the cleared area as well as the kinds of plants (species) present therein. After 2 or 3 weeks, take another photograph of the area and again try to list down the plants observed. Do this again after another 2 or 3 weeks. Complete the table below with your observations.

Week of Observation	*Plants Observed (common name)*
0-2 weeks	
After 2-3 weeks	
Another 2-3 weeks	

2. From the transcription and readings from the Internet or reference books in libraries, what do you think is the importance of ecological succession as an ecosystem function?

3. From your knowledge and understanding, how is ecological succession applicable in the IRT landscape? Briefly explain your idea.

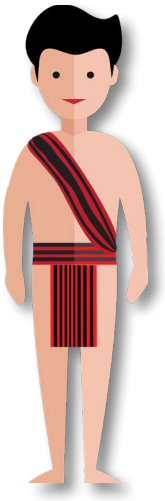
ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

CHAPTER 4: ECOSYSTEM SERVICES

OBJECTIVES

At the end of this chapter, you should be able to:

1. Identify the key ecosystem services associated within the IRT landscape; and
2. Differentiate the benefits according to the categories they belong to.



You have already learned what are ecosystem components and functions, how these are formed, and how these continue to exist today.

In this chapter, you will learn about what we can get or benefit from ecosystems, which hopefully will make you realize how important ecosystems are.

We are going to introduce here the term "ecosystem services," referring to the things we gain from the ecosystem. There are 3 ways of which these are crucial: direct services, indirect services, and aesthetic/ ethical effects.

TOPIC 1

ECOSYSTEM SERVICES

To start with the topic on ecosystem services, read this video transcription about ecosystem services. This video was adopted from California Academy of Sciences (Youtube channel).

Tappiya Falls in Barangay Batad, Banaue, Ifugao. Photo by the Youth for Ifugao Rice Terraces Project. Used with permission.

Ecosystem services refer to the benefits we gain from the ecosystem, and it is these services that makes biodiversity important to us, especially to humans. There are three reasons why these services are crucial to us: 1) direct services; 2) indirect services; and 3) aesthetic and ethical effects.

Direct services are those things we get directly from the environment. There are clothes, food, water, wood, medicines, and many more. These things are taken directly from the species that provide them, such as picking fruit from fruit trees for food, drinking water directly from springs, applying herbal medicine from medicinal plants, and using the lumber from sturdy wood trees to make houses.

Indirect services, on the other hand, refers to the things that a healthy ecosystem provides to us that are not directly felt during the interaction. Examples of indirect services are temperature regulation for forests, protection from waves in the case of mangroves in the coastline of our seas and oceans, prevention of soil erosion that is a benefit provided to us by the

roots of trees, provision of clean and filtered water provided by forests, and many more. Loss of the ecosystem that provides these indirect services is dangerous to us. Imagine losing the forests near you. You will, in effect, lose the benefits provided such as climate regulation, water provision and filtration, and clean air.

Lastly, there are aesthetic and ethical effects. In some ways, these can be considered as the most important ones. These are benefits that affect us on a more personal level and should be passed onto future generations. Beautiful landscapes, pristine beaches, and clear and clean bodies of water makes us feel happy and blessed. You may feel peace of mind and contentment when you are in a secluded cabin in the woods. These feelings are benefits that are brought about by the ecosystem, and these abstract benefits are what comprises the aesthetic and ethical effects.

Nowadays, ecosystem services are attached with monetary values to help in their preservation and conservation. Direct services are the easiest to put a price tag on as they are directly sold, such as when you grow and sell fruits and vegetables, and collect, bottle, and sell spring water. For indirect, and aesthetic and ethical services, it is harder to put a price on. However, in some popular environmental tourist spots like majestic waterfalls, clean and clear bodies of water like lakes and rivers, and beautiful landscapes, environmental fees are collected by local government units. These are considered as payment for the benefits you gain from these environments.

RESOURCES

In addition to the foregoing discussion, review the webinars on ecosystem services of the IRT landscape: Ecosystem Structure, Function and Services, and Community-based Assessment of the IRT by Asst. Prof. Mark Anthony F. Rabena and Dr. Nathaniel C. Bantayan.

You can view this at the University of the Philippines Open University (UPOU) Networks website networks.upou.edu.ph.

LEARNING ACTIVITY 8

Let us put ecosystem services into context.

Choose one you would like to discuss between direct services, indirect services, and aesthetic and ethical effects. After choosing your topic, identify the things you would gain or benefit from the IRT that belong to your chosen topic. You should also discuss why you think those benefits are important to you.

SELF ASSESSMENT QUESTION:

Fill-up the table below with what you gain from the Ifugao Rice Terraces.

Direct Services	*Indirect Services*	*Aesthetic/Ethical Effects*

ECOSYSTEM SERVICES OF THE IFUGAO RICE TERRACES LANDSCAPE

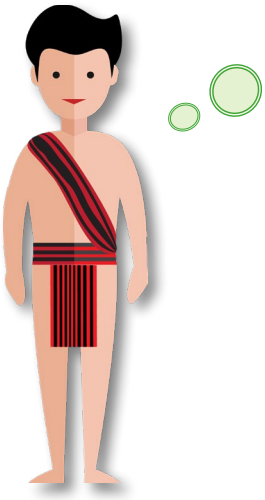
CHAPTER 5: IMPACTS OF HUMAN ACTIVITIES ON ECOSYSTEM SERVICES

OBJECTIVES

At the end of this chapter, you should be able to:

1. Identify the major human activities occurring in the IRT;
2. Discuss the impacts of the identified human activities on the different ecosystems within the landscape; and,
3. Explain how such impacts affect ecological functions or processes and ultimately on ecosystem services.

Development activities (economic, political, socio-cultural, technological) can contribute both positively and negatively to the environment and to its ecosystem services. The more commonly observed activities, such as agricultural production and other economic activities, forest management and conservation, mass and eco-tourism, and ongoing urbanization, coupled with increasing population, tend to have significant impacts on the sustainability of the IRT landscape.



Some examples of negative effects are warming of the surrounding areas of the forest and soil erosion after logging activities, and decreased biodiversity due to urbanization. Positive effects are also brought about by some human activities, such as forest management and conservation, where trees are planted to replace old and dying trees, and also eco-tourism wherein the profits gained from the tourism activities make it possible to conduct conservation and preservation activities.

LEARNING ACTIVITY 9

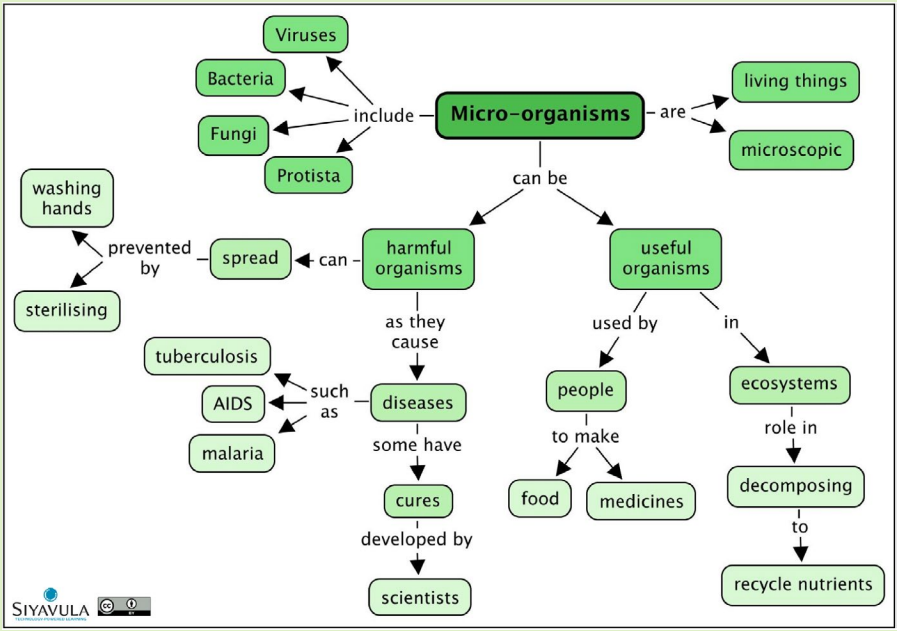
1. You are highly encouraged to read articles about the topic of contemporary development status and problems faced by the IRT from the Internet, newspapers, etc. You may use the keywords: "Contemporary development problems in Ifugao Rice Terraces" when you search online and you may use Google Scholar for this activity. You can also bring or show pictures depicting issues and problems in the IRT to aid in your discourse.

2. Consult with your family members or friends or colleagues on the topic at hand (impacts of human activities on ecosystem services). Discuss with them their opinions, as well as your own. Based on the discussion, try to fill out the table below and submit your answers on a document.

Activity	*Main ecosystem affected*	*Issue/ Problem*	*Ecosystem service affected*	*Effect (+, -, or neutral)*
Ex. conversion into vegetable gardens	*payoh*	*Decreased area for traditional rice production*	*Provisioning function: decreased native rice production*	*(-)*

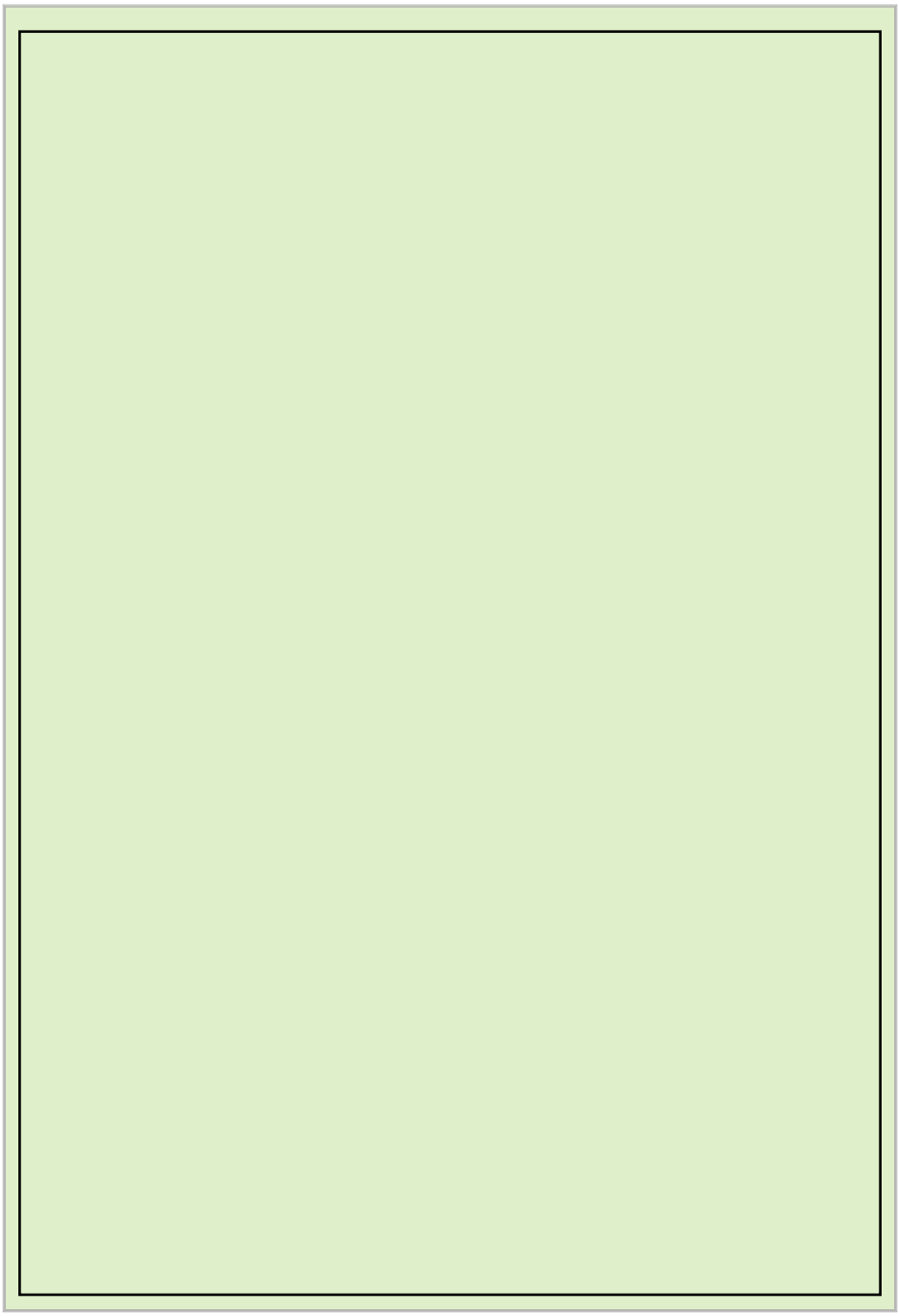
Bear in mind that an activity can produce both positive (+) and negative (-) impacts on the surroundings or environment. This is what we call a "trade-off." You can debate what decisions can be made based on this information.

In order to concretize your understanding of the issues and problems and their effect on ecosystem services, create a conceptual map to inter-relate these issues or concepts. A conceptual map is a diagram or illustration of ideas (key points or words) put in boxes, in which the relationships are shown through arrows. An example is shown below.



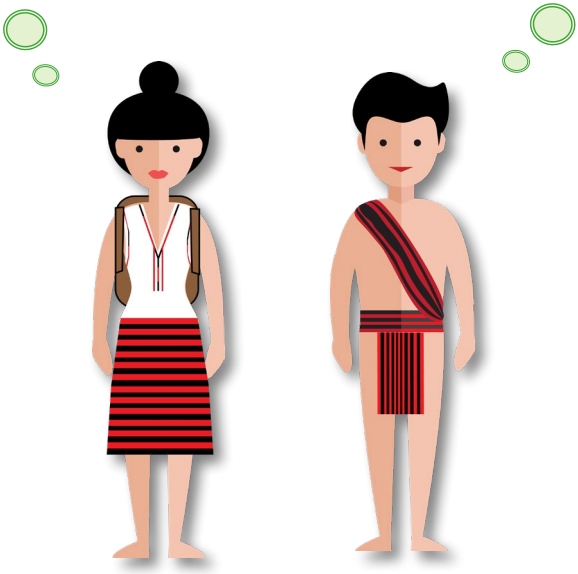
Conceptual map from Siyavula Education. Retrieved from https://www.flickr.com/photos/121935927@N06/13537347284.

You can use the next page for your conceptual map.



That's it for the book! See you on the next one!

Congratulations on completing the activities!



ABOUT THE AUTHORS

MARK ANTHONY F. RABENA

Assistant Professor Mark Anthony Rabena specializes in botany, general ecology, plant ecology, and environmental biology at the Institute of Biological Sciences (IBS), College of Arts and Sciences, University of the Philippines Los Baños (UPLB). In 2015, he started in the UP Open University as an Affiliate Faculty of Landscape Ecology under the Master of Environment and Natural Resource Management program of the Faculty of Management and Development Studies. As a young scientist, Asst. Prof. Rabena has two published articles in ISI journals, and has presented more than 10 oral and poster papers in the Philippines, Malaysia, and Japan. He was a recipient of the UP Varons Undergraduate Thesis Grant Award, Commission on Higher Education (CHED) Masters' Thesis Grant Award, Department of Science and Technology-Science Education Institute Masters' Thesis Grant Award, and the Department of Agriculture-Bureau of Agricultural Research Graduate Thesis Grant for Organic Agriculture. At the IBS, Asst. Prof. Rabena was recognized as one of the Outstanding Teachers in 2015.

ROMEO A. GOMEZ, JR., Ph.D.

Dr. Romeo Gomez is a Professor in ecology, biology, and environmental science. He is currently the Dean of the Graduate School, and the Director of the Open University of the Benguet State University (BSU). He passed the PASUC Accreditation Screening for University Professor in 2016. He obtained his Ph.D. in Environmental Science from SESAM, UPLB. As a Southeast Asian Regional Center for Graduate Study and Research in Agriculture Scholar, he also passed the Board Examination for Environmental Planners in June 2019. He received the Outstanding Researcher Award by BSU in 2011, and the distinguished Alumnus Award for Academe awarded by SESAM-UPLB Alumni Association in 2013. He was the recipient for the Philippine Society for the Study of Nature Service Award having served as its National President form 2013 to 2014. Dr. Gomez is a registered EIA/IEE Preparer and Reviewer. He has published over 20 articles in various refereed research journals including studies on the Ifugao Rice Terraces in the JESAM, and in the Philippine Agricultural Scientist. He is presently a member of the Technical Committee for the Ifugao Satoyama Meister Training Program.

ABOUT THE AUTHORS

ELPIDIO BASILIO, JR., Ph.D.

Dr. Elpidio Basilio Jr. finished his Bachelor of Science in Biology major in Genetics in UPLB. He pursued his Masters in Biology at Saint Mary's University in Nueva Vizcaya, and his Doctor of Philosophy in Genetics in UPLB. Currently, he is a Faculty of the College of Agriculture and Home Science in Ifugao State University, and is designated as the University Director for Research and Development.

MELANIE S. SUBILLA

Associate Professor Melanie Subilla of the College of Forestry, Mountain Province State Polytechnic College (MPSPC) has been actively involved in environmental awareness programs through community immersion in Mountain Province since the start of her career. Her research and publications focused on water resources, biodiversity assessment, and conservation. This includes mossy forest' floral assessment and identification towards propagation of endemic and endangered species with economic potentials. She is now currently exploring the valuation of water resources and biodiversity. She was awarded Best Paper by Highland Agriculture Resources and Research and Development Consortium in 2012 for her study "Woody Plant Species Diversity of Mount Data National Park." Vertical to her Bachelor and Master's degrees (Bachelor of Science in Environmental Science from Benguet State University, and Master in Environment and Natural Resources Management fromUP Open University), she is currently pursuing her Ph.D. in Resource Management in the Isabela State University as a grantee of the CHED K+12 Scholarship Program.

THADDEUS P. LAWAS, Ph.D.

Dr. Thaddeus Lawas is a Science Communicator with research related to disaster risk reduction and management. His projects are focused in early warning systems and information, education, and communication. He is the Production Editor of the Journal of Environmental Science and Management (JESAM), and Editor of UPLB's School of Environmental Science and Management (SESAM) bi-monthly newsletter, SESAM Updates, and the SESAM Website.

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ANSWER TO ASSESSMENT QUESTIONS

Chapter 1

Topic 1 Learning Activity 2

1. living and nonliving, environment
2. Producers, decomposers

Topic 2 Learning Activity 3

Type of Interaction	*Organism 1*	*Organism 2*
Predation	+	-
Herbivory	+	-
Competition	-	-
Mutualism	+	+
Parasitism	-	+
Commensalism	+	+

Chapter 2

Topic 1 Learning Activity 5
1. d
2. c
3. a
4. b
5. a

Nitrogen Cycle
1. d
2. a
3. b
4. d
5. a

Phosphorus Cycle
1. c
2. b
3. d
4. b
5. b

Carbon Cycle
1. b
2. a
3. a
4. b
5. a

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