



Topic 8:

# Protecting the Land

## Lesson Plans for Children and Youth

**Rise Up Against Climate Change!**

A school-centered educational initiative  
of the Inter-American Development Bank



# Rise Up

Against Climate Change

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educational initiative  
of the Inter-American  
Development Bank

**Developed by** Emma Näslund-Hadley, María Clara Ramos,  
Juan Paredes, Ángela Bolívar, and Gustavo Wilches-Chaux

**Editor:** Steven Kennedy

**Design and illustration:** Sebastián Sanabria

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## *Rise Up Lesson Plans*

Our Climate Is Changing

Energize!

Water to Treasure

Intelligent Consumption

Sustainable Cities for Smart Urban  
Growth

You Are What You Eat

Ensuring Healthy Environments

Protecting the Land

People Committed to Fight Climate  
Change



# Rise Up

## Against Climate Change

Rise Up is a climate change education initiative of the Inter-American Development Bank that seeks to encourage children and youth to use their creativity and energy to come up with feasible, sustainable, long-term strategies to mitigate and adapt to climate change. This set of lesson plans is one of nine on different climate change topics that can be used independently or together with the

other lesson plans and materials of the Rise Up initiative, including instructional videos, learning games and a Green School Toolkit. Each set of lesson plans includes an introductory text about the topic that can serve as a background material for the teacher or as a text for older students. The lesson plans can be used at the primary and secondary levels of education; they are divided into basic, intermediate, and advanced plans to help each teacher determine what activities are appropriate for his or her students. To find all the Rise Up materials please go to **[www.iadb.org/riseup](http://www.iadb.org/riseup)**

*Emiliana Vegas, Chief, Education Division,  
Inter-American Development Bank*



## Protecting the Land

<b>General Introduction to the Lesson Plans</b>	<b>6</b>
» What factors shape the land?	9
» The interplay of land and wind	9
» How are ocean currents formed?	10
» Tectonic plates	11
» How the Earth reached its present shape: Continental drift and the breakup of Pangea	12
» What is an earthquake?	14
» Natural phenomena and disasters	16
» Disasters are the unresolved problems of development	16
» Humans transform the land; the land transforms humans	17
» How do human activities affect the land?	17
» Biodiversity and transformation of the land	17
» City planning: A matter of life and death	19
» Industry: Road to progress—or disaster?	21
» Hydropower: Environmental friend or foe?	22
» What's happening to our wetlands?	24
» Environmental services provided by forests	26
» Deforestation and climate change	27
» Deforestation and biodiversity	27
» Appreciating the land through ecotourism	27

<b>Lesson Plans at the Basic Level</b>	<b>30</b>
» Basic lesson plan 1: Where does our food come from?	31
» Basic lesson plan 2: When does a natural phenomenon become a disaster?	33
<b>Lesson Plans at the Intermediate Level</b>	<b>38</b>
» Intermediate lesson plan 1: I think like the wind, I feel like the sea, I move like the Earth	39
» Intermediate lesson plan 2: Transformation by nature	44
<b>Lesson Plans at the Advanced Level</b>	<b>49</b>
» Advanced lesson plan 1: We transform the land; the land transforms us	50
» Advanced lesson plan 2: Landscape transformation or exploitation?	52
» Advanced lesson plan 3: What role does deforestation play in climate change?	62





# General Introduction to the Lesson Plans

**W**e do not live in a vacuum. Instead, we are connected to innumerable other living entities, and our individual vantage point is only one among many.

When we hear people talk about protecting the land and the landscape that we enjoy, it may be helpful to consider that each of us has a personal environment, experienced from a particular point of view. This personal environment, the landscape that we see, is made up of and affected by everything we can perceive using our senses—immobile mountains, buildings, and trees; moving animals, cars, and people; changes in light, humidity, and temperature as well as the interactions among these things (figure 1). As we observe and influence these interactions, we participate in the process of creating the landscape we experience.

The environment, in turn, contains multiple ecosystems.

**Ecosystems** are composed of *biotic* (living) and *abiotic* (biologically nonliving) elements that coexist and interact in a

specific area. Examples include watersheds and river basins, a stretch of desert, a coastline. The concept of an ecosystem can, arguably, be extended to human developments: a city, for example, may be considered an urban ecosystem. And there are systems within systems, so a neighborhood garden or a school yard in a city may be considered an “agroecosystem” (box 1).

Your personal landscape is in large part determined by the interactions within and between ecosystems. For example, a neighborhood garden depends on water transported through city pipes. Excess water drains into a creek that joins a large river downstream, and this deposits surplus water into a coastal wetland during the rainy season.

In short, every ecosystem has various distinguishable elements and factors. Their innumerable and constantly changing (that is, *dynamic*) relationships and interactions make the total environment much greater than the sum of its parts.



*Figure 1. The Cristo Redentor monument in Rio de Janeiro, Brazil, under different atmospheric conditions*

### Box 1. Agroecosystems

Agricultural ecosystems, or agroecosystems, mimic natural ecosystems in their structure and function, but are designed by humans for the production of food and other products for human use.

A traditional coffee plantation is a good example of an agroecosystem. Alongside coffee bushes, trees with large boughs and plentiful foliage (usually of leguminous varieties) are planted to provide shade and protection from the rain. Their deep root systems benefit from the nutrients that the coffee bushes add to the soil, while wild birds build nests in the tree branches and feed on insects, thus keeping pest populations under control. Traditional coffee farmers also typically grow plantains, bananas, corn, cassava, pineapples, and other plants to contribute to their families' food security and economic solvency. Often, they raise hens

and other domesticated fowl that feed on the corn produced by the agroecosystem as well as the worms in the soil.

You can create your own agroecosystem right at your school. A school garden provides food as well as medicinal and ornamental plants to the academic community, and serves as a laboratory where students' understanding of ecosystems and the biosphere can be nurtured. It also creates an opportunity for community members of all backgrounds to share information on medicinal plants and their use, farming and food preparation methods, and natural pest control.

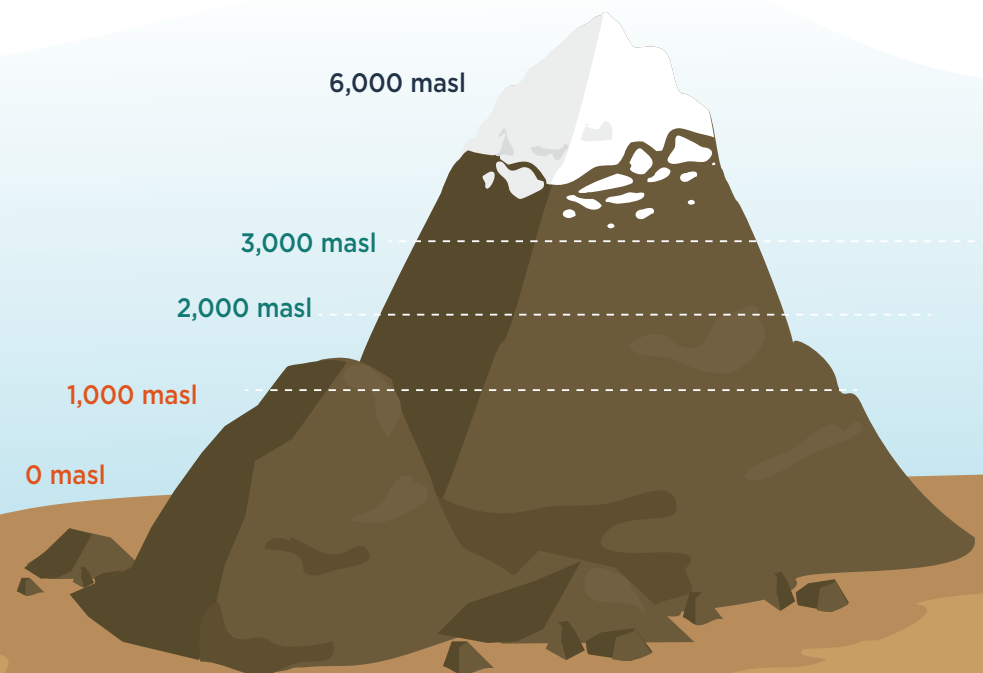
Some agrosystems employ natural processes and avoid chemical products. This choice not only saves farmers money but also cuts down on soil and water pollution and the emission of greenhouse gases.

Figure 2. Sierra Nevada de Santa Marta, Colombia

The highest coastal mountain range in the world.



masl: Meters above sea level





### What factors shape the land?

Earth is shaped by the interaction of the lithosphere (land surface), the atmosphere (system of gases surrounding the planet), the hydrosphere (all water resources on the planet), and the biosphere (all living things, including humans).

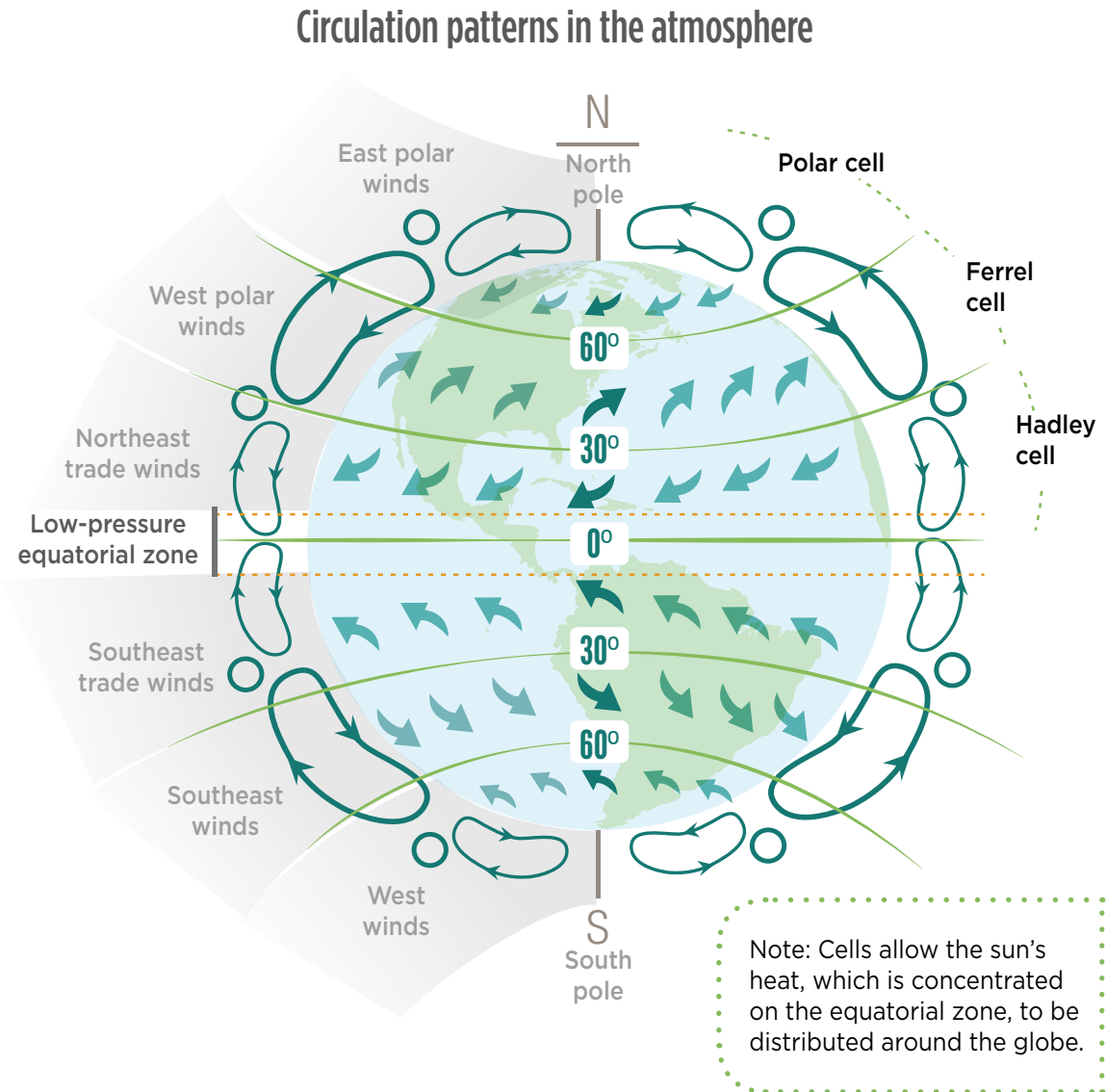
The Earth's geological formations—mountains, seas, deserts, plateaus—influence temperature, climate, winds, ocean currents, and the features of rivers and lakes. This topography was formed by the movement of the Earth's tectonic plates, as well as factors such as wind, rain, and human activity. The tectonic plates are large segments of the Earth's crust that rub against one another. Over long periods of time, this movement can produce large mountain ranges. When the plates collide suddenly, they can cause strong earthquakes, which are also capable of altering the landscape.

### The interplay of land and wind

Landforms play an important role in deciding regional climates. Consider, for example, Colombia's Sierra Nevada de Santa Marta, the world's highest coastal mountain range. The warm temperatures typical of the mountain range's base resemble those of tropical climates. Ascend midway and you will find temperatures associated with moderate climates. Meanwhile, the highest points are covered by snow year-round (figure 2).

Differences in elevation and sun exposure variously cool and heat air masses. The movement of cold air settling and warm air rising in turn produces wind currents (figure 3).

Figure 3. Wind circulation patterns in the atmosphere

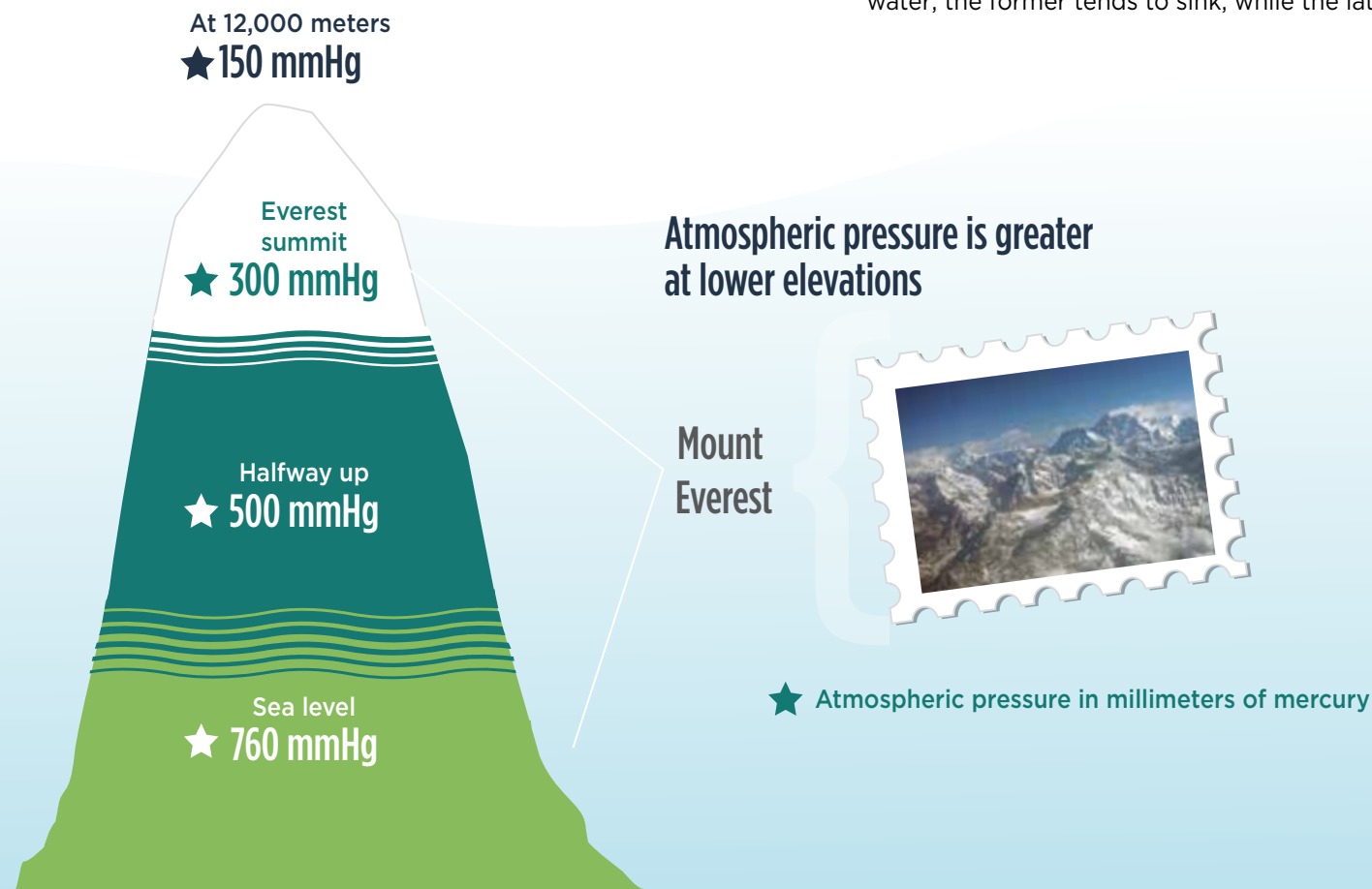


Just by occupying space, air exerts a certain amount of pressure on the Earth's surface. Areas at low elevation tend to be under higher air pressure, since there is more air sitting on them (figure 4).

Air currents not only affect the atmosphere but also the lithosphere. Plains, lowlands, hills, and canyons are carved out and transformed in part by direct, sustained wind. The wind also affects the biosphere: A sudden gust can spread a forest fire or disperse seeds; a steady current can help flying insects and migrating birds along their way.

Landforms serve as barriers to air currents. As wind pushes against mountains and rock formations, it gains altitude and becomes colder. As it is pushed higher, it hits the clouds and cools them, sometimes causing precipitation.

Figure 4. Atmospheric pressure varies by elevation



### How are ocean currents formed?

As with the movement of warm and cool air, water currents are also generated by displacement. Wind pushes the water along the surface of oceans and large seas, creating surface currents that can at times look like rivers flowing in various directions. Underwater currents, meanwhile, are driven by the Earth's rotational movement. Barriers posed by the continents and the shape of their coasts also influence the movement of ocean currents, as do differences in the temperature and salt content (salinity) of water masses. The many types of currents include the following:

- » *Tidal currents* are generated by the gravitational pull of the moon and the sun.
- » *Density currents* arise from variations in temperature and salinity levels among water masses at different depths. Cool, salty water tends to be denser than warm, less salty water; the former tends to sink, while the latter tends to rise.

Meanwhile, surface water is subject to evaporation, which concentrates the salt content at that level and generates a surface current.

- » *Wind-driven surface currents* are generated by the interaction of the wind with the water's surface. The winds that blow across the Atlantic and Pacific create currents that move large masses of water toward the west.

**Figure 5. The Earth's tectonic plates**



### Tectonic plates

The lithosphere is divided into seven major continent-sized tectonic plates and nearly a dozen smaller plates. These pieces fit together like a puzzle and cover the Earth's entire crust. These plates once moved across the Earth's surface, shifting the position and sizes of continents and oceans and forming mountains and volcanoes.

The seven main tectonic plates are the South American Plate, the North American Plate, the Eurasian Plate, the Indo-Australian Plate, the African Plate, the Antarctic Plate, and the Pacific Plate. Among the secondary plates are the Cocos Plate, the Nazca Plate, the Philippine Plate, the Anatolian Plate, and the Caribbean Plate (figure 5).

The word *tectonic* means “builder.” Tectonic plates move continually at an average rate of 2.5 centimeters (cm) per year. Their movements create mountain ranges through a process called orogenesis, as well as earth tremors, earthquakes, and volcanic eruptions. Tectonic plates move because the lithosphere (that is, the outermost layer of the Earth’s crust) is less dense than the layer immediately beneath it. This variation in density stems from movement produced on the ocean floor as well as from gravitational forces.

There are two main types of tectonic plate boundaries: divergent and convergent (figures 6 and 7). Each affects the Earth’s topography and crust differently as plates move and divide.

Friction along a *transform boundary* makes two plates slide over each other. An example of this type of boundary is the San Andreas Fault, located in western North America, between the North American and Pacific plates. Faults are areas where tectonic plates collide, rise, and sink.

### How the Earth reached its present shape: Continental drift and the breakup of Pangea

The world as we know it is the result of innumerable natural transformations. Some 225 million years ago, all the Earth’s continents were joined together into one supercontinent, Pangea. Major geographical features we know today, such as the Andes, did not exist. So, how did the continents move so far apart? The most widely accepted explanation combines the theories of “continental drift” and “plate tectonics.”

Figure 6. Divergent (or constructive) plate boundaries

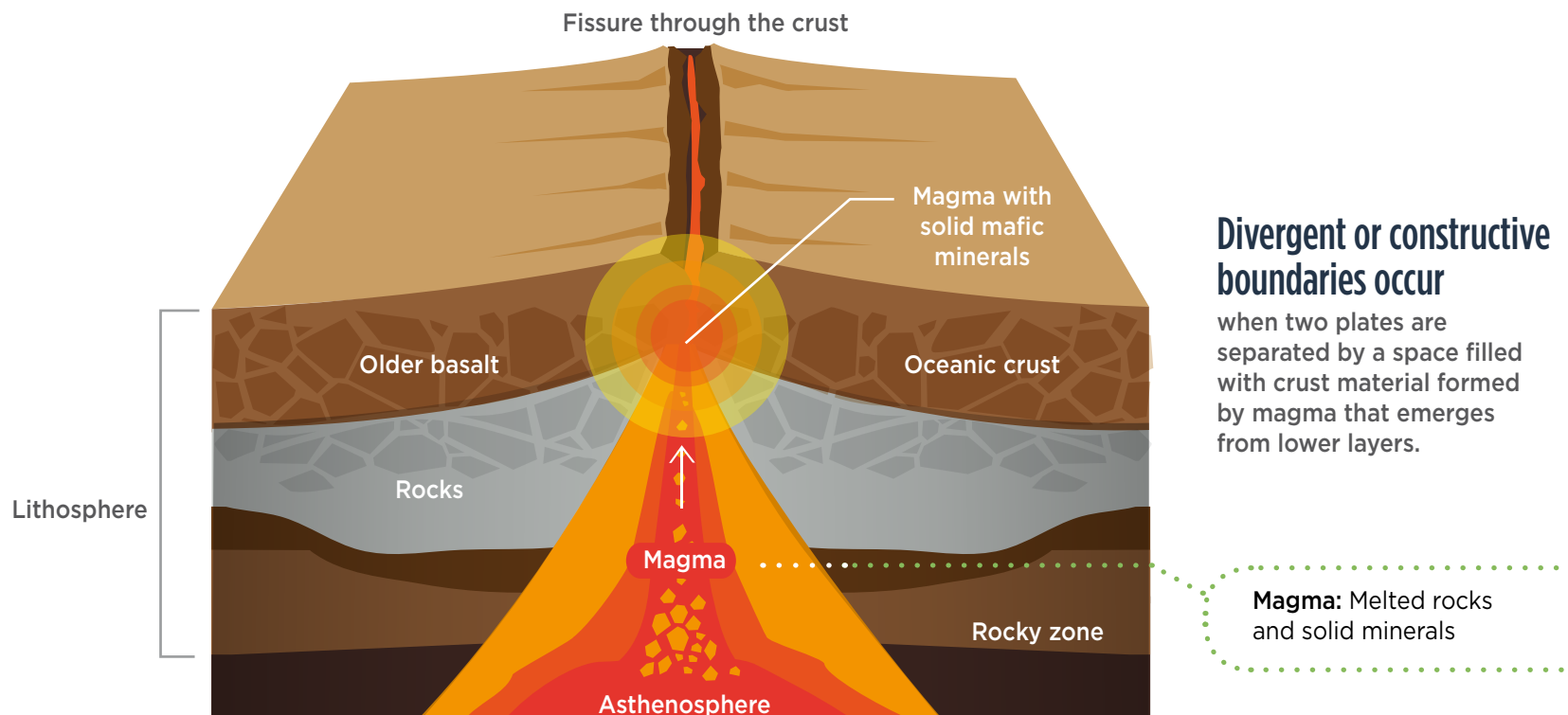
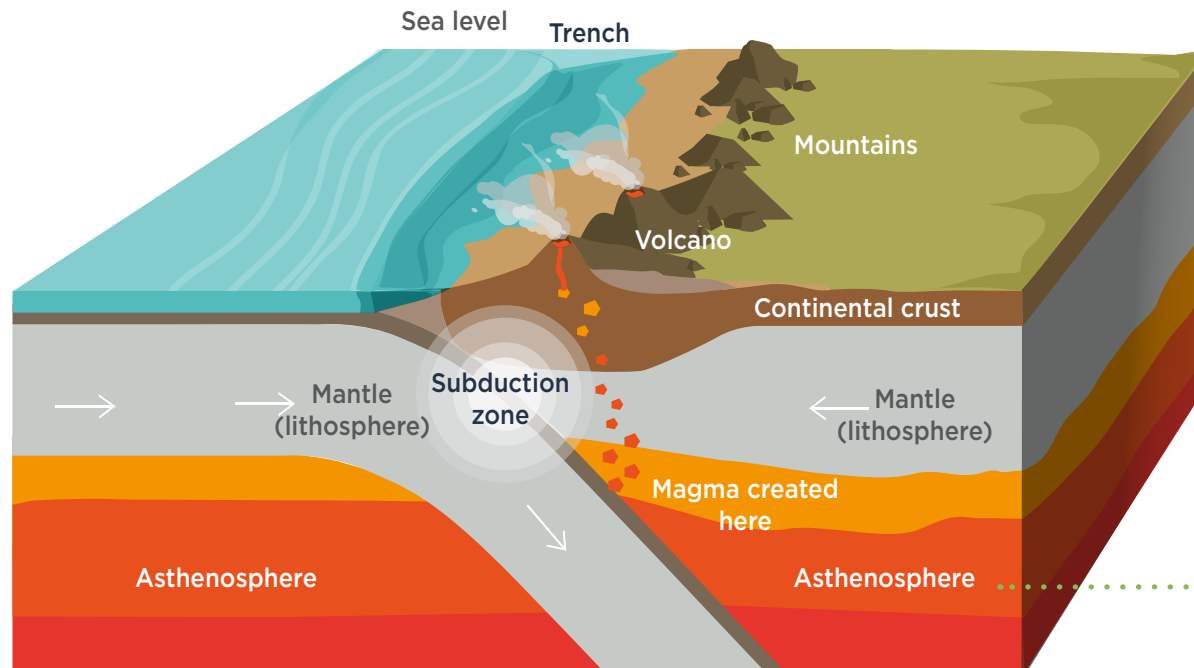


Figure 7. Convergent plate boundaries



### Divergent or constructive boundaries occur

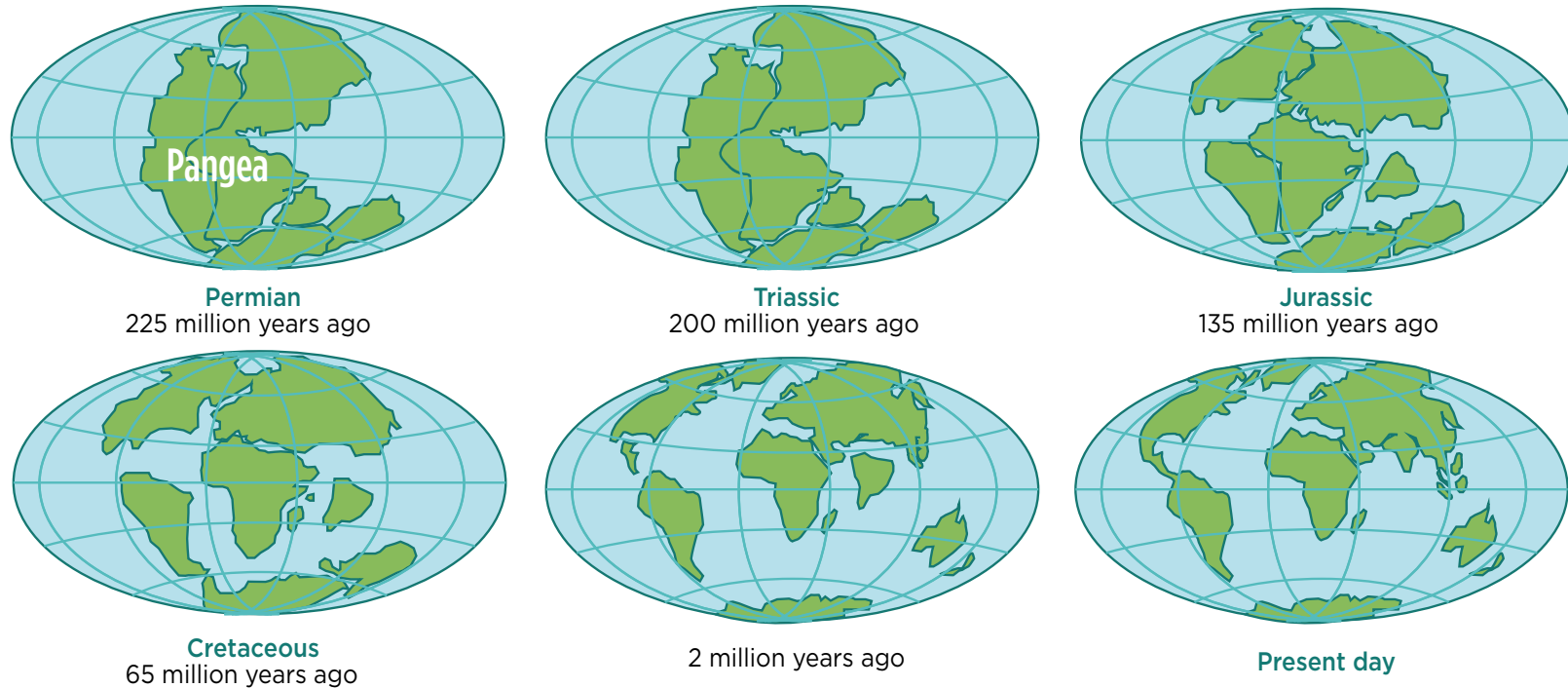
when oceanic plates sink beneath continental plates, forming subduction zones. This causes the formation of oceanic trenches in the sea and mountain ranges on land.

**Asthenosphere:** The layer located below the lithosphere and loaded with rocks near their melting point.

As early as 1620, English philosopher Francis Bacon noted that the west coast of Africa and the east coast of South America looked like puzzle pieces that had once fit together. In 1858, the French geographer and scientist Antonio Snider-Pellegrini proposed the hypothesis that continents can move. Later, German meteorologist and geophysicist Alfred Wegener developed Snider-Pellegrini's theory in his book, *The Origin of Continents and Oceans*, published in 1915. Wegener posited that continental land masses move, drift, and deform one another on the Earth's surface. He researched fossils in Africa and Latin America and came to the conclusion that a supercontinent existed some 250 million years ago, which he called Pangea, from the Greek word pan (πᾶν, meaning "complete

or whole") and Gaia (Γαῖα, meaning "earth"). Sixty years later, the theory of plate tectonics was developed. According to the theory, the Earth's crust was divided into moving segments, or plates, and that collisions between these plates formed geographical features such as volcanic islands and mountain ranges. Scientists estimate that Pangea began breaking up roughly 190 million years ago, when the era of dinosaurs was near its peak and the first mammals were just starting to appear (figure 8).

Figure 8. Theory of continental drift and the separation of Pangea



### What is an earthquake?

Earthquakes are caused by the collision or friction of one plate against another (tectonic earthquakes) or by movements—usually ruptures—of active geologic faults (fault earthquakes). Most earthquakes are of the second kind. Volcanic eruptions may also spawn earthquakes far from tectonic plate boundaries.

When an earthquake occurs, scientists look for the precise place where it originated, called the *hypocenter* or *focus*. This tells them where within the Earth the energy was released. The hypocenter is considered *shallow* when it occurs in the Earth's crust (up to about 70 kilometers deep), *intermediate* if it is between 70 and 300 km in depth, and *deep* if it exceeds 300 km.

The earthquake's *epicenter* is a point on the Earth's surface located directly above the hypocenter. The epicenter receives the highest

intensity shock that is generated by the colliding plates (figure 9).

The instrument that records the vibrations caused by the movement of the tectonic plates and measures their magnitude and duration is called a *seismograph*. A seismograph records two types of waves: internal waves that travel through the interior of the Earth's crust, and surface waves that occur when the internal waves reach the Earth's surface and move on top of it.

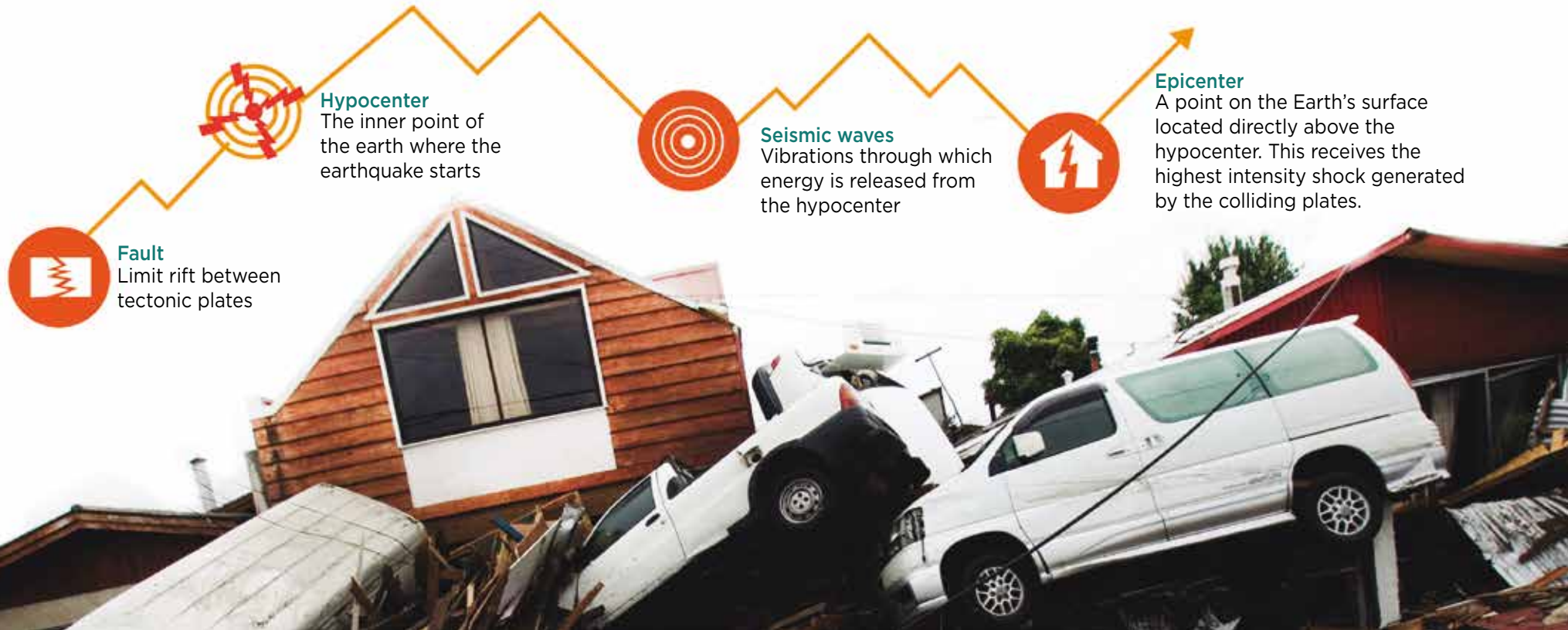
The amount of energy released by an earthquake, called the *magnitude*, is measured on the Richter scale designed by Charles F. Richter at the California Institute of Technology in 1935. Richter associated an earthquake's magnitude with the amplitude of its seismic wave movements on Earth. The Richter scale is open, meaning that it has no upper limit. The highest recorded value is slightly over 9 degrees.



The following are the effects observed at each level on this scale:

Less than 2.0	Microquakes; not perceivable	6.0–6.9	Can be destructive in populated areas
2.0–2.9	Generally not perceivable	7.0–7.9	Can cause severe damage over a wide area
3.0–3.9	Often perceivable, but rarely cause damage	8.0–8.9	Can cause severe damage, even hundreds of kilometers from the epicenter
4.0–4.9	Significant earthquake, but with little damage	9.0–9.9	Devastating for thousands of kilometers
5.0–5.9	Slight damage to well-constructed buildings	10.0 and above	Never recorded

Figure 9. Components of an earthquake



## Natural phenomena and disasters

Even when natural phenomena—torrential rains, earthquakes, hurricanes, and volcanic eruptions—actively change the landscape, they are not necessarily catastrophic. But human activity has increased their intensity and frequency and thus exacerbated their impact. In other words, human activity is causing natural phenomena to become increasingly catastrophic.

When speaking of “natural disasters,” it is important to define the following key words: *vulnerability*, *threat*, *disaster*, *prevention*, and *mitigation*.

**Vulnerability** is the degree to which specific areas (and their ecosystems and communities) are able to absorb or contain the effects of an event unharmed. Highly vulnerable places are at greater risk for disasters than less vulnerable places.

Circumstances that increase vulnerability include:

- » Homes on land not suitable for housing.
- » Poorly built homes that lack good foundations, use flimsy materials, or are unsuitable for the area's climate.
- » Socioeconomic conditions that fail to meet basic human needs, including high unemployment, lack of income and assets, illiteracy, social exclusion, and a poor business climate.

Disruption of local ecosystems due to rapid, unplanned urban growth that results in deficient sewage and trash collection and disposal systems.

A **threat** is a process or event that poses a danger to a specific area and its ecosystems, communities, and institutions.

A **disaster** negatively affects physical, economic, and social structures as well as normal societal activities for prolonged periods of time. When heavy rains flood towns, earthquakes destroy homes and schools, crops are lost due to drought, or lava from a volcano destroys cities, the effects are greatest where communities are exposed, vulnerable, and ill-prepared.

**Prevention** consists of measures put in place to reduce vulnerability, such as designing homes that can withstand natural phenomena; having emergency plans; ensuring active, organized community

participation to prevent disasters; and educating people about disaster response.

**Mitigation** is the degree to which negative consequences are reduced in a specific area due to the implementation of well-designed prevention measures.

Natural threats that pose risks to humans may be grouped into the following categories:

- » *Hydrometeorological threats* are linked to water and weather changes such as floods, droughts, frosts, tidal waves or tsunamis, cyclones, hurricanes, the “El Niño” and “La Niña” phenomena, and fires.
- » *Geological threats* include earthquakes, volcanic eruptions, and landslides.
- » *Biological threats* are linked to living beings, and include disease epidemics and overpopulation.
- » *Technological threats* include industrial and health risks.

The effects of disasters are magnified when human activities deteriorate ecosystems and when people do not take preventive measures.

## Disasters are the unresolved problems of development

Disasters are linked to human development processes. According to the World Meteorological Organization (WMO), the number of disasters recorded worldwide has increased substantially over the past three decades. Each year, disasters associated with meteorological, hydrological, and climate-related phenomena cost many lives and significantly delay economic and social progress.

Between 1980 and 2005, roughly 2 million people lost their lives in some 7,500 disasters worldwide. Risks related to weather conditions (climate and water)—including droughts, floods, storms, tropical cyclones, storm surges, extreme temperatures, landslides, forest fires, epidemics, and pests directly related to meteorological and hydrological conditions—caused 90 percent of these disasters.

The good news is that the WMO also reported that improvements in monitoring and forecasting methods and climate-related hazard warnings involving emergency preparedness and response have saved many lives. We must continue strengthening these systems.



## Humans transform the land; the land transforms humans

Like all living beings, humans transform their surroundings. As they use, adapt to, settle on, and take sustenance from the Earth, humans affect the environment and its many coexisting elements.

Over time, humans have expanded their occupation of the land and exploited nearly every space on Earth. Recent human activities have led to environmental deterioration in the form of extensive erosion, desertification, shattered ecosystems, pollution, alterations to the local and global climate, and loss of biodiversity and cultural heritage.

Meanwhile, as we have already learned, the Earth is not passive. The combination of natural dynamics and human activity leads to disaster, as when earthquakes destroy entire cities.

Disasters, in turn, compel humans to think about their relationship with their surroundings, and to adapt and adjust their activities accordingly. Humans must seek a harmonious relationship with the Earth, balancing their need for development and economic progress with prudent protection for the land and the wider environment. Only through such a balance will they avert further disaster.



## How do human activities affect the land?

Every time humans create something new—a school, hospital, farm, monument—the landscape changes. These changes, in turn, affect human beings themselves:

Roughly 35 percent of the Earth's land is devoted to raising crops, and over 2 billion people are engaged in farming.

Human demand for transportation, especially cars, has spawned a complex network of roads that now cover the land like a web.

Population growth has prompted the expansion of cities and towns, sometimes onto unsuitable and unstable land.

Cities' demand for energy has prompted the construction of dams and reservoirs, which change the course and flow of rivers and dramatically affect ecosystems and the natural landscape.

Less obvious changes come from air and water pollution and rising temperatures owing to the accumulation of greenhouse gases (GHGs). Even remote locations such as the polar regions, the deserts, the ocean floor, and mountain peaks have been modified in some way by human activities.

## Biodiversity and transformation of the land

Biodiversity means “diversity of life.” You, your family, your friends, animals, plants, the mountains, forests, rivers, our food—all are part of the world's biodiversity. Without biodiversity, our lives would be vastly different because everyone would be identical and our food supply, our cultures, and our landscapes would be very limited. The more we know about biodiversity, the more we can understand how transformation of the land affect our lives.

Activities such as mining, construction, and tourism can transform complex, diverse natural habitats into areas that are uninhabitable to most wildlife, especially when these transformations occur quickly and over extensive areas.

Even partial deforestation of an area can have serious consequences, as changes in microclimates split biological corridors, restricting species' ability to interact. For example, if parrots disappear, so will the plants that depend on the parrots to spread their seeds. Thus, even partial deforestation can eventually

lead to the extinction of flora and fauna. Risk factors for extinction include the following:

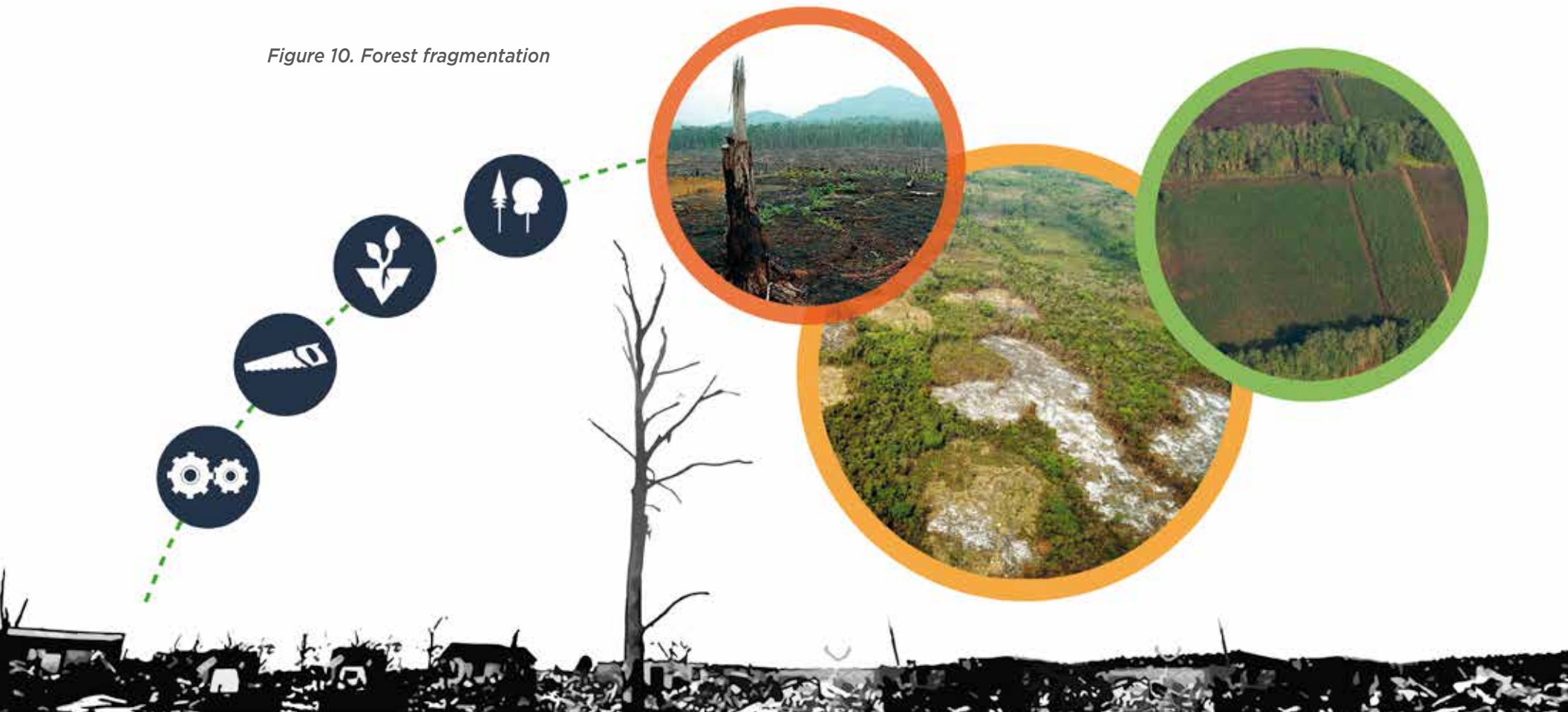
- » *Reductions in forest cover owing to deforestation, forest fires, or agriculture.* Such reductions diminish biodiversity, affecting forest plants and animals, as well as species that need large land areas, such as jaguars, pumas, and certain bears.
- » *Fragmentation owing to partial deforestation.* Fragmentation isolates animal populations from their habitats. Their chances of survival depend on the size of the remaining patch of forest and how far apart they are from one another (figure 10).

In coastal areas, humans have transformed the land through the

development of cities and infrastructure. Improper land use and a pervasive belief that the ocean can withstand all the sewage, debris, and sediment that humans dump into it seriously threaten coastal and marine ecosystems.

Without strict controls, recreational activities such as scuba diving, spearfishing, and sailing can affect fragile ecosystems such as coral reefs by altering the reefs and the delicate interactions that take place there. In many coastal cities, natural barriers such as mangrove or seagrass-bed ecosystems have been converted into agricultural areas and waste sites. Thousands of marine species that once used these ecosystems for a nursery are increasingly vulnerable to predators and the threat of extinction.

Figure 10. Forest fragmentation



### City planning: A matter of life and death

We have seen how human-driven changes affect resources essential to our well-being. We have also seen that natural phenomena are not disasters in and of themselves, but are disastrous to human lives when we fail to adapt or take preventive actions to lessen our vulnerability.

Humans all too often rush to develop the land without reflecting on the potential ramifications of irreversibly transforming the land.

We build cities in areas at high risk for flooding or earthquakes, such as along geological fault lines. For example, the San Andreas Fault, which runs along the Pacific coast from southern Chile to San Francisco, California, has caused hundreds of earthquakes. Most of the world's earthquakes occur on plate margins (figure 12 demonstrates this), and human construction activities exacerbate the earthquakes' adverse effects.

People have also settled into communities in the vicinity of volcanoes—with disastrous results. For example, in 1985, Colombia's

*Figure 11. Breakwaters and seawalls on beaches in the Caribbean*



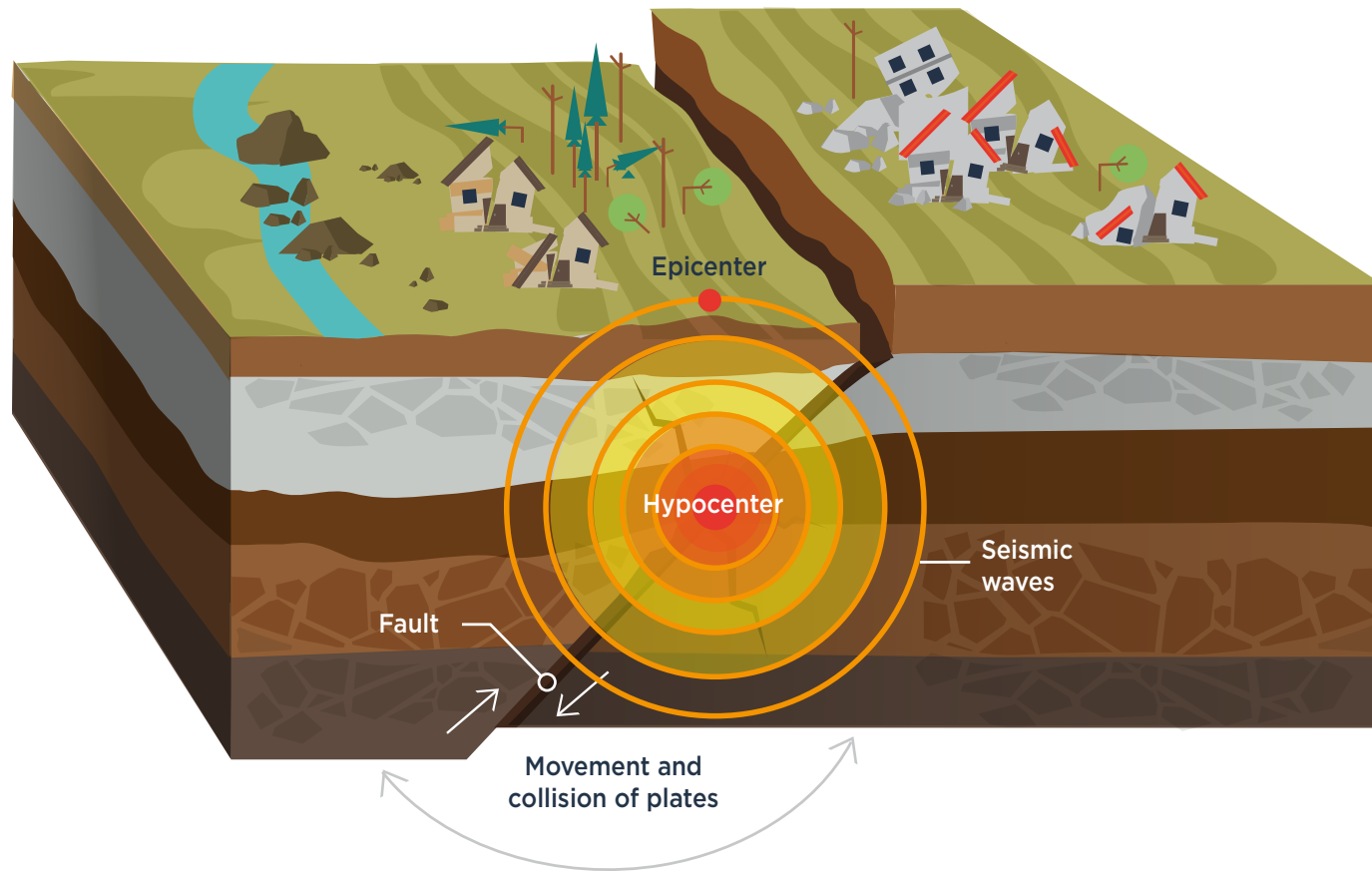
To protect coastal cities from pounding waves, people have built dikes and breakwaters in ports. While both effectively lower the surf's impact, they also affect the natural currents that deposit sand on the beaches; over time, these changes will cause beaches to disappear.

Nevado del Ruiz volcano erupted, detaching a massive block of ice, which slid down the mountain and wiped the entire town of Armero off the map, killing 23,000 people (figure 13). What is worse is that people knew better—the same thing had already happened some 200 years ago, in the very same location.

As the case of Armero shows, disaster can—and often does—strike the same area more than once. Paying attention to clear messages from the Earth can help us make better decisions about how and where to plan our cities. Disaster risks can be reduced through proper planning and land use. Building codes are an important way of reducing the impact of recurring natural phenomena such as earthquakes.

Yet all too often we fail to pay attention to disaster risks. More and more people are choosing to live in high-risk areas, exposing their cities, infrastructure, and themselves to possible disaster.

*Figure 12. Earthquakes and tectonic plates*





### Industry: Road to progress—or disaster?

Industrial activities such as mining drastically alter the landscape. Not only do they mar its natural beauty and integrity, but they also affect biodiversity and the quality of soil and water, sometimes with disastrous consequences for area residents.

At the same time, mining, nuclear energy, and other industrial activities can convert a country's natural wealth into economic wealth, which potentially translates into socioeconomic development. Since socioeconomic development improves people's living conditions, the debate over the costs and benefits of industrial activities is very complex (figure 14).

Figure 13. Armero, Colombia

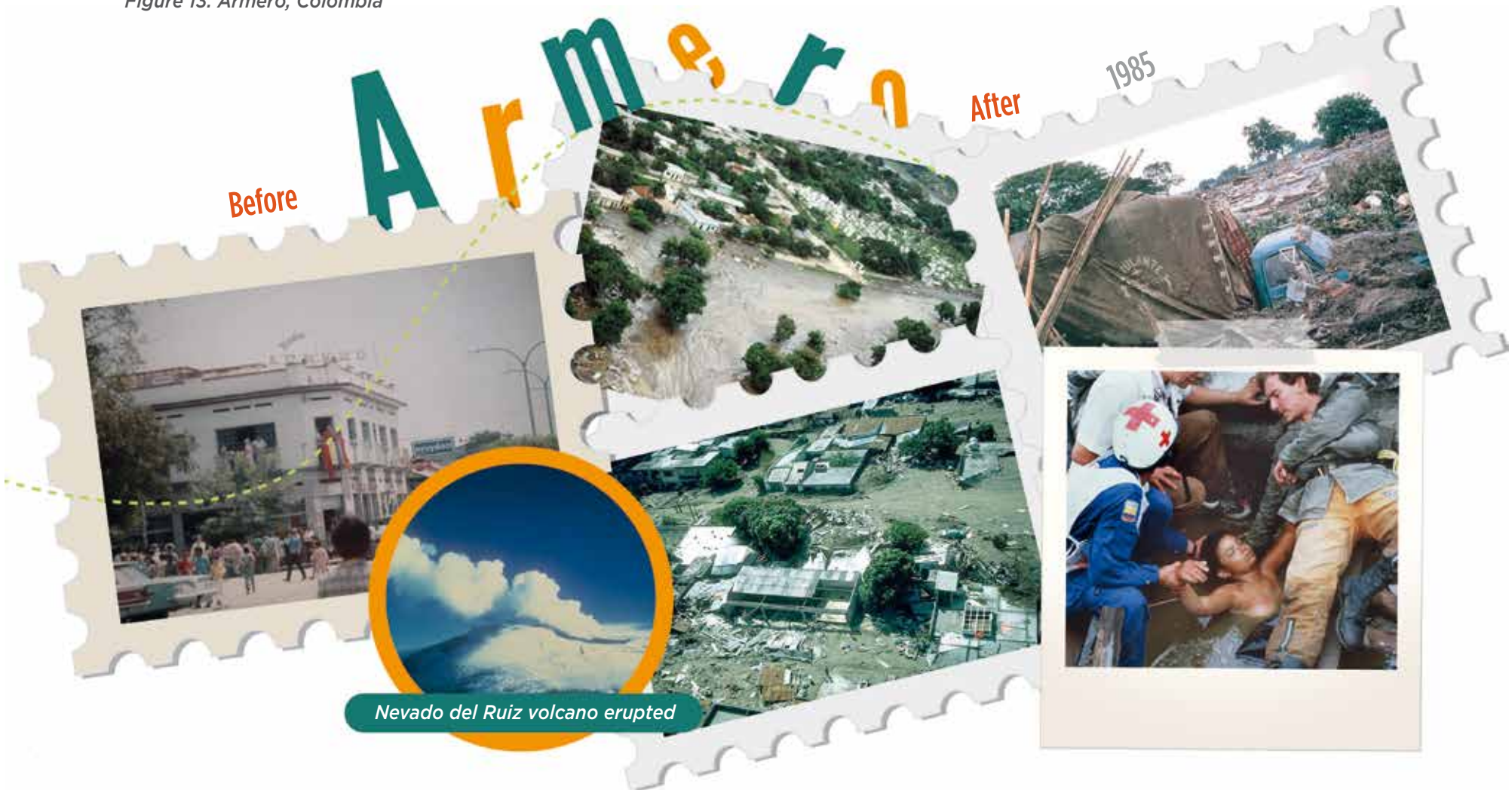




Figure 14. Progress or disaster?

With the signing of the Rio Declaration in 1992, people realized that economic growth cannot be pursued without taking into account its costs to the well-being of the environment and humans. A newly signed international treaty regulating the use of mercury in mining, particularly gold mining, also clearly states that progress and development must not come at the expense of human health and the environment. It is hoped that such agreements will raise awareness of the potentially negative effects of human activities on the environment, as well as their boomerang effect on our well-being.

### Hydropower: Environmental friend or foe?

While it may not be a basic necessity, people depend heavily on electricity. To meet that demand, the power industry often relies on hydroelectric plants built on rivers to harness the force of the water to generate a renewable, possibly even inexhaustible, source of energy.

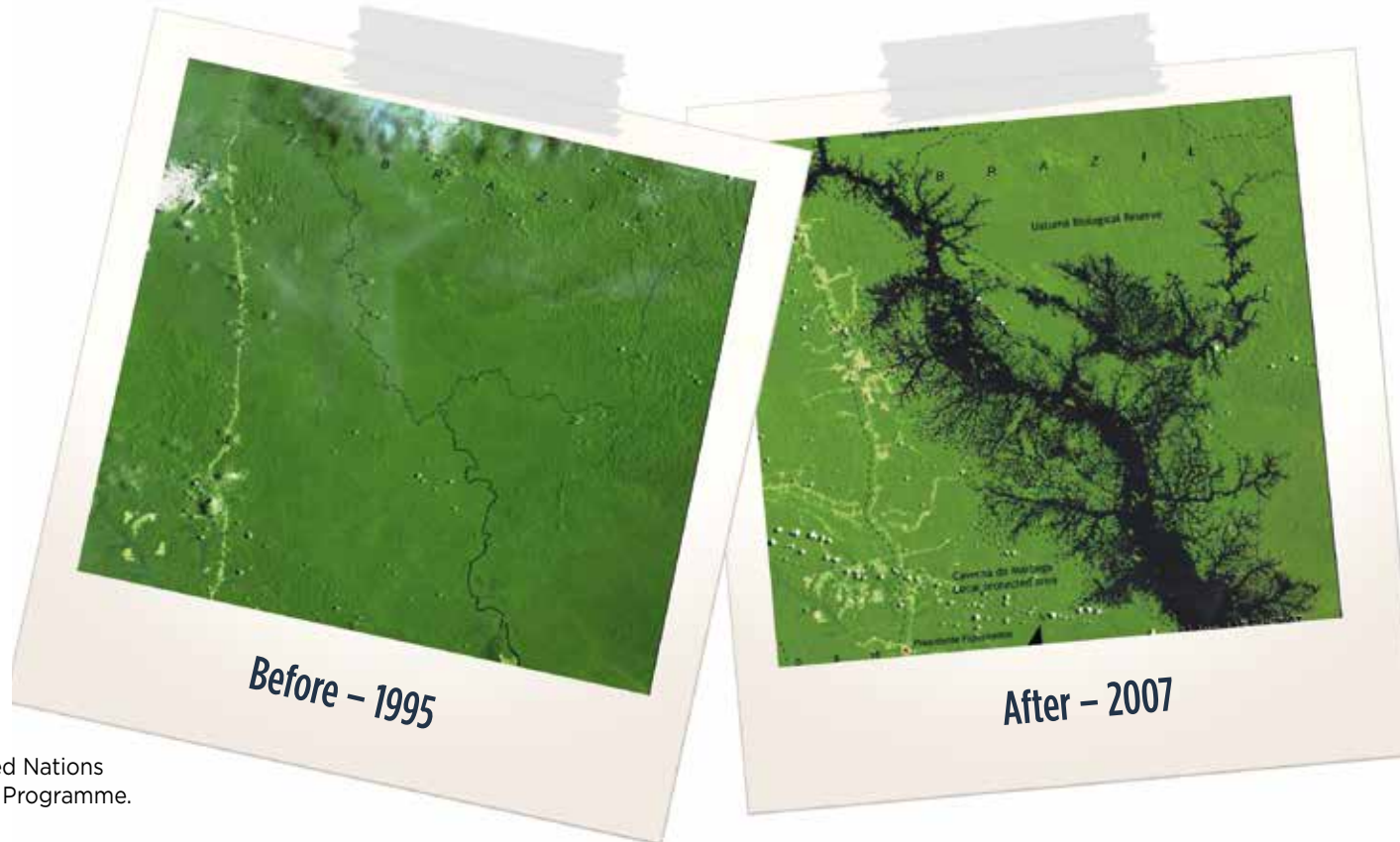
Such a source may appear ideal on the surface, since it produces electricity “cleanly” (that is, without generating GHG emissions). Unfortunately, appearances are deceptive in this case, since the dam itself has negative effects on the environment (figure 15).



Two of the most obvious effects are dramatic change to the land and the devastation of existing ecosystems that occur when the free flow of river water is impeded. Equally dangerous, though less obvious, is the effect of the pressure exerted by the heavy water on the Earth's crust, which affects the dynamics of the tectonic plates and may even increase the incidence of earthquakes.

*Figure 15. The hydroelectric power plant in Balbina, Brazil*

To construct the hydroelectric dam in Balbina, Brazil, more than 100 million tons of vegetation were flooded, releasing more carbon dioxide and methane gas than a thermal power plant with the same generating capacity.



Source: United Nations  
Environment Programme.

### What's happening to our wetlands?

Wetlands are highly productive ecosystems that provide many benefits to society. They supply water; recharge groundwater (ensuring water supply during droughts); regulate water flows and control floods during the rainy season; filter sediment, nutrients, and toxins; supply animal, vegetable, and mineral products; facilitate transportation; supply gene banks; provide habitats for wildlife; and serve as centers for tourism and recreation. In addition, wetlands are carbon dioxide sinks that help reduce GHGs and mitigate climate change.

Wetlands are classified according to their characteristics, as follows:<sup>1</sup>

- » **Estuary:** This is the area where the river mouth meets the sea, and the water is of medium salinity (deltas, marshes, and muddy banks).
- » **Coastal marine:** Areas between the land and sea (beaches, coral reefs, and mangroves).

<sup>1</sup> M. E. Stolk, P. A. Verweij, M. Stuip, C. J. Baker, and W. Oosterberg, *Valoración Socioeconómica de los Humedales en América Latina y el Caribe* [Socioeconomic Evaluation of Wetlands in Latin America and the Caribbean] (Netherlands: Wetlands International, 2006).

*Figure 16. The Papallacta wetland, Ecuador*



**Coca-Cayambe**  
ecological reserve  
in Ecuador





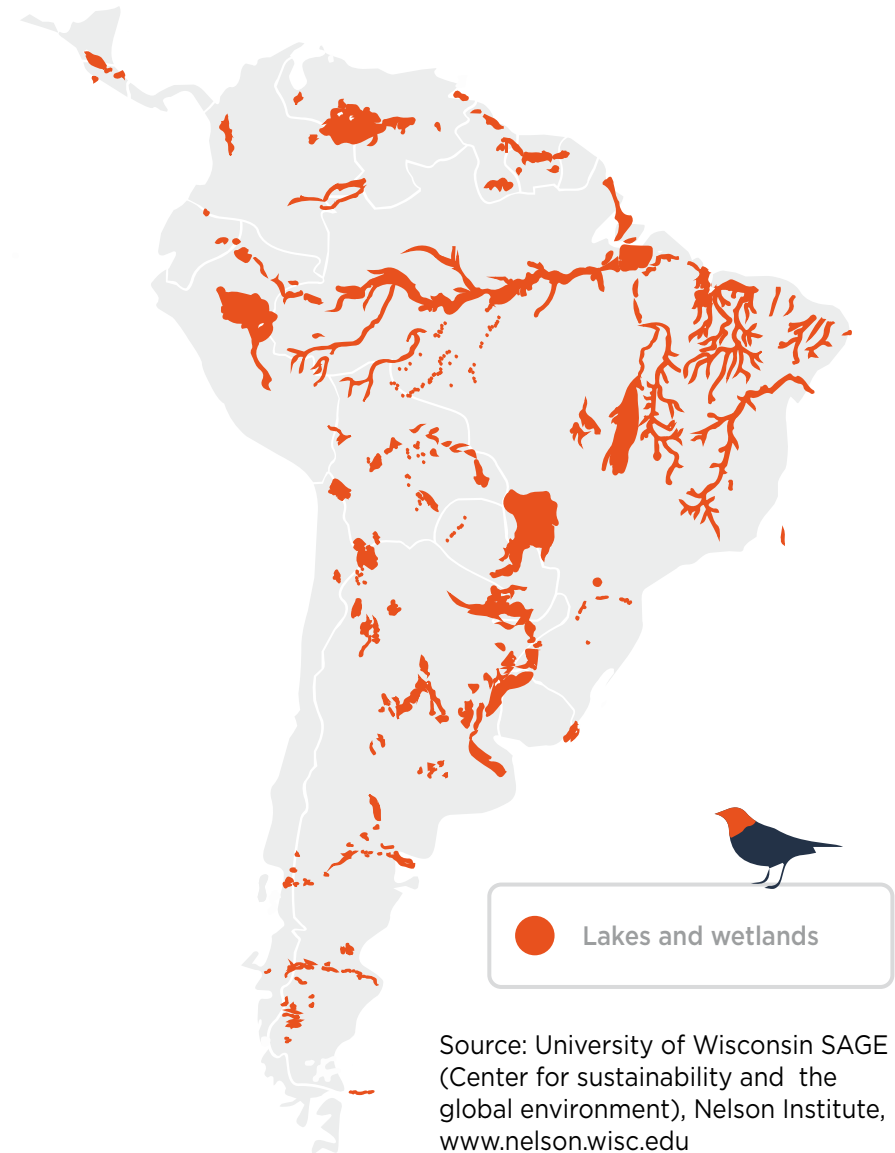
- » **Fluvial:** Land that is periodically flooded (flooded plains and forests, oxbow lakes, and river islands).
- » **Palustrine:** Areas with relatively permanent waters (bogs, marshes, and swamps).
- » **Lacustrine:** Areas with constant, low-circulating water (ponds, lakes, volcanic craters, and glacial lakes).

Wetlands are favorable habitats for both local and migratory birds that travel in the winter in search of food and favorable places to reproduce.

Even with all their benefits, we are failing to protect our wetlands in Latin America and the Caribbean. Rather, these areas (figure 17) are constantly threatened by development and economic activity, making them highly vulnerable ecosystems. Cities also endanger populations and species of fauna and flora. The most visible threats include:

- » Wastewater discharge and landfills from cities
- » Dumping of wastewater contaminated by chemicals from farming
- » Illegal fishing
- » Sediment and agrochemical residues from erosion and agricultural and mining activities in river basins
- » Drainage activities undertaken to expand agricultural and urban areas
- » Diminished water volume/flow as protective forest areas disappear, reduction/loss of tributaries from riverbank deforestation and river headwater areas, and clearing of forest cover from watersheds
- » Introduction and growth of invasive exotic aquatic plants along riverbeds, which often overwhelm native fauna and flora
- » Loss of strategic aquatic habitats for flora and birds
- » Fragmentation created by roads, irrigation canals, and landfills
- » Construction of dikes in rivers or streams; installation of water pipes

*Figure 17. Important wetlands in South America*



Source: University of Wisconsin SAGE (Center for sustainability and the global environment), Nelson Institute, [www.nelson.wisc.edu](http://www.nelson.wisc.edu)

- » Loss of biodiversity, primarily of birds and species of flora owing to habitat deterioration or loss
- » Lack of official protection, with few wetlands being declared protected areas
- » Low levels of environmental awareness and appreciation of the strategic importance of wetlands to local ecosystems
- » Inadequate environmental management in governmental entities responsible for ecological recovery, protection, and sustainable ecosystem management.

Wetlands are highly vulnerable to the effects of climate change. The current environmental deterioration of wetlands and watersheds adds to their vulnerability, which is compounded by the low priority accorded them by governments, based on their low property values.

We simply cannot afford to underestimate the value of our wetlands; rather, we must seek out ways to protect and regenerate them. Otherwise, we risk losing much more than the wetlands themselves. We also risk losing the many resources and protections they provide for us: strong construction materials, medicinal plants, fish, fruit, materials to develop biofuels, recreation and tourism areas of exceptional beauty that offer many opportunities to observe wildlife, and much-needed water control and supply services.

### Environmental services provided by forests

Forests are highly complex ecosystems that provide a range of useful services to humans, other living things, and the Earth itself. They help preserve ecological equilibrium and biodiversity, limit erosion in river basins, and regulate the climate. They also supply communities with a variety of products, such as wood, food, fodder, fiber, and organic fertilizers.

Ecosystems within forests also provide many products and services:

- » **Ecosystem support:** Soil formation, photosynthesis, primary production, nutrient cycles, and the water cycle.
- » **Products:** Food, fiber, fuel, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources, and fresh water.

## Change in land use

Roughly 60 percent of the world's tropical forests are located in Latin America, primarily in the Amazon biome. All are currently threatened by deforestation.

According to the FAO, South American forests are disappearing at a rate of about 4 million hectares per year. This trend is difficult to reverse because most South American countries lack institutions that are capable of tackling the problem.

The causes of deforestation are typically socioeconomic. Agricultural expansion is the leading cause, followed by infrastructure construction and timber harvesting. As humans

convert forested land to agricultural use, the forest floor is stripped naked of trees and replanted with crops or fodder for livestock. Farmers often plant very demanding crops year after year without investing in technology and replenishing the soil. In the Amazon, road construction and other infrastructure projects are key reasons for deforestation.<sup>2</sup> Large tracts of forest are also commonly cleared to exploit the subsoil and to extract metals, minerals, and other raw materials. These factors tend to appear in combination, and weak forest governance only compounds the situation.

<sup>2</sup> IUCN (International Union for Conservation of Nature), <https://www.iucn.org/about/work/programmes/forest/>.

- » **Regulation and purification:** Of air, climate, water, erosion, diseases, pests, pollination, and natural hazards.
- » **Culture:** Nonmaterial benefits, including spiritual enrichment, cognitive development, reflection, recreation, and aesthetic pleasure.

In its Statement of Forest Principles, the United Nations Conference on Environment and Development acknowledged that all forests and ecosystems should be managed (or planned) sustainably so as to ensure the perpetuity of the economic and ecological services and benefits that they provide.

### Deforestation and climate change

Although the relationship between agricultural production, logging, and GHG emissions does not seem obvious at first glance, the disappearance of tropical forests is the second leading cause of global warming. The Intergovernmental Panel on Climate Change estimated that 1.6 billion tons of carbon dioxide were emitted each year during the 1990s due to changes in land use.<sup>3</sup>

The IPCC has also estimated that roughly 10 million square kilometers (km<sup>2</sup>) of forest have been assigned a different use over the past three centuries. According to climate experts on the panel, in the intertropical zone (situated between the Tropic of Cancer and the Tropic of Capricorn, an area that encompasses most of Latin America and the Caribbean), this drastic reduction in forest cover has disrupted the balance of water systems (river levels, rainfall levels, evapotranspiration volumes), decreasing rainfall, damaging water cycles, and making the climate increasingly drier and hotter. In the Amazon, for example, studies project that the temperature may rise 5-8°C by 2100, and rainfall volumes may drop by as much as 0.2 inches.<sup>4</sup>

### Deforestation and biodiversity

We have already seen how deforestation can lead to the local or regional extinction of species, with the loss of genetic resources and of some of the ecological functions that these species provide,

such as nutrient recovery. This process also creates an imbalance among species, leading to an increase in pests, which could in turn curtail pollination and affect soil formation and maintenance processes (erosion control).

In 1988, English ecologist Norman Myers pioneered the concept of “biodiversity hot spots” to solve one of conservation’s biggest dilemmas: Which areas are most important for preserving the Earth’s biodiversity?

Observing that biodiversity is unevenly distributed across the planet, Myers sought to identify threatened regions where the highest levels of endemism are concentrated (that is, where species exist only in that area and nowhere else in the world). An area with at least 1,500 endemic plant species that has already lost more than three-quarters of its original vegetation is considered a “hot spot.”

Between 1996 and 2005, American primatologist Russell Mittermeier expanded on Myers’s work with a research project involving more than a hundred scientists. This work continues.

Today, 34 land areas and 10 marine areas are classified as “biodiversity hot spots.” Eight are in Latin America and the Caribbean (figure 18). A full 75 percent of the planet’s most endangered mammals, birds, and amphibians live in these areas; most have already lost at least 70 percent of their forest cover. These hot spots account for only 2.3 percent of the Earth’s total surface area, but they are home to some 50 percent of the Earth’s plant species and 42 percent of its vertebrate species.<sup>5</sup>

### Appreciating the land through ecotourism

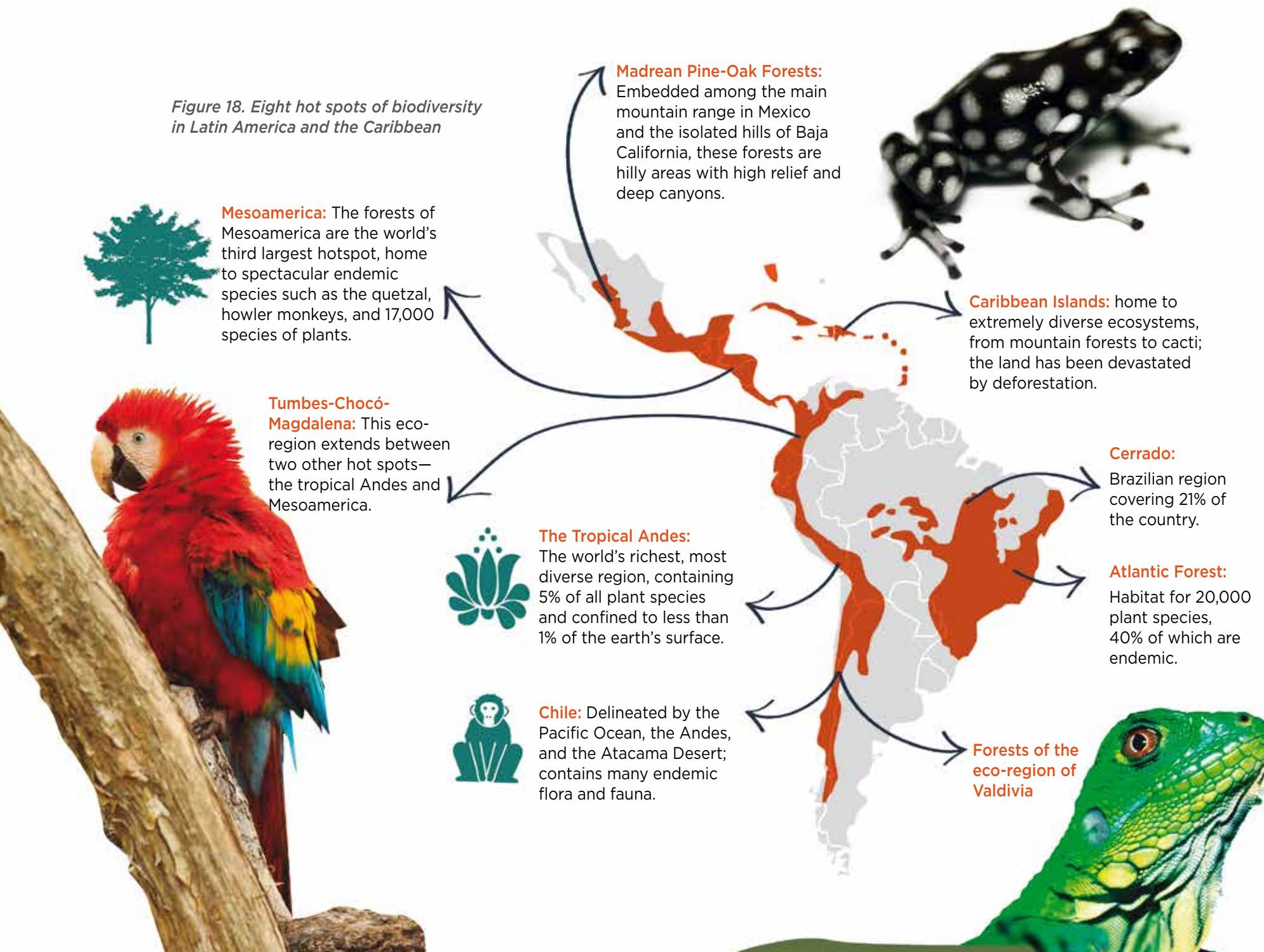
Ecotourism is “responsible travel to natural areas that conserves the environment and improves the well-being of local people.”<sup>7</sup> In addition to exerting minimal impact on natural ecosystems, ecotourism presupposes respect for cultural heritage. It educates people and raises awareness about the importance of conserving resources, while also economic resources for local communities.

<sup>3</sup> IPCC (Intergovernmental Panel on Climate Change)—Fourth Report (2007). Quoted by the Brazilian Institute of Amazon Environmental Research (IPAM).

<sup>4</sup> Ibid.

<sup>5</sup> Conservation International, <http://www.conservation.org>.

Figure 18. Eight hot spots of biodiversity in Latin America and the Caribbean





Tourism has changed in recent years. Whereas people used to prefer passive tourism, such as staying in large hotels and sunbathing on the beach, tourists today want travel experiences that enable them to learn something, be active, walk, meet “the locals,” try new foods, and contribute to preserving the land and the wider natural environment.

Widespread concern over the deterioration of our planet and global warming has sparked interest in ecotourism. Countries such as Costa Rica and Guatemala have made nature tourism a mainstay of their economies. As nature is their greatest resource, environmental protection has enabled people to generate income by capitalizing on their mountains, forests, birds, wetlands, and crops.

Ecotourism consists of three main tenets: conservation and protection of natural resources, conservation and protection of culture, and economic development in local communities. Achieving balance among these tenets ensures the sustainability of the land and its inhabitants. Latin American and Caribbean countries that engage in ecotourism have policies that focus on protecting and conserving natural resources and ensuring sustainability.

These policies aim to minimize ecotourism’s environmental impacts by:

- » Avoiding disturbance of the habitat or ecosystem
- » Advocating for and teaching environmental values to both the local community and visitors
- » Actively involving the local community
- » Leveraging the knowledge of the local community
- » Leveraging the cultural heritage of the local community.

Ecotourism is a respectful and sensible way of appreciating the land and benefiting from it by carefully sharing it with responsible tourists. It engages visitors in natural and self-enriching, yet respectful and conscientious, experiences. Ecotourism infrastructure involves little or no transformation of the visited areas. Facilities for receptions, lodging, and food service are minimally invasive and optimally adapted to the environment.

Ecotourism has other advantages. Guides with specialized

knowledge are well paid, and visitors are typically willing to pay a high rate for amenities in remote places. Ecotourism offers an attractive way to bolster economic development without adversely affecting ecosystems or the landscape.

Bird-watching is one of the largest and fastest-growing modes of tourism worldwide. By virtue of their great wealth in vegetation, bodies of water, and sheer number of species, the countries of Latin America and the Caribbean are among the most coveted destinations.

Colombia, Peru, and Brazil have the richest bird populations in the world, and Mexico and Venezuela are also in the top ten.<sup>8</sup> Travelers vie to boast about their bird sightings, eager to learn about and catch glimpses of beautiful, endemic, or endangered species. Countries with the highest demand for this type of tourism are the United States and Great Britain, closely followed by the Netherlands, Germany, Taiwan, South Africa, Japan, and Australia.



Lesson Plans at the

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# Basic Level

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## Basic lesson plan 1: Appreciating our land

### General objectives

- » Recognize different land formations.
- » Understand that land is exposed to many environmental factors and therefore is constantly changing.

### Class activity 1: Experiment on substrate changes

Objective	Time	Place
Observe changes in various substrates caused by environmental factors.	1 hour (monitor for 4 weeks)	Outdoors

#### Materials

- » Four transparent containers per group, Water; Substrates: sand, clay, small stones, soil

#### Preparation

Select an outdoor area at school where students can place their containers for 4 weeks and where they will not be disturbed.

Do the experiment yourself beforehand.

#### Step by step

- » Organize students into groups of three.
- » Explain to students what a substrate is.
- » Ask the class: How do landscapes change over time?

- » Have each group fill each container with a different substrate and add a little water. Tell them to describe what the water does to each substrate.
- » Ask them to leave the containers outside for 4 weeks and track any changes they observe in table 1. For example, they may write: the substrate became soft or compressed, seedlings sprouted, organisms appeared, it gave off an odor or was odorless, and so on. Changes may also be accompanied by drawings.
- » At the end of the 4-week period, ask students the following:
  - Are all the substrates equally resistant to water? Which were the most resistant? Which were the least?
  - How did each substrate change during the month?
  - What environmental factors altered the substrates?
  - How do human activities alter the substrate? Why does this happen?
- » Explain that these substrates form part of the land and ask the class again: How do landscapes change over time? Students should justify their answers using their findings.

Finally, ask them to apply their knowledge of what happens to these substrates on a larger scale to predict how rainfall will affect landscapes. For instance, what would happen if a recently deforested mountain received a great deal of rain? What would happen if a sand quarry received constant rainfall? Also ask them

*Table 1. Substrates in nature*

	Sand	Clay	Small stones	Soil
Week 1				
Week 2				
Week 3				
Week 4				

to observe what happens in the school's green areas, their gardens at home, or the neighborhood when it rains.

### Formative assessment

Before proceeding to the next topic, ensure that students understand:

- » The elements that make up the land
- » The human activities that transform landscapes

### Integration with other subjects

- » **Science:** Determine the types of ecosystems in your region.
- » **Language:** Describe the land where you live, both biotic and abiotic factors.
- » **Social studies:** Use newspaper clippings, interviews, and photographs to compare the land where you live today with what it looked like about 10 years ago.

### Remember

- » The Earth is constantly changing.
- » The Earth's surface is modified through weathering, erosion, and the effects of wind, water, and ice.

Earthquakes, floods, fires, volcanic eruptions, tropical storms, and landslides are all part of nature, like the sun and the rain. These natural phenomena transform the Earth regularly, but we notice them more when humans are affected. Humans unwittingly amplify their effects when they fail to adequately plan human settlements and implement necessary safety measures, emergency plans, and early warning systems.

### Tips for the teacher

Encourage your students to talk to their grandparents about how the land has changed over their lifetime. What types of changes have they noticed? Do they prefer today's landscape to the way things were when they were young? You may even wish to invite a few grandparents to come to class.

Decorate the classroom with elements of the landscape that inspire your students and have them use their imaginations to paint landscapes that they love and enjoy.



# 2

## Basic lesson plan 2: When does a natural phenomenon become a disaster?

### General objectives

- » Make a distinction between natural phenomena and disasters.
- » Understand the causes of disasters.

### Class activity 1: Game “The eruption”

Objective	Time	Place
Understand that disasters are not natural.	1 hour	Outdoors

#### Materials

- » Chalk or string

#### Preparation

Find an open area to play the game and create a story about a volcanic eruption.

#### Step by step

- » The activity is based on a traditional game called “catch me if you can.”
- » Mark off an area the size of a basketball court with chalk or string. Select one corner to be the “safe zone” and explain that the students can run in the remaining area.
- » Tell the students a story about the eruption of a volcano, for example:

*In 1899, Saint Martin was a beautiful town situated in the foothills of “Temperamental” Volcano, which had been silent and dormant for many years. The town had grown with more and more people coming to live there. Everyone said, this volcano is asleep and will likely remain that way for many years to come.*

*One day, ashes started to rain down from the sky and the smell of sulfur filled the air. Later that day, a rumble was heard from deep inside the Earth. However, people never dreamed that it came from “Temperamental,” so they stayed where they were in their homes, until suddenly, a dreadful sound was heard as the volcano erupted!*

- » Before telling the story, select a student to be “lava.” “Lava’s” mission is to grab the other “unprepared” students, who should run around the enclosed area and try to avoid being caught.
- » When the “unprepared” are caught, they also become “lava” and join hands, forming a row, to catch more of the unprepared.
- » The “unprepared” can use the “safe zone” to keep safe from the clutches of “lava.”
- » Start the game by reading the story, and when you say the word “erupted,” do so loudly enough to cause a panic.

- » The game ends when all of the “unprepared” have been caught by “lava.”
- » The students can play several times, but the game should always start by telling a story; invite your students to make up new stories!
- » After the game is over, ask your students the following:
  - How did you feel when you were “lava?” And when you were “unprepared?” Which was scarier?
  - What helped you escape from “lava?”
  - How can we avoid getting caught by “lava” and prepare for the future?
  - What would happen if the “lava” did not catch anyone?

Think about the natural phenomena in your region and how they have affected you and others. Have you ever been affected by natural phenomena, such as floods or earthquakes? Have you seen others be affected by these things? What could people do to avert disasters? Think of places that could be used as safe areas and how you could tell people where they are.

## Class activity 2: Experiment on natural phenomena vs. disasters

Objective	Time	Place
Understand the causes of disasters and distinguish them from natural phenomena.	2 hours	Classroom

### Materials

- » Recycled items: plywood, bottles, lids, small cardboard boxes, styrofoam, aluminum foil, plastic packaging, colored paper, magazines; soil, sand, water, glue, scissors, X-Acto knife, cards depicting natural phenomena (figure 19)

### Preparation

- » Set up the activity beforehand, locating sites to build the models.
- » Please note that the room may get a bit messy.
- » Print the cards depicting natural phenomena.

### Step by step

- » Organize students into groups of four. Have each group build a model of a landscape, including an ecosystem and its characteristic vegetation and animals, houses, and people.
- » Ask your students whether they think they could survive a natural phenomenon. How?

When the groups finish their models, have them switch places with another group. Hand each group a card depicting a natural phenomenon and have them pretend that the phenomenon is occurring in their area, following the instructions provided.

Afterwards, have the groups rotate again to a different model and landscape and restore the affected area using measures they deem necessary to establish safe conditions for those who live there (i.e., relocate and rebuild homes, repair homes, build a temporary shelter for residents, rebuild access roads, etc.).

Then, ask the groups to return to their original model and record any changes they observe in it.

Ask your students:

- » What changes did you observe in the landscape that you built?
- » Why did the landscape change?
- » What do you think happened to the people who lived there when the changes that took place?

Discuss how the dynamics of the Earth are constantly changing, and that natural phenomena are indications of that change. Consider how a beach is changed after a strong windstorm or how a mountain is changed after a landslide. Then consider the same situations again, with people and human activities added to the same landscapes.

Figure 19. Natural phenomena cards

Natural phenomenon:

**Earthquake**

} Movement of tectonic plates with different levels of intensity.



Natural phenomenon:

**Flood**

} Rising waters of a river, torrential rainfall, melting snow, avalanches or tides above the usual level.



Natural phenomenon:

**Hurricane**

} The union of a tropical storm and spiraling winds.



Natural phenomenon:

**Tsunami**

} A series of waves caused by undersea earthquakes



Ask your students to consider natural phenomena that could occur in their region and list them on the board. Brainstorm how they could prevent those phenomena from affecting them and developing into disasters.

### Formative assessment

Before proceeding to the next topic, ensure that:

- » Students understand the difference between disasters and natural phenomena.
- » Students understand that disasters can be avoided by taking preventive action.

### Integration with other subjects

- » **Science:** Research three natural phenomena that occur in other parts of the world.
- » **Language:** Draw a comic strip about taking action to prevent a natural phenomenon. Also, research folk sayings about disasters and reflect on their accuracy.

### Remember

- » A natural phenomenon is any manifestation of nature—that is, one that results from natural processes—that can be perceived by the senses or by scientific detection instruments.
- » Some natural phenomena involve risks, but we can reduce or increase those risks and promote or prevent disasters through our choices. For example, humans can avoid building houses next to rivers and preserve wetlands and forests so that if rainfall rises, forests will protect the soil, preventing erosion, and wetlands will hold surplus water.
- » Weather forecasts and information on climate enable people to better plan their response to natural phenomena and lower the risk of weather-related disasters.

### Tips for the teacher

To reinforce the concept of preventing hazards vis-à-vis natural phenomena, use various everyday life situations to illustrate how taking small steps can lower our risk of falling ill. For example:

*Table 2. Risk and prevention*

Situations	Risk prevention
Rainy season in the region	<ul style="list-style-type: none"> <li>» To keep dry and avoid getting sick, we can:</li> <li>» Carry an umbrella and/or raincoat</li> <li>» Use rubber boots to protect our feet from the cold and rain</li> <li>» Change clothes immediately if we get wet</li> <li>» Eat healthy foods that support our immune system</li> <li>» To prevent the proliferation of mosquitoes we can:</li> <li>» Remove water puddles near our homes (because mosquitoes lay their eggs there)</li> </ul>
Dry season	<ul style="list-style-type: none"> <li>» To avoid falling ill, we can:</li> <li>» Use a hat or cap and sun block for protection from the sun</li> <li>» Drink plenty of fluids to avoid dehydration</li> </ul>

Invite your students to play the game Rise Up Risk, which you can find at [www.iadb.org/riseup](http://www.iadb.org/riseup).

## Suggested reading and viewing

- » The United Nations Office for Disaster Risk Reduction offers games and projects that teach children about many types of threats and disasters—and how to reduce the risks they pose. From [www.unisdr.org/](http://www.unisdr.org/) enter “let’s learn to prevent disasters” or “learning about disaster prevention” into the search line. Resources on how families, communities, and schools can prevent natural or human-caused disasters are also available. Try these search phrases: “family plan for disaster prevention” and “disaster prevention for schools.”
- » “Managing Risk in the School” is module 9 of the Green School Toolkit, which can be found at [www.iadb.org/riseup](http://www.iadb.org/riseup).



Lesson Plans at the

# Intermediate Level

# 1

## Intermediate lesson plan 1: I think like the wind, I feel like the sea, I move like the Earth

### General objectives

- » Understand how wind and ocean currents transform the land.
- » Learn how tsunamis and earthquakes form and influence the land.

### Class activity 1: Traveling by sea and air

Objective	Time	Place
Understand wind and ocean currents in the Americas.	1 hour	Outdoors

#### Materials

- » Map of South and Central American ocean and wind currents, instruction cards for the game, chalk

#### Preparation

- » Read and discuss the introduction to this unit with your students.
- » Find an area to draw a map of Latin America and Caribbean on the ground and play the game.

#### Step by step

- » Divide students into four groups and have them stand in rows around the map of Central and South America. One row should stand at each cardinal point.
  - Group 1: Right side, representing the East Winds and the Brazilian Current.

- Group 2: Left side, representing the West Winds and the Peruvian Current.
- Group 3: Top, representing the North Winds and the Equatorial and Caribbean currents.
- Group 4: Bottom, representing the South Winds and the Cape Horn currents.

- » Ask the students to move about, mimicking the direction of the wind and marine currents in Central and South America. For instance: if the teacher says, "Southerly winds blow from the north and easterly winds blow from the west," the students in the south must go to the north, those in the north go to the south, those in the east switch to the west, and in the west, switch to the east.

- Play a round just with the winds, another just with the currents, and a third with both the winds and currents. Increase the speed of the game as students learn the movements. Correct them when they make mistakes.

- » Base your instructions on the following movements:

- » First round:

- North winds move south
- West winds move south
- East winds move west
- South winds move north
- West winds move east
- North winds move west

- South winds move east
- East winds move north
- North winds move east
- East winds move south
- South winds move west
- West winds move north

» Second round:

- Equatorial current moves to Peruvian current
- Peruvian current moves to Cape Horn current
- Cape Horn current moves to Brazilian current
- Brazilian current moves to Caribbean current
- Caribbean current moves to Brazilian current
- Brazilian current moves to Cape Horn current
- Cape Horn current moves to Peruvian current
- Peruvian current moves to Equatorial current
- Cape Horn current moves to Peruvian current
- Caribbean current moves to Brazilian current

*Important rule: The winds can cross the continent, but the currents must move around it in the ocean.*

- » Use the names of the currents rather than the four cardinal points when referring to the ocean currents to help students remember them.

Discuss with the class the importance of marine currents and wind to nature's dynamics, including how they shape the land and affect animal life cycles, the climate, and our lives. Discuss the changes that occur in their cities when winds are strong, and how they affect the seasons for certain fish species in coastal cities. Consider how they affect ocean currents.

Tell them that oceanic and atmospheric phenomena are directly linked to wind and currents, such as the El Niño and La Niña phenomena, which occur cyclically every 2–7 years. Although they affect the entire globe, they exert the greatest impact in the Pacific Ocean and near the equator. Their effects on the climate differ by region. El Niño is caused by above-average ocean and

environmental temperatures, primarily on the Pacific coast, and brings increased relative humidity. La Niña occurs with below-average water temperatures in the Pacific and brings excessive rainfall in some areas and drought in others. Invite your students to watch the video “What are El Niño and La Niña” at [www.iadb.org/riseup](http://www.iadb.org/riseup).

## Class activity 2: Account of a disaster

Objective	Time	Place
Understand how earthquakes affect populations and why we must be prepared.	1 hour	Classroom

### Materials

- » News from the Spanish newspaper “El Mundo” on the earthquake in Chile in 2010

### Preparation

- » Read the text on plate tectonics and the origin of earthquakes that begins on page 11.
- » Print and make copies of the story on the next page.

### Step by step

Group students in pairs, distribute copies of the article on the next page, and have them read it.



## Strong earthquake in Chile has left at least 300 dead

Saturday 02/27/2010

The death toll from the earthquake that devastated central and southern Chile now exceeds 300, according to the National Emergency Office (ONEMI) Director Carmen Fernández.

*"We are facing a disaster of historic proportions," Chilean Interior Minister Edmundo Pérez Yoma told reporters, referring to the 8.8-magnitude earthquake that rocked central and southern Chile today, causing widespread destruction.*

*The earthquake erupted at 03:36 a.m. local time, when most of Chile's 17 million inhabitants were asleep. According to experts, the quake was 50 times more powerful than the one that devastated Haiti on January 12th.*

*Maule, 300 kilometers from Santiago and the region hardest hit by the earthquake, was home to 34 of the 82 victims that have been confirmed dead so far, according to Pérez Yoma.*

*According to authorities, 13 fatalities have been recorded so far in the capital metropolitan area, along with another 14 in the southern region of Bío Bío, 12 in O'Higgins, four (4) in Valparaíso and five (5) in La Araucanía. The number who have been wounded is not yet known.*

*In Bío Bío, 400,000 people are currently without power or access to running water or gas. From Valparaíso to Araucanía, which are 800 kilometers apart, many areas are experiencing water, sewerage and telephone outages. In the metropolitan area of Santiago, several towns are without power or drinking water.*

### Incomplete information

*The U.S. Geological Survey reported that the earthquake registered 8.8 on the Richter scale and that its epicenter was in the southern region of Bío Bío, 500 kilometers from Santiago and 90 kilometers southeast of the regional capital of Concepción.*

*However, the Seismological Institute of the University of Chile said that the quake was 8.3 on the Richter scale and that the*

*epicenter was on the coast, 63 kilometers southwest of the city of Cauquenes, along the border between the regions of Bío Bío and Maule, farther north.*

*In either case, the earthquake reminded the Chilean people that they are living in one of the most seismically active countries on earth.*

### Tsunami

*The earthquake in Chile caused a tsunami in the Pacific Ocean, which hit Hawaii shortly after 21:00 GMT, according to the National Oceanic and Atmospheric Administration (NOAA).*

*"A tsunami was generated which could cause damage to the coastline of every island in the state of Hawaii. Prompt action should be taken to protect lives and property," said the NOAA in a press release.*

*Chilean President Michelle Bachelet, who arrived at the National Emergency Office (ONEMI) just minutes following the quake, traveled to the region of Maule shortly before noon to survey the effects of the powerful earthquake.*

*Her successor, Chilean President-elect Sebastián Piñera, announced that he will allocate 2% of the national budget to rebuild the areas hit by the earthquake, which he estimated had killed 122, in contrast with the National Emergency Office (ONEMI), which has reported an official death toll of 82.*

### Coast on alert

*The area between the regions of Valparaíso and Araucanía was declared a disaster area by the government, which immediately began documenting the damage to physical infrastructure, including collapsed bridges and pedestrian walkways along the highways connecting Santiago with the north and south of the country.*

*The Chilean authorities recommended that citizens not travel except when strictly necessary, as many cities, including the capital, remained virtually paralyzed.*

*In Santiago, the subway is closed, there is limited ground transportation, and the international airport is closed due*

to damage to the control tower and the passenger terminal. Authorities had initially said that the airport would be closed for 24 hours, but this was later extended to 48 hours, and sources have not ruled out the possibility of an even longer closure.

Locally, weekend soccer matches were suspended as were the closing day activities of the Festival at Viña del Mar. According to authorities, the earthquake extended over 800 kilometers of the Chilean landscape, with intensities as high as nine (9) degrees on the International Mercalli scale, which ranges from one to twelve.

### **Aftershocks**

So far 58 aftershocks have followed the initial earthquake in Chile, some of which have exceeded a magnitude of six (6) on the Richter scale, according to the U.S. Geological Survey (USGS).

The epicenters of most of the aftershocks were in the Chilean regions of Bio Bío, Maule and Valparaíso. Six registered six (6) or above on the Richter scale, including one off the coast of Bío Bío that reached 6.9.

Chile is situated in the “Ring of Fire,” one of the world’s most seismically active areas. Statistically, interaction between the Nazca and South American tectonic plates produces a destructive earthquake every 10 years as well as some twenty tremors per day and almost 4,000 earthquakes each year, according to the University of Chile’s Institute of Geophysics.

Prominent in Chile’s seismic history is the earthquake of 28 October 1562, which killed 2,000 people in the region of Concepción, 520 kilometers to the south of Santiago. Since then Chile has experienced 83 major earthquakes, causing 40,265 fatalities.

The last major earthquake that hit Chile was on 30 July 1995, when an earthquake measuring 7.8 on the Richter scale struck the northern city of Antofagasta, 1368 kilometers from Santiago, causing many deaths and injuries and extensive damage.

Source: [www.elmundo.es](http://www.elmundo.es) 02/27/2010

» Ask your students to answer the following questions based on the reading:

- How do earthquakes affect local populations?
- What should survivors expect in the wake of an earthquake?
- Have you ever experienced an earthquake? Were you affected? How?
- How could you prepare for a major earthquake?
- What kinds of natural disasters are possible in your municipality?

» Discuss potential local disasters and students’ likelihood of being affected by a natural occurrence. Stress the importance of prevention and risk management in disasters.

### **Formative assessment**

Before proceeding to the next topic, ensure your students understand:

- » How wind currents and tides move and affect the land.
- » How the Earth’s tectonic plates produce earthquakes.

### **Integration with other subjects**

- » **Science:** Research how drilling for oil causes sinkholes.
- » **Language:** Interview a member of your community who has experienced and been affected by a natural phenomenon. Ask him or her: How did you survive? What did you learn from the event? How did you adapt to the situation?

### **Remember**

- » Earthquakes can usually be felt for only 10 to 15 seconds, but sensitive recording instruments tell us that they last longer. Distance from the seismic source also determines how long they will be felt.
- » A tsunami is a large wave produced by a drastic change in the ocean level caused by an earthquake in the oceanic crust. Depending on the distance between the epicenter

and the coast, the wave could take anywhere from several minutes to several hours to arrive on shore.

- » It is impossible to predict earthquakes; we can only discuss probabilities of an occurrence and its potential characteristics.

### Tips for the teacher

Ask your students to consider what they and their families can do to avoid disaster in the event of a natural phenomenon. Help them by saying:

- » Think about your home and consider: “What hazards are close to home? Could we make improvements to our home to make it safer?”
- » Think about your neighborhood or community and consider: “Which places in my community are the safest in the event of a life-threatening natural phenomenon?”
- » Consider which nearby individuals and places may be of help, such as the firehouse, the Red Cross, or a hospital or health-care facility.
- » Develop an action plan with your family. Be sure that you specify a meeting place away from home, such as a park, church, or another house, if you are evacuated; a second meeting point if the first is inaccessible; and the phone number of a relative who lives in a different province or department, in case you become separated.
- » Ask your parents to discuss their action plan with the neighbors.
- » Identify professionals within your community who can help you, such as doctors, engineers, firefighters, psychologists, and so on.

### Suggested reading and viewing

- » The American Red Cross, [www.redcross.org](http://www.redcross.org), publishes recommendations for the public on minimizing the damage from natural disasters. Look for the rubric “Plan and Prepare” at the bottom of the home page. You’ll find downloadable brochures on prevention, myths and facts, and how to live safely in earthquake zones.

## Intermediate lesson plan 2: Transformation by nature

### General objectives

- » Understand how transforming the land can lessen biodiversity.
- » Identify which transformations are natural and which are due to human activity.

### Class activity 1: How one gram of gold transformed an entire landscape

Objective	Time	Place
Use a (fictitious) case study of how human activities transform the land.	1 hour	Outdoors, in a quiet place

#### Materials

- » The story of Cantagallo (opposite), photographs (figure 20)

#### Preparation

Make copies of the story and photographs.

a.Panning: This technique involves washing the sand without the help of machinery to separate and collect precious metals contained in the sand.

#### *The Story of Cantagallo*

A few years ago, a new gold rush erupted in a Latin American country. Some 50 companies from around the world embarked upon exploration projects there, investing close to \$200 million—a lot of money!

On the banks of the Utopia River in a town called Cantagallo, people used traditional panning techniques to extract gold.<sup>a</sup> Many families lived on the banks of the river. They fished there and caught delicious freshwater shrimp. The town's kids loved playing in the river, too.

One day, a stranger arrived with a backhoe. He dug a hole almost 15 meters wide in the river bank. After sifting the soil through a two-meter-high sieve, he found gold. A few days later, more strangers arrived with backhoes before the shocked villagers even had time to react.

Along 20 kilometers of the river, 245 machines dug huge holes, large enough to hold dinosaurs! Almost from one moment to the next, the green forest disappeared and the children's shouts and songs were silenced by the desperate noise of the machines, hungry for land and gold.

Life changed completely in the village. Prices began to rise and everything became more expensive. The village's population grew from 1,000 to 8,000 residents, almost overnight. The newcomers brought with them fighting, public disorder, insecurity, and hunger for gold. Fish and shrimp disappeared from the river. Traditional songs and games were replaced by children sweeping tables, trying to collect a share of the gold.

Gold-mining fever infected the peaceful neighboring village, too, leaving Cantagallo's landscape completely transformed. The huge holes left behind by gold mining were filled with plastic, paper, waste, and things that the miners once used. The Utopia river basin is now part river, part-broken, muddy ponds.

The river's waters flow so quickly that it is almost impossible to swim there now; the force of the current would sweep you away! As time passed, the sandy beaches along the river bank disappeared; the river took everything. The monkeys that used to live on the other side disappeared, too.

One day, the river rose higher and flowed faster than usual. Days before it had rained incessantly near the river's headwaters. The rain produced so much river water that its force killed 38 people and destroyed 217 homes, two schools, and several acres of crops. Everything was carried out to sea.

Some people said it was God's punishment. Others said that the river was angry. But Berthilda, the town's wise grandmother, said it was neither. The river simply followed its natural course after people disrespected its resources, not thinking about the consequences of their uncontrolled looting. This made the water run harder than usual, and not even the roots of the trees along the river bank could hold the land along its banks in place. The enormous holes in the riverbed had formed channels that made the water run faster than ever before.

The grandmother thought about the letter that Native American Chief Seattle wrote, which said, "Only when the last tree has been cut down, the last fish has died and the last river has dried up, will we realize we cannot eat money."

a. Panning: This technique involves washing the sand without the help of machinery to separate and collect precious metals contained in the sand.

*Figure 20. Snapshots from Cantagallo*

### Before the gold rush



The shores of the river

Children playing in the water

Fishing in the river

Panning for gold



## After the gold rush



Muddy water



Dead fish

### Step by step

- » Invite your students to listen to the “Story of Cantagallo.”
- » Pass out copies and have students take turns reading the story aloud. Show the photos to the class as the story progresses.
- » After reading the story, ask your students:
  - What caught your attention most in the story?
  - How was the land changed?
  - How were the lives of the people changed?
  - Were the river’s rising waters a punishment sent from God? Why or why not?
  - What do you think would happen next, if we continued the story?
  - If something similar happened in our town, how would you deal with it?

- » If your students don’t mention them, bring up and discuss the following points:
  - Destruction of the forest and species habitat
  - Change in the hydraulics and morphology of the river
  - Increased sediment load in the river
  - Surface and groundwater pollution
  - Effects on the stability of the surrounding areas and road infrastructure
  - Higher volume of sediments dumped into the sea
  - Higher level of illnesses in the area, due to the dramatic demographic shift

Conclude by discussing production-related activities in your region and/or town and their effects on the land: think about livestock pastures, crops, coal mining, oil wells, tourism activities, and so on. What did this land and its biodiversity look like before those activities began?



## Class activity 2: Game: “In the event of a natural phenomenon . . . get ready”

Objectives	Time	Place
<ul style="list-style-type: none"> <li>» Study land transformation and identify which events are natural and which are due to human activity.</li> <li>» Understand how to reduce our vulnerability to natural phenomena.</li> </ul>	1 hour and 30 minutes	Outdoors

### Materials

- » Chalk or rope to trace a line on the ground

### Preparation

Find an area outdoors where you can play the game and mark off two areas separated by a line or a rope.

### Step by step

- » Take your students outside, divide them into two groups, and mark off an area where they can line up side by side in two rows on opposite sides of the area, facing one another.
- » Draw a line halfway between the two rows of students.
- » The following three roles will be used in the game:

**Natural phenomenon** (PHENOM! beats OUCH!): PHENOM! players must choose and act out one of the following:

- » Earthquake: run in place
- » Flood: pretend to choke (hands on the neck)
- » Volcanic eruption: pretend to vomit, leaning body and head forward
- » Players must choose one of the above on each round.

**Disaster prevention** (PREVENT! beats PHENOM! and OUCH!): PREVENT! players must do one of the following:

- » Survival kit: Hold one hand horizontally at chest height and the other at belly level and pretend to hold a box.
- » Relocation: Hands above the shoulders, as if carrying a pack suspended from a stick.

**Disaster victim** (OUCH! beats no one): extend hands out in front, palms facing up, as if pleading for help.

- » The game is similar to “Rock, Paper, Scissors.” Players collectively choose one role per round. Then the two groups line up facing each other, separated by the line indicating the respective area of each group.
- » Students should count to 3 and then shout: “PHENOM! PREVENT! OUCH!” Then, they must act out the role they’d selected for that round. The group acting out PHENOM! or PREVENT! wins, and the group acting out OUCH! loses and has to run to their safe zone before their classmates catch them.
- » Anyone who is caught becomes part of the winning team.
- » Play as many rounds as you wish. The team with the most players at the end wins.

End the game by asking your students how they felt when acting out each role, and, when they caught someone or were caught themselves. Did they have a strategy for communicating and teamwork? Explore this topic further back in the classroom, asking “Why do we sometimes find it hard to communicate?” “What are the potential implications of miscommunication?”

Also, discuss what each role represents and why they don’t all win. Review the concepts of disasters, threats, vulnerability, prevention, and mitigation.

Invite your students to watch the video “Are you risk averse?” You’ll find it at [www.iadb.org/riseup](http://www.iadb.org/riseup). Discuss it.

## Class activity 3: Online game: Putting together an emergency kit

### Objective

Learn what things we need to have ready in the event of an emergency.

### Step by step

Invite your students to play the game “Rise Up Risk” at [www.iadb.org/riseup](http://www.iadb.org/riseup).

### Formative assessment

Before proceeding to the next topic, make sure your students know:

- » Landscape transformations are caused by natural phenomena and human activities
- » We must be prepared for natural phenomena
- » Which items should be in an emergency kit

### Integration with other subjects

- » **Science:** Research what causes hurricanes, volcanic eruptions, and storms, and explain them through illustrations.
- » **Mathematics:** Research common natural phenomena in your region and construct a table to compare how many events occurred in the past five years. Which occurred most frequently?
- » **Social studies:** Research natural phenomena in your region and study your community’s disaster prevention plan.
- » **Language:** Interview a person in your community who has experienced a natural phenomenon and write an article summarizing the interview. Ask: What kind of phenomenon did you experience? How were you affected? What did you learn from this experience? How do you prepare for natural phenomena now?

### Remember

The likelihood that a species will become extinct when its habitat is transformed largely depends on its geographic range, its adaptability to habitat variations, and the size of its population. The smaller its area and population and the lower its adaptability, the higher the likelihood for extinction.

### Tips for the teacher

- » Discuss potential risks near the school and in the local community with your students. Use the Green School Kit that you can find at [www.iadb.org/riseup](http://www.iadb.org/riseup).
- » Go on a field trip to observe rivers and streams that have flooded and harmed residents in the past. Discuss your observations.

### Suggested reading and viewing

- » The United Nations Office for Disaster Risk Reduction offers games and projects that teach children about many types of threats and disasters—and how to reduce the risks they pose. From [www.unisdr.org/](http://www.unisdr.org/) enter “let’s learn to prevent disasters” or “learning about disaster prevention” into the search line. Resources on how families, communities, and schools can prevent natural or human-caused disasters are also available. Try these search phrases: “family plan for disaster prevention” and “disaster prevention for schools.”
- » October 13 is International Day for Disaster Reduction. Ideas for leading a campaign to commemorate the day can be found by searching on “disaster reduction October 13” at [www.un.org/en/](http://www.un.org/en/).



# Lesson Plans at the **Advanced Level**

## Advanced lesson plan 1: We transform the land; the land transforms us

### General objective

- » Understand the close relationship between humans and the land.

### Class activity 1: Human beings: Surgeons of the Earth

Time	Place
Two 2-hour classes (total: 4 hours). Two hours for online observation and research, and 2 hours for presentations and discussion	Computer room and classroom

#### Materials

- » Internet access, notebooks

#### Preparation

- » Select several cases that seem relevant and interesting, where the “before” and “after” images are very different.

#### Step by step

- » Ask your students to find a partner.
- » Ask each pair to explore the list of sites modified by humans in the atlas (see above). Each pair should select one place. Make sure there is no repetition. Guide students toward the cases you preselected.
- » Ask them to observe satellite images taken before and after the physical transformation of the land and to note the differences between the two. Ask them how the changes have likely affected the land and the environment.

- » Have them research the history of the site they selected. What kind of transformation took place and why? What have been the positive and negative impacts of this transformation?
- » Back in the classroom, ask each group to briefly present (for five minutes) their site, the changes that took place there, and the impacts they identified.
- » After the presentations, have them categorize the types of transformations caused by humans (hydropower plants, towns, roads, etc.) according to their purpose: industrial production, transportation, housing, and so on.
- » Discuss the impacts of the transformations in each category. Ask them what they think about the images, whether or not the changes made by humans are justified, and why?

#### Formative assessment

After completing this activity, students should have a clearer sense of transformations caused by humans. They should understand the purpose of these transformations as well as their potential effects.

## Integration with other subjects

- » **Geography:** Use the interactive maps on the UNEP website to draw maps of the countries that are home to the areas they researched, outlining political divisions, cities, and towns around the transformed land.
- » **History:** Choose one of the historical causes uncovered in researching the transformations and conduct additional research into what led people to transform the land, what unmet needs they had, and so on.
- » **Social sciences:** Discuss the Rio Principles (particularly the principle of free access to and use of natural resources) and their potential legal implications. Search for the principles on the website of the United Nations Environment Programme (unep.org).

## Tip for the teacher

Organize a field trip to an area near your school where a great transformation can be observed. Have students create a brochure on the history of the site and have them include “before” and “after” drawings of the landscape.

## Remember

- » Landscapes are the result of many transformations caused by nature and humans.
- » It is difficult to find lands that humans have not affected in some way.
- » Humans often transform the land when they use natural resources, especially for industrial purposes or for building cities, towns, and roads.



# 2

## Advanced lesson plan 2: Landscape transformation or exploitation?

### General objectives

- » Reflect on how transformations of the land affect ecosystems and ourselves.
- » Explore alternative uses for land.

### Class activity 1: The wetlands in our backyard

Time	Place
2 hours	Classroom

#### Materials

- » Magazine articles, maps, documents on local wetlands

#### Preparation

Have your students research the wetlands in your region. They should gather information regarding their current conditions, including: whether they have shrunk in size or are polluted, if people use them for recreation or tourism, if they are protected by any organization, if they are urbanized, if they have fauna and flora, if they supply water to the community, and whether surrounding areas have experienced flooding in recent years. Ask them to provide images of these wetlands.

#### Step by step

- » Ask: “What is a wetland?”
- » Draw a table on the board showing the classification of wetlands with their respective names, and record what your students say. Ask them to provide examples of wetlands in

the area and to describe them. For example, whether they are at the mouth of a river or along the coast, or whether they are the result of overflowing rivers, standing water, or relatively permanent, moving water.

- » Ask them which wetland they chose to research and divide them into groups, accordingly.
- » Have them share their research on the wetland they chose with their groups.
- » Ask: “Why are wetlands important?” Discuss and supplement their answers, if necessary.
- » Ask: “What are the consequences of wetland transformation?” Have them discuss this question in their groups before discussing as a class; make sure they discuss the topic of flooding in areas close to the wetlands. Supplement the discussion with information about the value of wetlands.
- » Optional: Organize a field trip to a nearby wetland.

#### Tip for the teacher

Wetlands that are managed by organizations may be easier to visit. Some organizations offer tours to educate students about the environmental benefits of wetlands and the activities that take place there.

## Class activity 2: Mining and housing

Time	Place
1 hour 30 minutes (2 class periods)	Classroom

### Materials

- » Images to project for this activity and projector

### Preparation

Set up the projector or print the images in figure 21 for the class.

### Step by step

- » Ask: “What human actions modify the land, aside from those involving wetlands?”
- » Project the images and only tell your students where the site is located and what the activity is, if any.
- » Ask them what they observe.
- » Read the text of box 2 to the group.

After reading the essays (in a future class), select the six students with the most solid, forceful arguments to serve as representatives to the UN for their region and have them present their ideas to the class.

### Tip for the teacher

To enrich the activity, invite a member of an NGO that works on land transformation to come to class to talk to your students about his or her organization’s work.

### Box 2. Children and Youth: Speak Up!

Given the impacts and risks of transformation of the land, public participation should be sought beforehand and the public must be informed and consulted whenever decisions about the land and environmental modifications are made, so that a consensus can be reached.

International forums on participation give citizens a chance to inform themselves and voice their suggestions, opinions, and criticisms. During the 1992 World Summit in Rio, speakers noted that citizen participation is crucial to sustainable development. The Agenda 21 planning document that came out of the summit acknowledged the roles and responsibilities of nine major groups: indigenous peoples, farmers, workers and trade unions, commerce and industry, local authorities, the scientific and technological community, women, nongovernmental organizations, and children and youth.

This last group is open to anyone under 30 who is interested in sustainable development. The document describes initiatives, forums, and contact points in almost every country that give children and young people an opportunity to voice their opinions and participate.

The United Nations’ Food and Agriculture Organization has an Institute for Future Global Leaders, which is the focal point for the children and youth group. Headquartered in Trinidad, the institute helps young people develop their community leadership capacity. The Institute for Future Global Leaders works with several networks, including the newly formed Sustainable Development Network of Trinidad and Tobago (TTSD-Net) and the Youth Forum of Southern NGOs. The TTSD-Net is a “think tank” as well as a forum for young people to combine their resources and abilities to achieve sustainability in their communities.

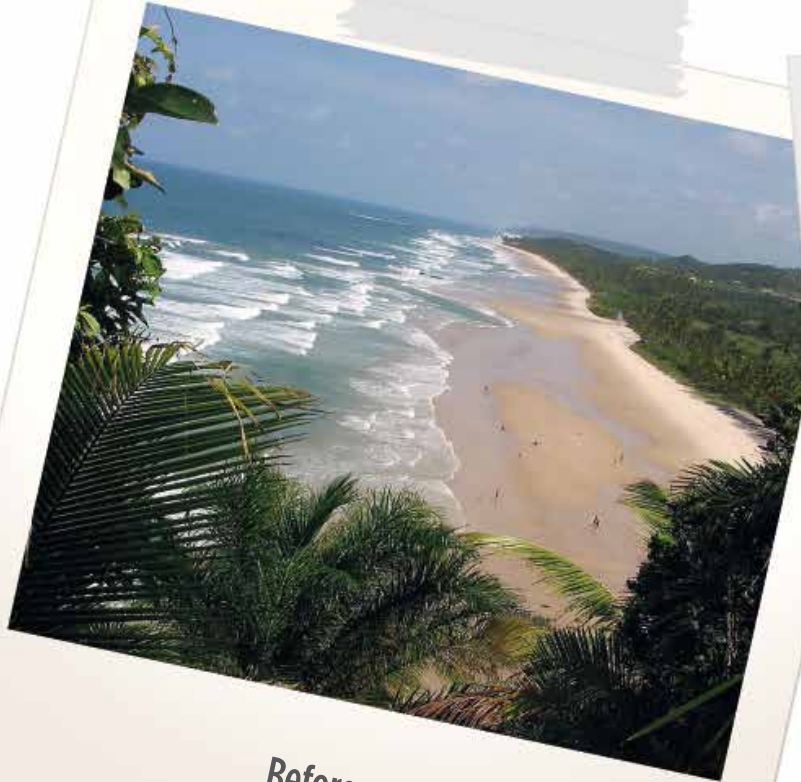
Have your students write an essay on their ideas on possible changes to the local landscape. They should explain the problem, its causes, and possible solutions. They must support their positions and present arguments on pros and cons as if they were UN delegates for their region.

Figure 21. Human alteration of the landscape

### Open pit coal mines in Panama



## Salt mining along the coasts of Mexico



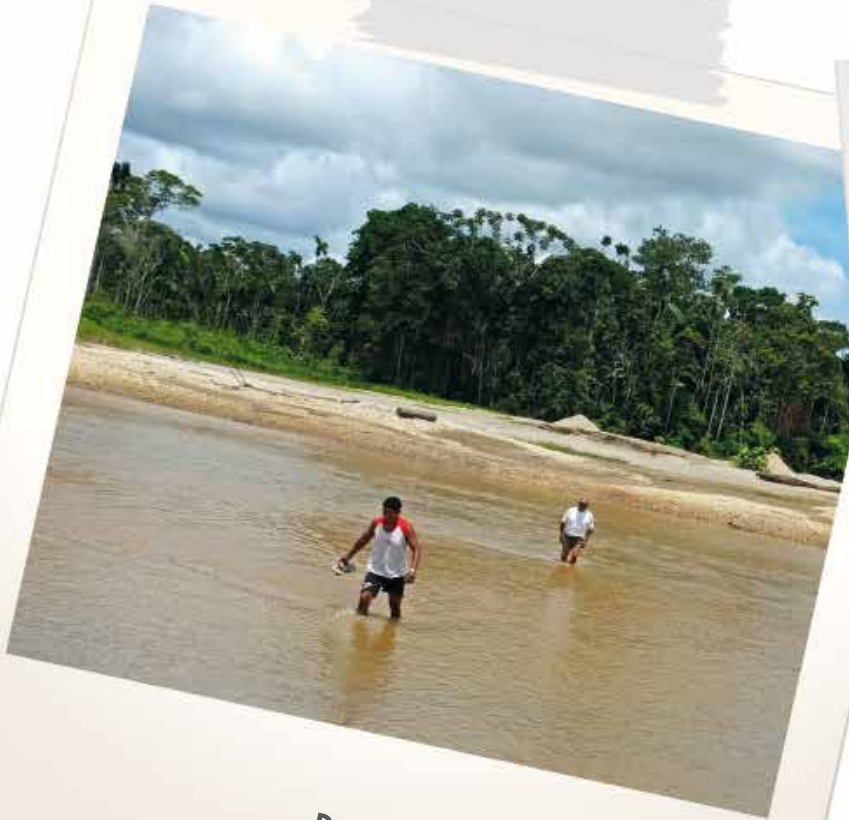
*Before*



*After*



## Open pit gold mining in Peru



*Before*



*After*



## Mexico City overpopulation

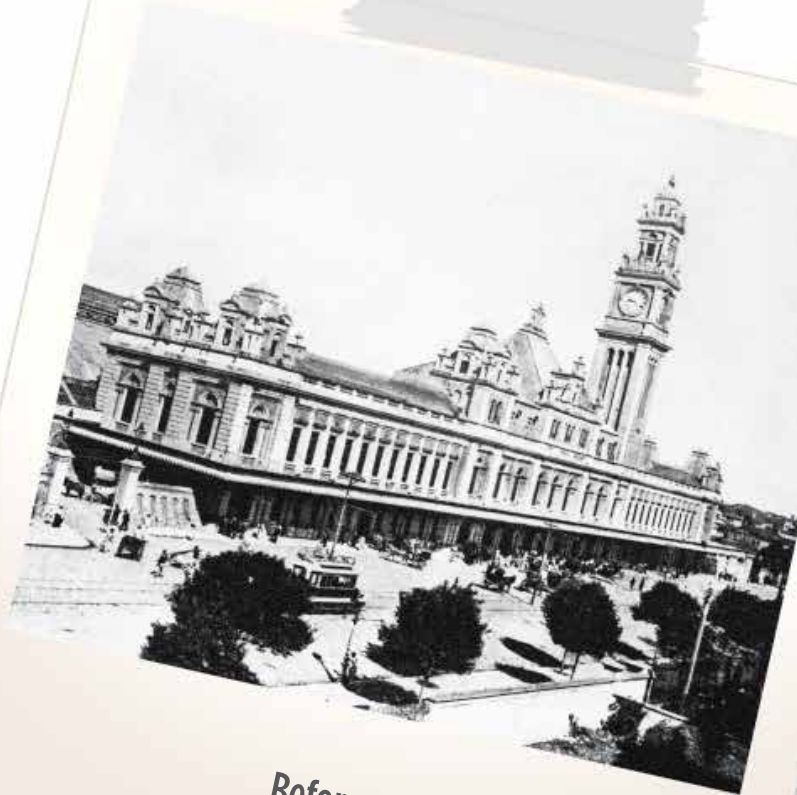


*Before*



*After*

## São Paulo overpopulation

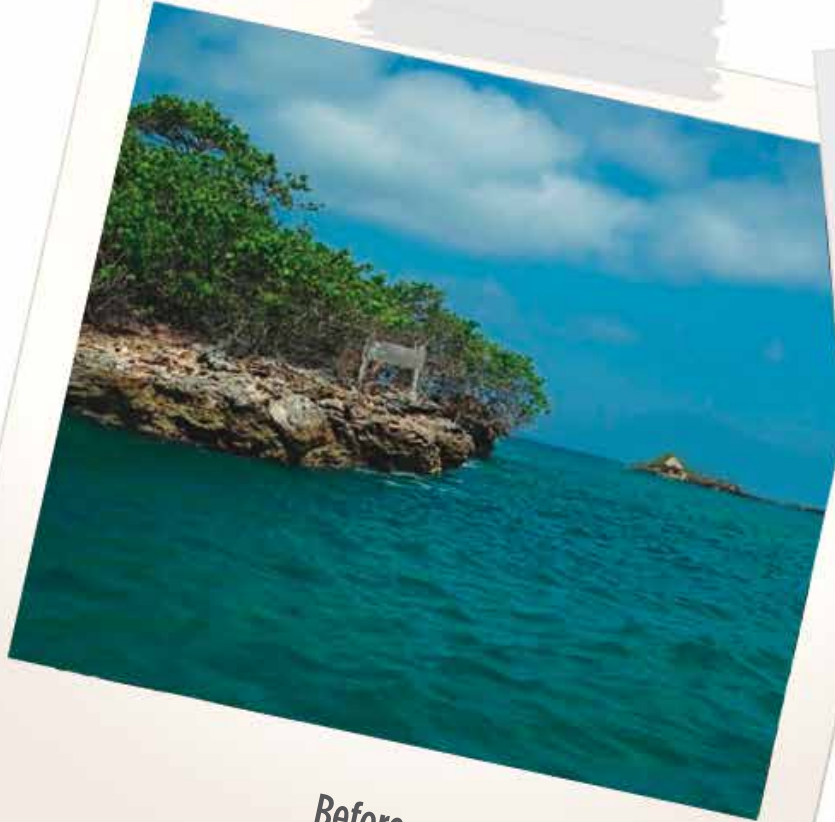


*Before*



*After*

## The Islote in Colombia: A major population explosion



*Before*



*After*

Photo: XibalbaWikiCommons



## Class activity 3: Bird-watching tourism: An alternative way to capitalize on and protect the land

Time	Place	Type
4 hours	Wetland or other local bird-watching site. You may also visit an ecotourism site.	Field trip

### Materials

- » Information about the site you are about to visit and the bird species and natural resources in the area

### Preparation

Contact a bird-watching or ecotourism organization in the area and plan the trip-related details. Ask your students to research bird species, tourist attractions, and natural resources that they will be visiting.

### Step by step

- » Let your students observe the natural resources that the area has to offer.
- » Ask them to look for changes that may have occurred to the land, such as: Are there buildings, information placards, or signs? What are they made of? How and where are they arranged? How is waste management and water and energy use handled in the area (if applicable)?
- » Ask the guides to talk about their work from an educational standpoint.
- » Ask the guides about the quality and quantity of natural resources in the area.
- » Ask your students how natural resources contribute to land preservation.

- » Ask your students to consider the potential for economic development in local communities that are affected by tourism.
- » Supplement the discussion with information from the introduction to this unit.

### Formative assessment

Make sure your students are familiar with the following concepts:

- » Forms of transformation traceable to human activities
- » The economy and development as causes of transformation of the land
- » Wetlands and their functions
- » Types of wetlands
- » Threats to wetlands
- » Ecotourism as a means of protecting the land
- » Biodiversity
- » Agenda 21—Convention on Biological Diversity (CBD)

### Integration with other subjects

- » **Social studies:** Research overpopulation in Latin America and the Caribbean and its influence on the land.
- » **Chemistry:** Research the elements that contribute to local wetland pollution and their influence on health and biodiversity.

### Remember

The decisions we make about land use affect our vulnerability to natural phenomena and can either prevent or promote disasters.

Wetlands—which can be classified as follows: estuarine, coastal marine, fluvial, marsh, and lacustrine—are immensely valuable for producing biomass, including strong construction materials, medicinal plants, fish, fruit, and even materials for the development of biofuels. They also provide recreation and tourism areas of exceptional beauty and abundant opportunities to observe wildlife. One of their most important roles is controlling flooding during the rainy season, and recharging the groundwater system to protect local water supply during droughts.

The most visible threats to wetlands are:

- » Discharge of wastewater from urban centers
- » Illegal fishing
- » Sediment and agrochemical residues from erosion due to agricultural and mining activities in river basin areas
- » Landfills, drying, and drainage to expand the agricultural/urban frontier
- » Decreased water volume and tributaries from disappearing protective forest areas and deforestation of riverbanks, river headwater areas, and watersheds
- » Invasive exotic aquatic vegetation in riverbeds
- » Loss of area and quality of aquatic and other habitats for flora, migratory birds, and biodiversity
- » Forest fragmentation due to roads, irrigation canals, and landfills
- » Piping water from its source and building dykes in the rivers and streams
- » Failure to declare wetlands as protected areas
- » Low levels of environmental awareness and appreciation among people living in microwatersheds
- » Inadequate environmental management by governmental entities responsible for ecological recovery, protection, and sustainable management
- » Climate change.

Alternatives such as ecotourism protect the land and provide the three components of sustainability: economic development for communities, environmental and cultural conservation, and social progress.

## Suggested reading and viewing

- » Comprehensive information on development and the environment in Latin America and the Caribbean is available from the United Nations Environment Programme, [www.unep.org](http://www.unep.org). “Environmental Perspectives: Latin America and the Caribbean” covers the state of the land, biodiversity, air and water quality, and urban issues.
- » The website of the Global Youth Action Network, <http://gyan.tigweb.org/>, deals with youth participation in global debates on sustainable development and climate change. Quotations from people working in these fields can motivate students to participate, volunteer, and lead projects.
- » The SARD Initiative of the United Nations Food and Agriculture Organization, [www.fao.org](http://www.fao.org), showcases young peoples’ roles in environmental decision making.
- » Learn what the signatory countries to the United Nations Convention on Biological Diversity (adopted in Rio de Janeiro in 1992) are trying to achieve with respect to land and diversity and how their decisions affect national land conservation legislation. From the UN website, search on “Agenda 21—Convention on Biological Diversity.”



# 3

## Advanced lesson plan 3: What role does deforestation play in climate change?

### General objective

- » Understand the environmental services rendered by forests and other natural settings, and the major causes and consequences of deforestation worldwide.

### Class activity 1: Debate: Standing forests/cleared forests—which are more valuable?

Time	Place
1 hour 30 minutes	Classroom

#### Materials

- » Copies of “Forests in Latin America” (box 3) or another similar article

#### Preparation

Read the article and the text beginning on page 26. Organize the classroom so that students can work in groups.

#### Step by step

- » Tell the class that you’re going to study forests and their environmental services.
- » Pass out copies of the text in box 3 or a similar text on the history of Latin America’s forests.

- » Discuss the article in class:
  - Were there any words that the students did not understand? Have them look up those terms in the dictionary.
  - What changed the way forests were viewed?
  - Do historical events in your country confirm or contradict the ideas expressed in the article?
- » Write the following sentence on the board: “Forests provide ecosystem services to humans.” Ask your students what that phrase means? Which “services” do forests provide for humans?
- » Restate their ideas and explain that forests quietly and consistently provide us with a series of very helpful “services”:
  - Protection against ultraviolet rays
  - Reduction of GHGs through photosynthesis
  - Protection against storms and floods
  - Erosion prevention through absorption of rainfall
  - Fertile soil formed through fixing nutrients
  - Decomposition and reabsorption of organic wastes
  - Spontaneous species renewal, both animal and vegetable, which provide food, medicines, building materials, and ornamentation
  - Production of rain through transpiration from trees

### Box 3. Forests in Latin America

In many Latin American countries, development policies and legislation have served as obstacles to the preservation of forests. This has happened because historically, some Latin American countries saw forests as antithetical to economic development.

Unfortunately, land titling and ownership laws were disastrous for sustainable forest management. Title regularization policies encouraged the clearing of forests to make the land “productive.” For many decades, laws protected owners who “cleaned up” the land—that is, those who deforested it. In contrast, owners of forested areas, primarily traditional indigenous communities, had no incentive to keep their land safe from external investors who made no commitment to long-term forestry management.

About twenty years ago, many countries began to realize that forest management is a promising alternative for indigenous and rural communities in Latin America. They realized that preserving and managing native forests through rational silvicultural procedures enhances the quantity and value of the forest’s products without compromising its regenerative capacity. This form of management is very important to sustaining plant and animal biodiversity in Latin American forests, and to preserving the forests’ environmental services.

Source: Michael Kiernan, Matthew Perl, Dennis McCaffrey, Robert Buschbacher, and Garo Batmanian. Undated. “Pilot natural forest management initiatives in Latin America: Lessons and opportunities.” United Nations Food and Agriculture Organization ([www.fao.org](http://www.fao.org)).

- » Ask them if they can think of any other services that forests provide?
- » Then ask: “What happens to all these services when humans damage or destroy native forest areas? Can they be replenished or replaced?” Explain that a forest is complex and takes centuries to form. It may never fully recover once damaged.
- » Discuss reforestation efforts with nonnative species or monocultures. Ask them what may happen in these cases? Is this positive? Will these new forests provide the same services as the original forest? Which services may cease to exist? Explain the impact of this type of reforestation on biodiversity and soil fertility. See the unit of the Green School Kit on green areas at [www.iadb.org/riseup](http://www.iadb.org/riseup).
- » Discuss why our societies continue to deforest and develop rationally stated proposals for balancing development needs with forest preservation.

## Class activity 2: Campaign: Protect a biodiversity hot spot

Time	Place
1 hour 30 minutes (2 class periods)	Classroom

### Materials

- » Map of hot spots (figure 22, projected or printed)

### Preparation

Read the text on biodiversity hot spots beginning on page 26.

### Step by step

- » Pass out or project the hot-spot map in figure 22 and explain what a *hot spot* is.

- » Divide the class into eight groups.
- » Ask your students to select one of the eight *hot spots* (see the list in chapter text) in Latin America or the Caribbean and mount a campaign to convince people to preserve

it. Tell them to research their hot spot in books, on the Internet, and in the media.

- » In the next class, collect their hot-spot preservation campaigns and have the groups outline their campaign proposals.

Figure 22. Biodiversity hot spots



## Class activity 3: Nature works for us?

Time	Place
1 hour 30 minutes	Classroom

### Materials

- » Blank maps of your municipality or region (in the largest available size)

### Preparation

Research and draw on one of the maps the areas that provide environmental services to your municipality or region, such as important parks and natural landscapes. Have your students research and bring in relevant information about these areas. Organize the class into groups.

### Step by step

- » Give each group a blank map and ask: “What natural areas have you visited in your municipality?” Think about forests, parks, rivers, waterfalls, and so on. List them in the margin of the map.
- » Locate and draw each site on the map. Then add cities and infrastructure, including roadways, power plants, mines, and factories. The class can use a digital mapping tool if one is available, or a geography textbook.
- » Indicate the types of environmental services that natural areas provided to people living in the municipality, such as drinking water, rainfall, fresh air temperature regulation, biodiversity maintenance, recreation, and so on.
- » Finally, indicate on the map the status of these natural areas. Are they well-kept and clean, or in disrepair and threatened? In the latter case, explain how.
- » Have the groups share their answers with the class.

### Remember

- » When forests are felled or burned to make way for pastures, agriculture, or other forms of land use, this adds to global warming and weakens biodiversity.
- » Forests provide environmental services that we need for sustainable development.

### Formative assessment

After completing this activity, students should be familiar with the following concepts:

- » The environmental benefits or services provided by ecosystems
- » The causes and consequences of deforestation
- » Hot spots
- » Native species
- » The advantages of native species to an ecosystem
- » How nonnative species damage ecosystems

### Integration with other subjects

- » **Geography:** Map deforested areas worldwide and discuss how they transcend national boundaries, introducing the concept of bioregions.
- » **Biology:** Discuss evapotranspiration, soil nutrient fixation, and species regulation.
- » **Communication:** Use the hot-spot preservation campaigns to develop television and radio ads or spots.

### Suggested reading and viewing

- » The website of Conservation International, [www.conservation.org](http://www.conservation.org), has sections on South, North, and Central America, including “biodiversity hot spots.”







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