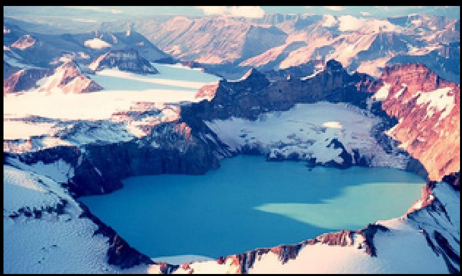
ECOLOGICAL BALANCE

CATEGORY GUIDELINE

Introduction

Ecology is a field that examines the relations of living things with each other and with the environment. The studied environment, the ecosystem, is dynamic and balanced in itself. In the Ecological Balance sub-category of the BioGate Competition, participants have the chance to closely examine this change in the ecosystem: Volcanic eruption and ecosystem harmony. There are many examples of the relationship between volcanic eruptions and ecosystems in history. Volcanic eruptions, which were also effective in the formation of the Earth, appear as a destructive force in our scenario. The scenarios about how the post-eruption process proceeds are endless. How the scenario will progress is completely left to the participants. The more original results the participants fill this free workspace with, the more points they will get and will have the chance to benefit from our surprise prizes and events.

Previous Eruptions



Katmai- Alaska

JUNE 6 ,1912

(VEI) 6

One of the most remarkable volcanic eruptions of the 20th century happened in the Alaskan region of the United States. The eruption of Novarupta Volcano in 1912 discharged ash and tephra clouds up to an altitude of 60 km. Over 160 km away, on the ground in Kodiak, more than 30 cm of ash accumulated. This eruption resulted in the formation of a valley named "Valley of Ten Thousand Smokes." Currently, the caldera resulting from this volcano lies within the Katmai National Park.

Krakatoa (Krakatau) - Indonesia

MAY 20, 1883

(VEI) 6

On 27-28 August 1883, the Krakatoa Volcano in Indonesia performed a large Plinian eruption. A powerful eruption was followed by tsunamis up to 30 meters and the injection of ash and gases into the atmosphere, the results of which were felt throughout the world. The island of Krakatoa disappeared but gave birth to new volcanic islands. This explosion was one of the loudest that has ever been registered, and its sound waves were audible around the world.

Previous Eruptions

Mount Tambora-Indonesia

APRIL 10, 1815

(VEI) 6

The 1815 eruption of the Tambora Volcano in Indonesia was possibly the greatest one in the history of mankind. This event, which is considered to be an Ultra-Plinian eruption, is among the most powerful explosions in history. The volcanic eruptions produce the ash clouds of hundred kilometers and the global climate changes greatly. It brought on the global cooling period known as the "Year Without a Summer" in 1816 and killed up to 71,000 people.

Mount St. Helens - USA

MAY 18, 1980

(VEI) 5

In 1980, the eruption of Mount St. Helens, situated in the state of Washington, USA, was caused by a 5.1 magnitude earthquake and resulted in a lateral blast. The eruption culminated in the failure of the summit followed by wide area spread of pyroclastic flows and ash clouds. The disaster killed 57 people and damaged 600 square kilometers to a severe level. This VEI 5 eruption was recorded as one of the most destructive volcanic catastrophes in recent times.

Previous Eruptions

Mount Pinatubo - Philippines

The lahars formed as a result of the eruption.

JUNE 15, 1991

(VEI) 6

In 1991, the Pinatubo Volcano located in the Philippines, released an impressive Plinian eruption. As a result, the environment changed dramatically due to the ash and gases that were ejected up into the atmosphere. This eruption was one of the largest in the modern era with lahars developing around the Pintaubo Lake, and the whole planet climate deterioration with global temperature decrease by 0.5 °C. The scientists evactuated people in the areas of the warning the day before the outburst.

Thera

1600 BC

(VEI) 7

The big eruption of Santorini almost 3,600 years ago was a catastrophe with a Volcanic Explosivity Index (VEI) of 6-7. The volcanic eruption saw the island being submerged underwater and it was followed by widespread pyroclastic flows and massive tsunamis. The volcanic eruption brought an ash cloud that had an effect on areas such as Asia, Egypt, and Turkey. The leading maritime trading community of the time, the Minoans, vanished completely from history, and around 30,000 people died in this devastating event. The Santorini volcano, which is still active, symbolizes as a warning that the area is not safe yet.

What do we expect?

Our expectation of the competitors is that making comprehensive analysis and interpretation of the crucial volcanic eruption with using scientific research. Effects of supervolcanic eruption should be analyzed from micro to global scales. Furthermore, while considering the effects of volcanic eruption, changes in ecosystems and the evolution process should be discussed.

Ecological Balance

Volcanic eruptions may initially sound unfavorable, but in nature, there is not inherent concept of good or bad. Volcanic eruptions have played a significant role in shaping the Earth from ancient times to the present. Every natural event is essential to maintaining ecological balance. volcanic eruptions that were considered as an instance of destructive force trigger a chain reaction felt throughout the entire ecosystem. As with any natural occurrence, following a volcanic eruption, the ecosystem inherently adapts and strives to reach equilibrium over time. What significantly matters and is noteworthy lies in the process of achieving this equilibrium. It provides us with insights into the inherent nature of ecosystems, offering a light for the future.

Location Value

Since this region is a subduction zone, it is one of the regions where major volcanic eruptions and major earthquakes occur. Additionally, due to its location, it has different ecosystems and diversity of living things. Various models of the Toba volcano, which was claimed to have erupted before, are available today. In addition, discussing the scenario of experiencing a similar explosion in our current world, which is claimed to have occurred in the past, is intended to be a guide for possible explosions in the future.

Volcanic Eruption Case

The competitors who will participate in the ecological balance stage of the BioGate Competition will discuss the volcanic explosion scenario provided in the (2.7861° N, 98.6161° E) region while adhering to scientific sources. The aim is to predict the potential effects of a large-scale explosive volcanic eruption while discussing the changes undergone by local and global ecosystems and the ecological balance process.

Pre-Eruption Phase

Months before the explosion, the precursors of the disaster began to unfold, indicating that the region was on the brink of a catastrophe. An increase in pressure in the magma chamber had led to ground deformation and a rise in seismic activity. Frequent earthquake swarm occurrences were clear indicators of movement beneath the surface, signaling the dynamic shifts in the magma chamber beneath the region. In addition to these changes, large cracks and fissures had emerged across the terrain, and the density of gases emanating from fumaroles had intensified.

Eruption Phase

A volcanic eruption with a Volcanic Explosivity Index (VEI) in a range of 7.4 to 7.7 signifies an extremely large and catastrophic event. Additionally, the magma chamber is very close to the surface, the magma reservoir beneath the volcano is situated at a shallow depths. This proximity can contribute to the intensity of the eruption, as the magma doesn't have to travel far before reaching the surface. In the case of an eruption, we are dealing with a colossal event involving the release of around 1,000 cubic kilometers (km^3) of volcanic material.

This eruption leading to the formation of a towering eruption column or plume can over 35 kilometers in height. The release of volcanic gases would accompany the massive release of ash, pyroclastic falls,flows,surges and other volcanic materials into the atmosphere. Additionally, the release of volcanic gases and ash can have complex and sometimes contrasting effects on atmospheric temperature, depending on their interactions with the atmosphere.

Post-Eruption Phase

After months of eruption, the ecosystem underwent significant transformations. The ejected materials and pyroclastic fall and flows leave a profound impact on both terrestrial and aquatic ecosystems in the vicinity of the volcano, leaving lasting traces even in areas tens of kilometers away. Temperature, atmospheric events, and other changes influence climate. Additionally, diminishing resources lead to repercussions on the food chain and biodiversity. After specific chain reactions, the eruption subsides, and the ecosystem enters a phase of recovery. While nature strives to restore balance and tolerate eruptions, the ecosystem still experiences changes. Eventually, through losses and gains, ecological equilibrium is achieved.

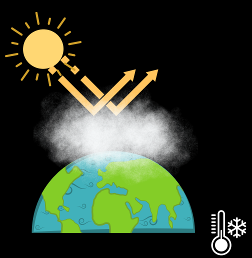
After Volcanic Eruption

A pyroclastic flow descended rapidly from the volcano's summit, incinerating everything in its path with a deadly mixture of gas, ash, and volcanic debris.

Triggered by the volcanic eruption, a towering tsunami surged across the ocean, devastating coastal communities miles away.

Thick ash fall blanketed the surrounding regions, turning day into night and causing widespread respiratory issues.

The eruption's far-reaching effects disrupted global supply chains, leading to shortages and economic instability worldwide.



The massive amount of volcanic ash released into the atmosphere had significant climate effects, acted as aerosols and caused cooling global temperatures for years

DISCUSSION

Ecological changes and consequences of the eruption:

1. Discuss how atmospheric changes and volcanic gasses affect the terrestrial ecosystem and biodiversity after the eruption.
2. Discuss how atmospheric changes and volcanic gasses affect the aquatic ecosystem and biodiversity after the eruption.
3. Identify the advantageous and disadvantageous species living in the land habitat in terms of the changing environmental conditions after the eruption and explain your reasons.
4. Identify the advantageous and disadvantageous species living in the aquatic habitat in terms of the changing environmental conditions after the eruption and explain your reasons.

Chemical changes and consequences of the eruption:

1. Discuss the effect of volcanic gasses on the chemical composition in the atmosphere.
2. Discuss the effects of volcanic ash and pyroclastic flows released during the eruption on soil chemistry.
3. Discuss the chemical effects of volcanic gasses and atmospheric changes on water resources.
4. Discuss the temperature variation and impacts of this volcanic eruption on global and regional temperatures.

DISCUSSION

Geological changes and consequences of the eruption:

1. What chemical properties do the new rock types formed by the cooling of lava and other volcanic materials have?
2. Discuss the effects of pyroclastic flows and lava flows on the geological structures of land and sea.
3. Discuss what volcanic eruptions are able to change in the structure of the earth's crust

Extra Challange:

1. Discuss what the interactions between volcanic activities and human activities are and how these interactions can be managed.
2. Discuss what are the methods of predicting volcanic eruptions and how the reliability of these methods can be increased.
3. Discuss the geological evolutionary process of the area that volcanic eruption has occurred.
4. Discuss how volcanic gasses cause climate change and global warming.
5. Discuss the role of volcanic ash and aerosols from volcanic eruptions in solar radiation management and their potential impact on global warming

DISCUSSION

Our visual presentation expectations:

1. Model the ecological succession of the environment where the eruption took place and the volcano's mouth throughout the process.
2. Design a map showing the geological changes that took place in the explosion area and their effects.Also consider the human factor in the map.
3. Based on the weather conditions you entirely created, model the weather before and after an explosion.

What Do We Expect?

MORE DETAILS ABOUT THE MODELS

- **Model the ecological succession of the environment where the eruption took place and the volcano's mouth throughout the process.**

The first visual request includes displaying the stages of the aquatic and terrestrial ecosystems in the region where the eruption occurred, as well as the life forms at the volcanic crater, from their ordinary state to process to reaching their stabilized state after the eruption. When analyzing the ecological succession in the area, we should survey the process, which involves observing the dynamic changes in living organisms, their ability to adapt to new conditions, and the modifications in the food chain. Contestants should resort to multiple maps, graphs, and diagrams to gain a wider perspective

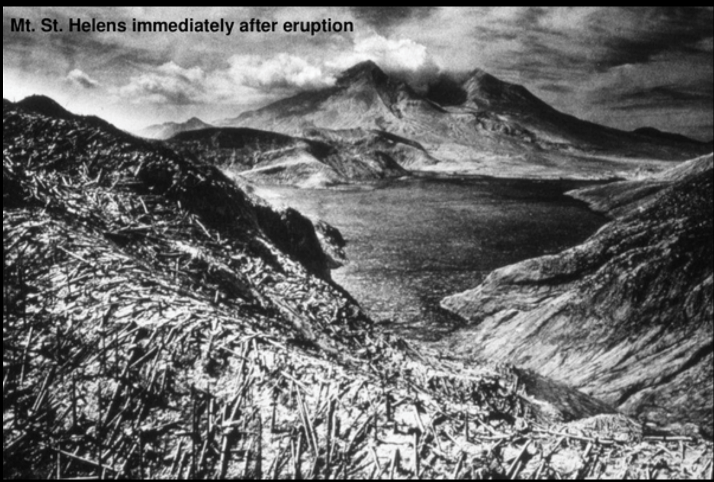
- **Design a map showing the geological changes that took place in the explosion area and their effects. Also consider the human factor in the map.**

The second visual request is to have participants construct a model map that has three zones that represent the origin of the eruption and the influence area. The map should show both during and after the eruption, with the locations of pyroclastic deposits, lava, pyroclastic flow, lava flow, lahars, and toxic gases shown. To assist in explosion cases, the map must include the data on evacuated points and evacuated people.

- **Based on the weather conditions you entirely created, model the weather before and after an explosion.**

Participants will simulate weather conditions before and after a volcanic eruption under specific atmospheric conditions. First, they will select and define the initial atmosphere with parameters like temperature, rainfall, wind speed, and humidity. Then, using these conditions, they will create a model with graphs showing thermal changes, precipitation, and wind speed. After the simulated eruption, they will analyze the resulting atmospheric changes using the same parameters.

Ecological Succesion



- Ecological succession is a series of predictable sequential changes following a disruptive force. Over time, certain species die out, and new species emerge. The number of species fluctuates throughout the succession process. Volcanic eruptions can create new areas or restrict existing ones, influencing the availability of resources.

- The dynamics that unfold as a consequence of the colonization of a previously unoccupied area by new species are referred to as primary succession. For instance, the eruption of a volcano, such as Mount Saint Helens in Washington, eradicated all living organisms in its vicinity. This eruption ignited the initial stages of a transformation that would span centuries.

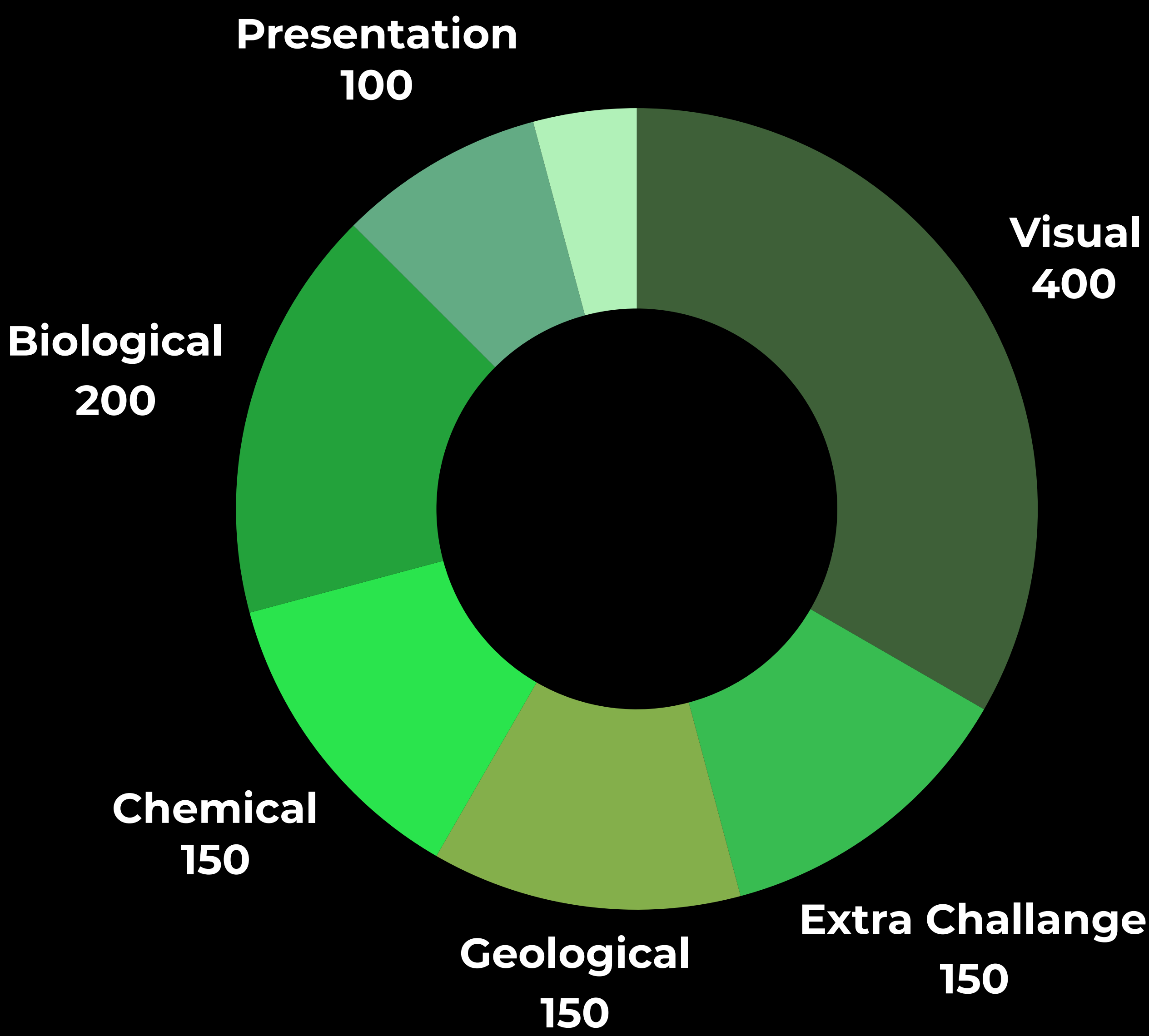
- Species that first establish in these areas, where no ecological communities previously existed, are termed pioneer species. Among the ecological pioneers that thrive on bare rock surfaces are lichens and certain grasses

- Lichens are a type of organism based on a mutualistic relationship between fungi and algae. Over time, lichens convert atmospheric nitrogen into useful forms or fix it. Additionally, their ability to break down (collapse)rocks and create new forms is beneficial to other organisms."

- At times, destruction may not obliterate all existing communities entirely. In such cases, secondary succession occurs. It progresses more rapidly than primary succession because only the community is disrupted without soil structure being compromised, enabling swift regeneration of new and surviving vegetation

- Secondary succession typically occurs after an uncontrollable event such as a wildfire, hurricane, or another incident. While we may perceive such events as disasters, many species possess the adaptability to cope with them.

Evaluation Chart



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