

# ***FRACTAL*** game

TEAM UP TO SAVE ALPINE ECOSYSTEMS!

# TEACHING GUIDE



**FRACTALgame** is a boardgame that teaches players how green infrastructure can be a game-changer for protecting ecosystems and the ecosystem services they provide. Dear Teachers, this game is for you too!

You can use FRACTALgame to teach students about both sustainability and natural science, as they explore the Alpine region's unique ecosystems. As you guide them through the game, students journey through the ecosystems that form the Alpine landscape and learn about the ecosystem services they provide that are fundamental to the survival of our Alpine valley communities.

While playing the game, you'll also be able to introduce your students to green infrastructure. You will help students understand the capacity of human communities to impact ecosystems, either undermining their functions or protecting them, according to the choices a community makes about its future.

In this Educational Guide, we'd like to give you some useful information to help you engage your students in the game and maximize their learning and educational outcomes.

**GAME TIP:**The gameboard represents a typical Alpine landscape and highlights some familiar features that we might see from our windows or on a walk outside of town. The ecosystems pictured on the gameboard are mountain forests and grasslands, alpine lakes and rivers, high altitude alpine peaks, and agricultural and urban ecosystems. Use the gameboard to help students reflect on the environment and its ecosystems! Review the illustrations and discuss what a natural or semi-natural ecosystem is and identify biotic and abiotic factors and their place in the food web.

## **WHAT SUBJECTS CAN I INTRODUCE USING THIS GAME?**

FRACTALgame features many scientific concepts, both in its illustrations and in its structure. We're certain you'll have no trouble putting the game to good use in your classroom, but if you'd like additional inspiration here are a few suggestions.

The game is centered on the Alpine landscape, which can be compared to a jigsaw puzzle made of numerous natural and semi-natural ecosystems.

**Ecosystems are defined as a geographic area where abiotic, or non-living, elements (like water, soil, and climate) and biotic, or living, organisms (such as trees and animals) interact with each other to form an energy and nutrient cycle that enables the ecosystem to sustain itself over time in its environment.**

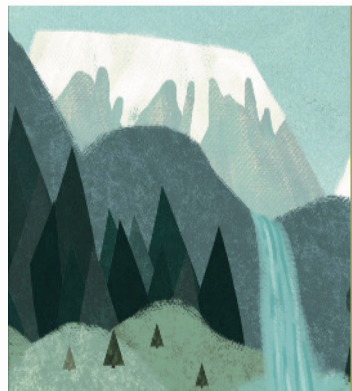
No ecosystem is isolated. Rather, each ecosystem interacts with nearby ecosystems, and impacts and is impacted by humans, both positively and negatively.

**GAME TIP: The game's collaborative aspect serves two primary functions:**

- 1) to develop players' ability to cooperate,**
- 2) to show them the importance of working together to plan a comprehensive and coherent GI network that can successfully**

There are many different types of ecosystems. According to their level of naturalness, they can be divided in three major groups: natural, semi-natural, and artificial ecosystems.

**Natural ecosystems** are those that existed before the invention of agriculture. These include old-growth forests, peatbogs, high altitude mountain biomes, oceans, and lakes and rivers that haven't been altered by humans. While human activities can disturb these ecosystems, they are highly resilient and able to restore themselves if the disruption was not excessive, and if the forces that caused the damage are no longer present.



**Semi-natural ecosystems** are those that have been moderately modified by humans in the last 10,000 years, primarily through pasturing livestock and harvesting biomass. These semi-natural habitats include lowland and upland hay meadows, and moorland and grassland plains in steppe biomes. Nearly all semi-natural ecosystems are maintained through traditional and extensive soil cultivation.



**Artificial ecosystems** are those that are fundamentally transformed by human activity, such as draining wetlands, intensive farming, and constructing infrastructure and buildings. Key examples of these ecosystems are intensively cultivated cropland, urban areas, and some types of “forests,” such as monoculture eucalyptus and conifer plantations. In general, these ecosystems have a low variety of species and can benefit from restoring natural elements.



The relationships between an ecosystem’s myriad elements constitute the processes that generate its various ecological functions. If we assume that an ecosystem’s functional biodiversity corresponds to the complexity of the interactions between its elements, that is, the number of paths along which energy flows through a community, then altering biodiversity (by direct and indirect factors, including disturbing the environment) alters the ecosystem’s delicate balance, reduces its functionality, and can lead to its disappearance.

When they are functional, ecosystems sustain humanity in many ways through Ecosystem Services (ES), the benefits and services that a healthy ecosystem provides human communities simply by existing and functioning.



**WELLBEING**

**PROVISION**

- Wellbeing
- Cultural identity  
aesthetic experience
- Sports and place for  
your free time
- Food and drinkable water
- Raw materials and  
medicine
- Energy

**REGULATING**

**SUPPORTING**

- Pollinators and fighting  
alien species invasion
- Regulation and defense  
from erosion and  
landslides
- Climate, water and  
fresh air regulation
- Biodiversity and  
habitats
- Biogeochemical cycles  
and soil
- Photosynthesis

There are three main categories of ecosystem services, along with a fourth ES category that sustains all the others. The various ES are illustrated in the cards and on the gameboard.

Ecosystem services that support life are the foundation for all the other ecosystem services. These Supporting ES include nutrient recycling, soil generation, photosynthesis, and habitat and species diversity. Among these, biodiversity holds a place of honor. Biodiversity means both functional diversity (the role a species plays in an ecosystem) and species diversity, which is directly related to environmental quality, and therefore benefits all the organisms that depend on the ecosystem’s functions.

Consequently, the more diverse an ecosystem, the more it can adapt to changes and the less fragile and vulnerable it is in the face of disruptive events.

Regulating ES include climate regulation, water purification, oxygen production, erosion control, landslide disaster prevention, invasive species control, and pollination. Provisioning ES are ecosystem services that provide food, raw materials, clean drinking water, energy, and even medicines.

Lastly, Cultural ES refer to values and benefits such as aesthetic beauty, recreation, education, spiritual and creative stimulation, cultural identity, and tourism that ecosystems can offer us.

**GAME TIP: The gameboard and cards illustrate different types of services that ecosystems provide.**

**For example, woodlands and forests are natural systems that provide a wide array of ES (regulating, provisioning, and cultural), including producing timber and other “forest ecosystem goods” (fruit, edible mushrooms, truffles, etc.), soil generation and retention, biodiversity conservation, recreational enjoyment of the landscape and tourism, carbon sequestering (which helps mitigate climate change), and absorption of Particulate Matter (PM) and other air-borne pollutants.**

An ecosystem’s elements, processes, and functions are the drivers of its ecosystem services. ES are valuable to society because they provide a region’s inhabitants with both direct and indirect benefits that are irreplaceable. Often, we aren’t aware of these intricate connections, and we underestimate the mid- and long-term effects that our actions and decisions have on ecosystems and, consequently, on our health and well-being. ES are highly interconnected. Look how many strong connections there are between the different ES these ecosystems provide!



As you can see, ES are very important because they influence and sustain human life and well-being by improving health, giving access to raw materials, providing sustenance, sustaining local economies, and so on.

They are so important that sometimes we even calculate their economic value! A region that has a high level of ES means it is “richer” per person in terms of natural capital. It is also less vulnerable to threats and disasters and its territories are healthier and resilient.

When ecosystems are altered, which is often caused by our economic, political, social, and personal choices, their functions are modified, often leading to increasing dysfunction, and the consequent loss of related ES. This effect isn't immediately obvious, making it hard to understand how and to what extent a decision we make today can have a negative impact on our region. Likewise, it's difficult to imagine when this outcome will materialize. In the past, we didn't always keep this principle in mind. In fact, it wasn't until 2005 that people began discussing ES on a global level. Since then, the concept of ES is still lagging in how we manage our region's territorial resources, and very few of our citizens are even aware of it. Protecting ecosystems and supporting their ES is critical for a prosperous and healthy future, but how do we do it?

In addition to being aware of the existence of ES, we can support healthy ecosystem function through **Green/Blue Infrastructure (GI)**. GI refers to a range of natural and artificial structures that specifically support certain ES, or that reconstruct or restore an ecosystem's damaged or compromised elements to help it function efficiently again.



One example of GI that directly supports an ES is a **pollinator garden**, with flowering plants, shrubs, and even trees that attract wild bees and other types of wild pollinators.

You can think of this type of GI as a support network for pollination and biodiversity.

**An example of GI that rebuilds an ecosystem is river re-naturalization, which involves planting aquatic species, and widening and re-wilding a waterway's banks.**

This allows rivers and their banks to return to a more natural state, restoring their biodiversity and consequently the functioning of the riparian ecosystem.

GI strategies can be implemented in every ecosystem, whether natural, semi-natural, or artificial, creating tangible benefits for ecosystems, making them more functional and more resilient to the effects of climate change.



**GAME TIP:** Using the two decks of cards, you can introduce both green infrastructure (GI) and ecosystem services (ES) to your students! The players' deck features a series of cards representing GI strategies that can be implemented in different Alpine ecosystems. Each GI Card also includes the ES that it supports or restores. The players' deck also includes ES Cards that you can use to discuss with students the different ES that each ecosystem provides.

**Note:** Due to space considerations, the ES Cards simply use an icon to represent each ecosystem service. You can find the complete description of each icon in the legend at the end of this Guide.



It may seem odd, but even Alpine ecosystems are heavily threatened by human activities (soil degradation, excessive tourism, intensive monoculture farming) and by climate change.

As they play FRACTALgame, players collaborate to effectively counter the negative impact of problem events on ecosystem functionality, and the related loss of ES benefits for our communities.

Using the GI/Management Cards, players can curb these negative effects. Enhancing the GI network across the region is a task that involves individuals and the whole community, through personal choices and collective actions. To fully reverse the damage and restore full ecosystem functionality, players also need the ES Cards. But time is of the essence: as ecosystems stop functioning, their services disappear at an exponential rate...

With this worksheet, you can explore how each of the green infrastructures of the solution card deck works so you can learn more about the scientific aspects of the game and discover that some green infrastructure practices can be within everyone's reach.



**Forest rewilding:** it is helpful to improve the diversity and stability of forests that have been excessively infrastructured or intensively cultivated. It fosters increased biodiversity of species and habitats, enhances the resilience of forests to extreme weather events and invasive alien species, and makes the Alpine landscape more diverse and pleasant.



**Green and Animal Corridors:** green infrastructures that can be implemented both in urban environments and in forests or mountains where anthropogenic pressure is high. These green infrastructures help improve connectivity in forests crossed by many forest roads, ski slopes, or downhill tracks, providing both refuge areas and safe spaces for the movement of wildlife, both large and small. They also help enhance ecosystem services related to regulation and provisioning.



In urban or peri-urban contexts, they are structures with trees and shrubs, often but not always elevated, that allow animals to move safely without invading roads and risking involvement in accidents with motorists. Thus, they are useful in increasing ecosystem services that support biodiversity and human well-being.



**Biodiverse mini-forests:** are wooded areas where plant species diversity is maintained really high, featuring many shrubs, trees, and flower cushions. These groves are maintained intact and provide a valuable refuge habitat for many species of small animals and wild pollinators. They are particularly valuable in cultivated forests or among intensively used pastures. They enhance ecosystem services that support biodiversity, photosynthesis, microclimate regulation, and cultural and psychophysical well-being.



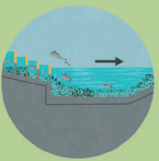
**Reforestation:** restoration for mountain slopes made fragile by excessive infrastructure such as ski slopes and roads, or by excessive timber exploitation. Native tree species are planted for slopes stabilization and consequently to support the ecosystem service of regulation and protection against landslides. Additionally, it increases plant and animal biodiversity, enhances the ecosystem service of carbon sequestration, and regulates the local microclimate.



**Phytodepuration:** These are small ponds with plant species suitable for filtering organic substances such as nitrogen and phosphorus, specifically developed, often next to barns, to function as filters for organic pollutants. They help ecosystems better perform or restore the service of filtration and management of biogeochemical cycles and can also provide refuge spaces for some animal species, as well as play a role in regulating the local microclimate.



**Rewilding Streams, Rivers, and Lakes:** areas of streams, rivers, and lakes that are freed from embankments, roads, and water regulation structures and restored to as natural a condition as possible. This involves reintroducing vegetation, diversifying the riverbed, and partially restoring spaces to naturally contain floods through meanders and river islands. This leads to an improvement in the ecosystem service of regulation, particularly for floods and water quality, and supports biodiversity.



**Fish ladders:** artificial structures built in watercourses heavily impacted by retention structures and small hydroelectric plants. They are actual ladders designed to help fish move along the watercourse. Often, these structures are complemented by rewilded riverbed areas, thereby promoting the overall biodiversity of the watercourse.



**Agroforestry and Organic Farming:** agricultural practices that aim to adopt more diversified approaches similar to ecosystem conditions. Specifically, **agroforestry** involves the use of perennial tree and/or shrub species, combined with crops and/or pastures, within the same land unit. The objective of this practice is to promote the sustainable use of natural resources. Organic farming is defined in many ways and sparks much discussion both scientifically and politically. In this context, we refer to **organic farming** as practices that respect the soil, the diversity of native species, and aim to cultivate with greater attention to seasonality and quality (rather than just quantity) of products. Both practices have proven very useful for enhancing ecosystem services supporting biodiversity, regulating pollinators, and consequently providing high-quality food supplies. Additionally, they have been beneficial for soil health and for regulating the biogeochemical cycles of nitrogen and phosphorus.



**Reduced Mowing:** Reducing the mowing of wild grass in gardens, urban or peri-urban areas, and agricultural areas helps the flourishing of a network of useful spaces for pollinating insects and small species of reptiles and mammals. Another positive effect of delaying or reducing mowing is the increase in herbaceous biodiversity. This practice is beneficial for the ecosystem services of supporting biodiversity, regulating pollinators, and consequently providing high-quality food supplies.



**Small ponds/lakes:** building or maintaining small ponds or inter-farm channels located between fields creates a network of aquatic infrastructures that can be very useful as they can provide new habitats or serve as refuge areas for various species, thereby aiding biodiversity. They play a significant role in regulating the local microclimate and act as water reserves.



**Vegetated buffer strips:** An increase in the abundance of hedges and trees is a practice that leads to the establishment of a veritable network of green infrastructures. The presence of shrubs and trees between crop fields helps soil health, provides habitats for some insect species and many wild pollinators, provides shelter for various birds and micro mammals, and can also be useful in increasing soil moisture and regulating the cycle of certain nutrients in the soil.



**Depaving:** removing pavements from urban areas to facilitate soil permeability and enable the growth of vegetation, thus positively acting on the regulatory and support ecosystem services that have to do with soil and its health as well as encouraging the growth of plants and thus reducing heat clouds in the city.



**Urban parks/green belts:** green spaces of different extents and variously connected. These gardens contain many shrub species and trees that are able to improve the ecosystem service of microclima regulation. They also provide habitats for several birds and mammals, improve the ecosystem service of wellbeing, offer spaces for sport and relax, and the uptake of CO<sub>2</sub> in urban areas.



**Pollinator gardens:** in public or private green areas is favoured to plant indigenous species of flowers that are more attractive to wild pollinators. They are often species that are flowering several times during the year or that flower at different times to prolong the period in which flowers are present to feed pollinating insects. A network of small pollinator gardens can be important in improving the ecosystem service of pollinator regulation and thus the ecosystem service of food supply.



**Rain gardens:** parts of gardens (private and public) or public spaces where hygrophilous species with high drainage and filtering power are planted. In some cases under rain gardens there are puddles for water storage. They are very useful green infrastructures in an urban context where they are useful for the ecosystem service of regulating floods or extreme climatic events as well as providing habitats for certain species of insects.

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