**Lesson 1: Natural Disasters of the World**

Are you ready to become a scientist over the next few weeks? Get ready to strap in and dive into the fascinating world of extreme weather conditions and natural disasters! We're going on an exciting journey to learn all about these incredible **phenomena** that shape our planet. Get ready to be amazed and inspired as we explore the forces of nature and the scientists who study them. Get ready to uncover the mysteries of hurricanes, earthquakes, tornadoes, and more. It's going to be an adventure like no other! So, buckle up for a thrilling expedition into the world of extreme weather and natural disasters!

**Natural disasters** are events that occur due to natural processes of the Earth, causing significant damage to life, property, and the environment. These disasters can strike with little warning, leaving communities **devastated** in their **wake**.

Understanding the major categories of natural disasters and the **crucial** role scientists play in predicting and **mitigating** their impact is essential for safeguarding lives and property. They can be categorised as:

* Geological events
* Meteorological events
* Hydrological events
* Biological events

Some natural events fit into two categories, such as floods- these are considered meteorological events and hydrological events.

**Geological events:**

One major category of natural disasters is **geological** events, which are caused by movements within the Earth's crust. Earthquakes, for instance, occur when tectonic plates shift along fault lines, releasing **seismic** energy. This sudden release of energy can result in the shaking and fracturing of the Earth's surface, leading to widespread destruction of buildings and infrastructure. Volcanic eruptions are another geological disaster, involving the eruption of molten rock, ash, and gases from beneath the Earth's crust. These eruptions can cause significant damage to nearby communities, as well as pose hazards such as lava flows, pyroclastic flows, and volcanic ash fallouts.

**Meteorological events:**

**Meteor**  is a Greek root meaning something from the Earth’s air/atmosphere. Another category of natural disasters is **meteorological** events, which are caused by atmospheric processes (weather conditions). This includes hurricanes, tornadoes, floods, and droughts. Hurricanes, also known as typhoons or cyclones depending on the region, are powerful tropical storms characterised by strong winds, heavy rainfall, and storm surges. Tornadoes, on the other hand, are violent rotating columns of air that extend from thunderstorms to the ground, causing destruction along their path. Floods occur when **excessive** rainfall, snowmelt, or dam failures result in the overflow of water onto land areas. Droughts, on the other hand, are **prolonged** periods of low rainfall, leading to water shortages and agricultural impacts.

**Hydrological events:**

**Hydro** is a Greek root meaning ‘water’. **Hydrological disasters** are yet another category, primarily involving water-related events. This includes tsunamis, landslides, and avalanches. Tsunamis are large ocean waves generated by underwater earthquakes or volcanic eruptions, **capable** of causing **widespread** **devastation** along coastal areas. Landslides occur when masses of rock, earth, or debris move downhill, often triggered by heavy rainfall or earthquakes. Avalanches, meanwhile, are rapid flows of snow down steep slopes, posing significant risks to mountainous regions and communities.

**Biological events:**

The root "bio" comes from the Greek word "bios," which means "life." In English, it is commonly used as a prefix to form words related to living organisms, biology, or the study of life. **Biological** **disasters** are another type, involving outbreaks of diseases or infestations of pests. **Pandemics,** an outbreak of a disease that occurs over a wide geographic area, is an example of a biological disasters. For example the COVID pandemic, causing widespread illness and death among populations. Pest infestations, such as locust swarms **devouring** crops, can also have devastating impacts on agriculture and food security.

**The Role of Climatologists:**

Climatologists play a crucial role in understanding and predicting natural disasters, particularly those related to meteorological and hydrological events. Climatology is the scientific study of climate, weather patterns, and atmospheric conditions over time. Climatologists utilise a range of tools and techniques to analyse data, develop models, and make predictions about future climate trends and extreme weather events.

One essential tool used by climatologists is **remote sensing**, which involves the collection of data from satellites and other aerial platforms. Remote sensing allows climatologists to monitor changes in the Earth's atmosphere, oceans, and land surfaces, providing **valuable** information for predicting weather patterns and identifying potential hazards. For example, satellites can track the formation and movement of hurricanes, enabling early warnings to be issued to at-risk communities.

**Lesson 2: Earthquakes: the largest on record**

Earthquakes, the powerful shaking of the ground caused by movements in the Earth's crust, are fascinating natural events that scientists study closely. But how do they measure something as big and strong as an earthquake? Let's find out!

**Seismometers:** Detecting Earth's Tremors

Scientists use special instruments called seismometers to detect earthquakes. These instruments can feel even the tiniest movements of the ground. Think of them like super-sensitive detectors that can pick up the Earth's vibrations.

Once an earthquake is detected, scientists use a scale called the Richter scale to classify its size. The Richter scale gives a number to show the **magnitude** (or how powerful) the earthquake was. The bigger the number, the stronger the earthquake. It's like giving a grade to how big the earthquake is!

**The largest earthquake on record:**

Throughout history, the Earth has experienced some of the most powerful and devastating earthquakes ever recorded. Among them stands the Great Chilean Earthquake of 1960, which remains the strongest earthquake ever recorded. With a magnitude of 9.5, it struck the coast of Chile, unleashing a **catastrophic** combination of ground shaking, tsunamis, and landslides that devastated communities across the region.

Another notable event is the Great Alaska Earthquake of 1964, which had a magnitude of 9.2. It caused **widespread** destruction in Alaska and triggered tsunamis that affected coastal areas as far away as California. More recently, the 2004 Indian Ocean earthquake, with a magnitude of 9.1-9.3, generated massive tsunamis that ravaged coastlines in countries bordering the Indian Ocean. We will look at the impact of these Tsunamis in later lessons. These historic earthquakes serve as **stark** reminders of the Earth’s **immense** power. They also show how interconnected natural disasters are, where earthquakes can cause another disaster (such as avalanche, landslides or tsunamis).

**Lesson 3: Earthquakes: closer to home**

**The largest recorded earthquake in Australia:**

In 1988 (36 years ago), Tennant Creek residents were left trembling after Australia’s largest ever recorded earthquake shook the small town in the Northern Territory. The magnitude 6.6 quake was one of three very large earthquakes to occur on the same day, and was followed by thousands of aftershocks felt throughout the Territory. Down the road at Uluru, the thunder of camel hooves shook the earth as the first Great Australian Camel Race set off for the Gold Coast.

The seismic event took place in a relatively **sparsely** populated area, which reduced some of its potential impacts on human life and infrastructure.

However, despite the low population **density** in the region, the earthquake still caused a lot of damage, particularly to a major gas pipeline. The intense shaking triggered by the earthquake resulted in lots of fractures along the pipeline's route, leading to leaks and disruptions in gas supply.

**The Christchurch earthquakes:**

The Christchurch earthquakes of 2011 were a series of big earthquakes that happened in Christchurch, a city in New Zealand. The most powerful earthquake (measured at 6.3 on the Richter scale) struck on February 22, 2011, and it was **catastrophic** in its impact. Many buildings in the city, like houses, schools, and even the famous Christchurch Cathedral, were damaged or destroyed. After the earthquake, there were lots of smaller ones called aftershocks. These aftershocks continued to cause damage to weakened structures and **hindered** recovery efforts.

The Christchurch earthquakes of 2011 prompted a significant response from the New Zealand government, as well as **international aid organisations** and volunteers.

**\*International aid organisations consist of large groups of people who respond to disasters across the world, by helping with rescue missions or rebuilding.**

Efforts focused on providing emergency relief, supporting search and rescue operations, and starting long-term recovery and rebuilding efforts.

The city of Christchurch **embarked** on a journey of reconstruction, with a focus on resilience and community engagement. Despite the **immense** challenges posed by the earthquakes, the people of Christchurch demonstrated **remarkable** strength, solidarity, and determination in the face of **adversity.**

**Lesson 4: Tsunamis: the colossal waves of the ocean**

**Tsunamis**

Tsunamis, **colossal** waves in the ocean\*, are triggered by seismic events such as earthquakes, volcanic eruptions, or underwater landslides.

When significant movements occur beneath the ocean floor, like during an earthquake, it can cause the water to **surge** suddenly, releasing a **tremendous** amount of energy that travels through the ocean. The largest ever Tsunami on record was over 500 metres tall, and washed over Lituya Bay in Alaska in 1958. That’s taller than the Empire State Building!

**Causes of tsunamis**

There are three main causes of tsunamis:

**Earthquake:** Imagine two pieces of land, called tectonic plates, which are like huge puzzle pieces under the sea or ocean. Sometimes these plates move **suddenly** against each other, causing an earthquake. This movement can push the water above it, making waves that spread across the ocean.

**Volcanic Eruption:** Sometimes, volcanoes under the ocean can erupt. When they do, they can push water out quickly, creating waves that move outward from where the eruption happened.

**Landslide:** Underwater landslides can also cause tsunamis. When a lot of rocks or **sediment** slide down a slope under the ocean, they can push water and create big waves.

When the energy from these movements reaches the surface of the ocean, it creates giant waves that can travel very fast across the sea. These waves can be really small in deep ocean water, but as they get closer to land, they start to build up and can become huge and very dangerous.

**Impacts of Tsunamis:**

Tsunamis can have devastating impacts on coastal communities and environments. When they hit land, they can cause widespread flooding, destroying buildings, roads, and other **infrastructure**. The force of the waves can also **erode** coastlines and carry away soil and debris. Additionally, tsunamis can disrupt ecosystems, affecting marine life and animal habitats along the coast.

**Tsunami Warning Systems:**

To help **mitigate** the impact of tsunamis, many coastal regions have implemented early warning systems. These systems use sensors, buoys, and seismic monitoring to detect seismic activity and changes in ocean conditions that could mean a tsunami threat. When a potential tsunami is detected, alerts are issued to coastal communities, giving people time to **evacuate** to higher ground and seek safety.

**Lesson 5: The Boxing Day Tsunamis**

**The Boxing Day Tsunami**

The Boxing Day Tsunami, also known as the Indian Ocean Tsunami\*, occurred on December 26, 2004. It was one of the largest tsunamis ever recorded. This catastrophe was triggered by a colossal earthquake under the ocean near Indonesia.

The earthquake in 2004 took place deep beneath the sea, registering as one of the strongest earthquakes in history. The **abrupt** movement of the Earth's plates caused the water above them to move suddenly as well, generating immense waves known as tsunamis.

When the earthquake occurred, it sent powerful waves racing across the ocean at tremendous speeds, **akin** to the ripple effect in a pond. These waves travelled for hours across the Indian Ocean, reaching countries such as Indonesia, Sri Lanka, India, and Thailand. Upon reaching the shores, the waves **collided** with the land with tremendous force, devastating coastal areas and sweeping away everything in their path.

**No plan for Indian Ocean tsunamis in 2004-** [**Australian Geographic Article**](https://www.australiangeographic.com.au/blogs/on-this-day/2014/12/on-this-day-in-history-boxing-day-tsunami/)

On the day seismic signals picked up by stations in Australia were the first to trigger an alert at the Pacific Tsunami Warning Centre in Hawaii. (An international tsunami warning system has existed in the Pacific, where quakes are more common, since the 1940s.)

When it was realised how **severe** the quake was, however, the response was slow and **unorganised**. “Back in 2004 we didn’t know where to send the warning in the Indian Ocean, we didn’t have national contacts”, says Dr Richard Bailey, head of Tsunami Warning and Ocean Services with Australia’s Bureau of Meteorology.

Tsunami waves travel at speeds of up to 800km/h depending on the depth of the water. In 2004 it took anywhere from fifteen minutes to seven hours (for Somalia) for the fatal waves to reach the various coastlines.

**Hampered** by a lack of a plan for the Indian Ocean, governments and organisations were alerted, but many were incredibly slow to react. \*This means they didn’t alert the people in time.

The northern regions of the Indonesian island of Sumatra were hit very quickly, while Sri Lanka and the east coast of India and Thailand were affected two hours later. However, in many places, no evacuation measures were taken.\*

**Australian Indian Ocean tsunami warning system- National Geographic Article**

In 2004, Geoscience Australia, the government body responsible for earthquake and tsunami detection\*, was only monitoring roughly 30 seismic detectors on the Australian continent and one on Antarctica.

Following 2004, the Australian Government pumped $68 million in to a warning system for the Indian Ocean, which is a major component of a multi-national Indian Ocean tsunami warning system. Of the 28 countries that ring the Indian Ocean, now Australia, Indonesia and India are responsible for spearheading tsunami warnings in the area.

Today Geoscience Australia’s capacity has built up to where they now monitor over 300 seismic stations across the globe. This operates 24 hours-a-day and a tsunami warning coming out the joint tsunami centre takes about 15 minutes.

“Australia is fortunate because we are a few hours distant from the closest sources of fatalities,” says Professor Phil Cummins, a natural hazards expert at the Australian National University and Geoscience Australia.Closest, are possible earthquakes generated south of New Zealand, which could mean a tsunami would hit Hobart and Sydney within two hours. With our current warning system, those cities would have an hour and 45 minutes to evacuate relevant areas.

**Lesson 6: Hurricanes, Cyclones and Typhoons**

Hurricanes, typhoons, and cyclones are all powerful tropical storms, but they occur in different parts of the world and are known by different names. Understanding the differences between these **phenomena** can help us understand the impacts they have on regions worldwide.

**Hurricanes:**

Hurricanes predominantly form in the North Atlantic Ocean, the north-eastern Pacific Ocean, and the North Pacific Ocean. Hurricanes are categorised based on their maximum **sustained** wind speeds using the Saffir-Simpson Hurricane Wind Scale, which ranges from Category 1 (weakest) to Category 5 (strongest). These storms can bring heavy rain, strong winds, storm surges, and flooding, causing widespread devastation to coastal areas and inland regions.

**Typhoons:**

Moving on to typhoons, these are essentially the same as hurricanes but occur in the north-western Pacific Ocean. Typhoons develop in the western Pacific basin, including the Philippine Sea, South China Sea, and northwest Pacific Ocean. Like hurricanes, typhoons form under specific conditions, such as warm ocean temperatures and low wind shear.

Typhoons can be just as powerful and destructive as hurricanes, often impacting **densely** populated areas in countries like Japan, China, and the Philippines. The effects of typhoons can include **extensive** damage to infrastructure (buildings), loss of life, and **disruption** of daily life for millions of people. Due to their frequency and intensity, countries in the western Pacific region have developed disaster preparedness and response measures to **mitigate** the impact of these storms.

**Cyclones:**

Finally, we have cyclones, which are similar to hurricanes and typhoons but occur in different parts of the world. Cyclones form in the South Pacific and Indian Ocean regions, including the Bay of Bengal, Arabian Sea, and South Pacific Ocean. The northern coast of Australia, including the regions of Western Australia, the Northern Territory, and Queensland, frequently experience cyclone activity during the tropical cyclone season, which typically runs from November to April. Cities and towns in these areas, such as Darwin, Cairns, Port Headland and Broome, are **accustomed** to the threat of cyclones and have developed disaster response measures to **mitigate** their impact.

These storms have similar characteristics to hurricanes and typhoons, such as strong winds, heavy rainfall, and storm surges.

Cyclones, like typhoons and hurricanes, are classified based on wind speed and **intensity**, with different regions using their own naming systems and scales. In the Indian Ocean, for example, cyclones are categorised using the India Meteorological Department's scale, while the Australian Bureau of Meteorology classifies cyclones in the South Pacific region.

One **notable** difference between cyclones and hurricanes/typhoons is their direction of rotation. In the Northern Hemisphere, hurricanes and typhoons rotate counter-clockwise, while cyclones in the Southern Hemisphere rotate clockwise due to the *Coriolis effect.*

**Lesson 7: The impact of Hurricanes and Cyclones: Hurricane Katrina and Cyclone Tracey**

**Naming storms:**

Today we are going to look at two notable severe storms:

* Hurricane Katrina
* Cyclone Tracey

Storms, including hurricanes and cyclones, were originally given female names to help people keep track of them and talk about them more easily. This practice began in the United States back in the 1950s. It's kind of like giving a personality or identity to each storm, making it easier to remember and discuss.

Later on, they started using both female and male names, and they follow an alphabetical order. So, if there's a storm called "Grace," the next one might be called "Henry." These names don't have any special meaning about the storm itself; they're just used for organisation and communication purposes.

**Hurricane Katrina:**

Hurricane Katrina was one of the most devastating storms in American history. It occurred in August 2005 and affected the Gulf Coast of the United States, especially the city of New Orleans. The hurricane caused massive flooding and destruction, leaving many people homeless and causing billions of dollars in damage.

Before Hurricane Katrina hit, people were warned it was coming, so many of them evacuated to safer places. But some people couldn't leave because they didn't have cars or anywhere else to go. When the hurricane arrived, it brought intense winds and heavy rain. The most serious problem, though, was the flooding.

New Orleans is a city that's mostly below sea level, which means it's lower than the water around it. So, when the hurricane brought a lot of rain and the water from nearby rivers and the ocean rose, it overflowed the city's protective levees. Levees are like big walls or barriers that are built to keep water out. When they **succumbed** to the pressure of the rising waters, water rushed into the city, flooding many neighbourhoods.

The flooding was so devastating because the water couldn't drain quickly. Many houses were **submerged** completely. People had to go up to their roofs to escape the rising water. Some even had to wait there for days to be rescued by helicopters or boats. It was a very frightening and dangerous situation for many families.

After the hurricane passed, the damage was immense. Entire neighbourhoods were destroyed, and many buildings were damaged beyond repair. People who had homes lost everything they owned. Schools, hospitals, and businesses were all affected. The city's infrastructure, like roads and bridges, was also damaged, making it hard for people to get around or for rescue workers to help. The aftermath of Hurricane Katrina was a national tragedy. Thousands of people lost their lives, and many more were injured or **displaced**.

 The government and relief organisations worked to help the victims by providing shelter, food, and medical care. It took a long time for New Orleans and the surrounding areas to recover from the devastation caused by Hurricane Katrina.

**Cyclone Tracy, Darwin, 1974.**

Picture this: it's Christmas Eve in 1974, and Darwin, a small but vibrant city in the Northern Territory of Australia, is **gearing up** for the festive season. But **amidst** the holiday cheer, nature had a different plan in store.

Cyclone Tracy, a fierce tropical cyclone, roared ashore with winds howling at speeds of up to 240 km/h . Imagine winds so strong they could tear roofs off houses and uproot trees like they were mere toothpicks! The cyclone's heavy rain added to the chaos, causing widespread flooding and destruction.

**The Aftermath of Tracy: Destruction and Displacement**

The impact was devastating. Nearly 70% of Darwin's homes were either flattened or badly damaged. Can you imagine waking up to find your house in ruins, your belongings scattered by the ferocious winds? It's a scene that thousands of people in Darwin faced in the wake of Cyclone Tracy.

Not only did the cyclone **wreak** **havoc** on buildings and infrastructure, but it also caused tragic loss of life. Despite evacuation efforts, 71 people lost their lives, and many more were injured. Families were torn apart, and the city was left reeling in shock.

**Response and Recovery of Tracy: Rebuilding from the Rubble**

With communication lines severed and infrastructure in ruins, Darwin was cut off from the outside world. It took months of hard work and dedication to rebuild the city from the ground up. In the face of such devastation, communities came together like never before. Emergency services from across Australia rushed to Darwin's aid, providing much-needed supplies, shelter, and medical assistance. It was a time of **resilience** and **solidarity** as people came together to support one another in the aftermath of tragedy.

Cyclone Tracy may have left scars on Darwin, but it also taught valuable lessons. In the years that followed, Australia implemented stricter building codes and improved cyclone preparedness measures to better protect against future disasters.

**Lesson 8: Tornadoes**

Tornadoes, a type of meteorological event, are among the most **awe-inspiring** and potentially devastating natural phenomena on Earth. These swirling columns of air can reach incredible speeds and wreak havoc on anything in their path. Understanding tornadoes involves delving into their formation, characteristics, and the measures taken to predict and mitigate their impact.

At their core, tornadoes are violent rotating columns of air that extend from a thunderstorm to the ground. They typically take the shape of a funnel, with the narrow end touching the ground and the wider end attached to the base of the thundercloud. While tornadoes can occur anywhere in the world, they are most common in the United States, particularly in the region known as Tornado Alley, which includes parts of Texas, Oklahoma, Kansas, and Nebraska.

**The formation of Tornadoes:**

Tornadoes form when certain weather conditions come together, usually during strong thunderstorms. A key ingredient for tornado formation is something called wind shear, which means the wind changes speed and direction as you go higher up in the sky. When warm, moist air near the ground meets cool, dry air above, it creates **instability** in the air, like mixing oil and water. This instability sets the scene for the formation of tornadoes.

Inside a thunderstorm, there's a powerful upward rush of air called an **updraft**. Sometimes, this updraft starts to spin sideways. If the spinning air gets tilted upright by the wind shear, it can create a tornado. It's kind of like stirring a pot of soup really fast, and then tilting the spoon. If conditions are just right, you might see a little whirlpool forming in the soup, and that's similar to how a tornado starts in the sky.

The strength of a tornado is measured on the Enhanced Fujita (EF) scale, which ranges from EF0 (weak) to EF5 (violent). The classification is based on the damage caused by the tornado, including the destruction of buildings, trees, and other structures. EF0 tornadoes might only cause minor damage to trees and signs, while EF5 tornadoes can obliterate well-built houses and toss cars like toys.

One of the most notable characteristics of tornadoes is their incredible wind speeds. While weaker tornadoes might have wind speeds of around 65 miles per hour (105 kilometres per hour), the most powerful tornadoes can exceed 200 miles per hour (320 kilometres per hour). These high winds are capable of lifting heavy objects, such as cars and even houses, and **hurling** them through the air, posing a significant danger to life and property.

 **Lesson 9: Storm Chasers!**

Storm chasers, the daring adventurers of the skies, embark on thrilling expeditions into the heart of nature's most magnificent and powerful spectacles: storms. These keen explorers, often led by fearless meteorologists, follow and track thunderstorms, hurricanes, and tornadoes to unravel their mysteries and understand their **ferocious** beauty.

Imagine a team of scientists and storm enthusiasts, their vehicles packed with **state-of-the-art** equipment, speeding down country roads with a sense of **anticipation** in the air. Their eyes are fixed on the horizon, where dark clouds loom and lightning crackles, as they wait for an **imminent** storm.

Armed with radar scanners and weather instruments, storm chasers navigate the **tumultuous** paths of nature's fury. They brave pounding rain, howling winds, and hailstones the size of marbles, all in pursuit of knowledge and discovery. But storm chasing isn't just about the thrill of adventure—it's also a vital scientific **endeavour**. By collecting data on temperature, wind speed, and atmospheric pressure, storm chasers contribute valuable information that helps meteorologists better understand and predict severe weather events.

For explorers with a passion for the wonders of the natural world, storm chasing offers a front-row seat to some of nature's most awe-inspiring displays. It's a chance to witness the breathtaking beauty of lightning dancing across the sky, the mesmerising swirl of clouds in a tornado's vortex, and the sheer power of a hurricane's winds.

But storm chasing is not without its dangers. These brave adventurers must always be vigilant and prepared for the unpredictable twists and turns of the weather.

As storm chasers document their **expeditions** through **captivating** photographs and videos, they also share their discoveries with the world, inspiring future generations of scientists and adventurers. Through documentaries, books, and educational programs, these modern-day explorers ignite a passion for meteorology and environmental science in young minds, fostering a deeper appreciation for the delicate balance between humanity and the forces of nature.

**Lesson 10: Wildfires**

A wildfire is an uncontrolled fire that burns in the wildland vegetation, often in rural areas. Wildfires can burn in forests, grasslands, savannas, and other ecosystems, and have been doing so for hundreds of millions of years. They are not limited to a particular continent or environment. In Australia, we call them bush fires.

Wildfires can burn in vegetation located both in and above the soil. **Ground fires** typically ignite in soil thick with organic matter that can feed the flames, like plant roots. Ground fires can smoulder for a long time—even an entire season—until conditions are right for them to grow to a surface or crown fire. **Surface fires,** on the other hand, burn in dead or dry vegetation that is lying or growing just above the ground. Parched grass or fallen leaves often fuel surface fires. **Crown fires** burn in the leaves and canopies of trees and shrubs.

Wildfires can start with a natural occurrence—such as a lightning strike—or a human-made spark. However, it is often the weather conditions that determine how much a wildfire grows. Wind, high temperatures, and little rainfall can all leave trees, shrubs, fallen leaves, and limbs dried out and primed to fuel a fire. **Topography** plays a big part too: flames burn uphill faster than they burn downhill.

Wildfires that burn near communities can become dangerous and even deadly if they grow out of control. Still, wildfires are **essential** to the continued survival of some plant species. For example, some tree cones need to be heated before they open and release their seeds; chaparral plants, which include manzanita, chamise (Adenostoma fasciculatum), and scrub oak (Quercus berberidifolia), require fire before seeds will **germinate**. The leaves of these plants include a flammable resin that feeds fire, helping the plants to **propagate**. Plants such as these depend on wildfires in order to pass through a regular life cycle. Some plants require fire every few years, while others require fire just a few times a century for the species to continue.

Wildfires also help keep ecosystems healthy. They can kill insects and diseases that harm trees. By clearing scrub and underbrush, fires can make way for new grasses, herbs, and shrubs that provide food and habitat for animals and birds. At a low intensity, flames can clean up debris and underbrush on the forest floor, add nutrients to the soil, and open up space to let sunlight through to the ground. That sunlight can nourish smaller plants and give larger trees room to grow and flourish.

While many plants and animals need and benefit from wildfires, climate change has left some ecosystems more **susceptible** to flames. Warmer temperatures have intensified drought and dried out forests. The historic practice of putting out all fires also has caused an unnatural buildup of shrubs and debris, which can fuel larger and more intense blazes.

**Australian Aboriginal fire use:**

For a long time, Aboriginal people have been using fire to do different things like hunting animals, taking care of the environment, and looking after the land. They do a special kind of burning called Cool Burning or Cultural Burning. This means they start small fires on purpose to clear away plants and bushes. This prevents big fires caused by lightning or accidents getting out of hand. In addition to using fire for hunting and managing the environment, Aboriginal people also employed controlled burning techniques to **cultivate** crops and promote agricultural growth, showcasing their deep understanding of the land and its resources. But over many years, when European settlers came to Australia, they didn't understand or like this way of using fire. They thought fire was dangerous and didn't see how Cool Burning could help the land. Because of this, the traditional burning practices started to disappear. This made things worse for the environment, and it made the land more at risk of severe fires. Now, more and more people, like farmers and communities, are interested in learning about these old ways of burning and how they can help protect the land. They want to use these traditional practices across the country to keep our land safe and healthy.

**Lesson 11: Bushfires in Australia: The Black Summer Bushfires**

During the 2019/2020 Australian bushfire season, known as Black Summer, devastating fires swept across several states from September 2019 to February 2020. These fires, some of the worst in decades, caused significant loss and destruction. Tragically, they claimed the lives of many people, including nine brave firefighters, and destroyed over 3,000 homes. Enormous **swathes** of land, totalling more than 17 million hectares, were engulfed in flames, including precious wildlife habitats.

The impact on wildlife was particularly heartbreaking, with an estimated one billion animals dying in the fires, many of them in New South Wales. This made it one of the worst wildlife disasters in modern history. Urgent efforts were made to identify and assist 810 species and habitats in need of immediate help.

In response to the crisis, the Australian Government took action by establishing the National Bushfire Recovery Agency (NBRA) and allocating $2 billion to aid affected communities. Additionally, a **Royal Commission** was **convened** to investigate the disaster and recommend strategies for future prevention and response. The Commission's findings, released in November 2020, emphasised the need for better disaster management and response procedures. **Subsequently**, the government announced the creation of the National Recovery and Resilience Agency in May 2021 to enhance disaster preparedness and recovery efforts nationwide.

The Climate Council also produced a comprehensive overview of the causes and impacts of the Black Summer Bushfires. According to the report, the catastrophic bushfires spewed an average estimate of 900 million tonnes of carbon dioxide into the atmosphere, which is approximately the same as annual **emissions** from **commercial** air travel worldwide. *"The fires produced more greenhouse gas emissions than Australia normally emits annually,"* said Climate Councillor and former Commissioner of Fire and Rescue NSW, Greg Mullins. "*We must remember that the recent fires took place in a world that has warmed just over one degree*," said Climate Councillor Professor Will Steffen.

**Lesson 12: Floods in Australia**

To put it simply, flooding is a when a normally dry area is covered in water. Floods can have both positive and negative impacts. They can bring welcome relief for people and ecosystems suffering from **prolonged** drought, but also are estimated to be the **costliest** natural disaster in Australia. No two floods are the same and can **vary** depending on the quantity, duration and location of rain falling on our catchments. (Australian Bureau of Meteorology)

**What causes floods?**

There are three main types of flooding experienced in Australia:

Riverine floods are perhaps the most common form of flooding in Australia. The two main contributors to riverine flooding are heavy rainfall and the lands capacity to absorb water. When the land becomes saturated, the excess water flows into river systems and can caused them to exceed their capacity. This causes the water the flow into the low-lying areas **adjacent.**

Flash floods can occur almost anywhere from short intense bursts of rainfall, making them one of the most dangerous forms of flooding. They can be particularly **problematic** in urban areas where the drainage system cannot cope with the amount of water. As the water rises quickly, flash floods can be difficult to warn for.

Coastal floods happen when a low-pressure system or strong onshore winds force sea levels to rise above normal levels, creating a storm surge that can cause flooding of low-lying areas close to tidal waterways and foreshores.

Floods are classified as minor, moderate or major based on their impact on communities and infrastructure.

**Where do floods occur?**

Floods occurring all over Australia, however different types of floods are common in different regions. Depending on your location, you may experience floods differently. Your location will determine whether you are likely to experience river, flash or coastal flooding or a combination of several of these types of flood risks.

Riverine flooding occurs in relatively low-lying areas adjacent to streams and rivers. In the extensive flat inland regions of Australia, floods may spread over thousands of square kilometres and last several weeks, with flood warnings sometimes issued months in advance. In the mountain and coastal regions of Australia, flooding can happen rapidly with a warning of only a few hours in some cases.

Flash flooding, otherwise known as overland flooding, can occur almost anywhere there is a relatively short, intense burst of rainfall such as during a thunderstorm. As a result, the drainage system has **insufficient** capacity or time to cope with the downpour. Although flash floods are generally **localised**, they pose a significant threat because of their unpredictability and normally short duration.

(Get Ready Queensland, Geoscience Australia)

**Risks**

The damage and impact of floods is **varied, substantial** and far reaching. The immediate impacts of flooding include loss of human life, damage to property, destruction of crops and loss of livestock. Floods also frequently damage power transmission and sometimes power generation, which then has knock-on effects caused by the loss of power.

(Get Ready Queensland)

**Lesson 13: Drought in Australia**

Drought is defined as “a **prolonged**,

abnormally dry period when the amount of available water is **insufficient** to meet our normal use” (BOM 2018a). Droughts can be  measured in many ways, but meteorologists monitor the extent and severity of drought in terms of rainfall **deficiencies**. A rainfall **deficit** occurs when an area’s total rainfall over a period is less than the average for

that period (BOM 2018a).

**What is the influence of climate change on drought?**

Climate change is causing changes in the weather patterns that bring rain to different places. In the southern parts of Australia, where it's already drier, the weather fronts that usually bring rain are moving further south because of the warmer climate. This means that places in the southern regions of Australia are getting less rain, which makes droughts more **likely.**

Over the past 50 years, the temperature in this area has also been getting hotter. This means there are more hot days and heatwaves. Hot weather can make droughts even worse.

So, because of climate change, places like southwest and southeast Australia are facing more severe droughts. On the other hand, some parts in the Northwest of Australia might actually get wetter because of these changes in weather patterns.

**Observed trends on drought in Australia**

Although Australia’s climate is characterised by droughts and flooding rains, their frequency and intensity has significantly increased. Australia has experienced several major droughts during the 20th and early 21st centuries. Some of the worst ones were during the Federation time (from 1895 to 1903), during World War II (from 1939 to 1945), and the Millennium Drought (from 1996 to 2010). A recent study showed that these droughts were the worst in at least 400 years! In the last 30 years, there has been less rain during the cooler months (from April to November) in parts of Western Australia and southeastern Australia. In southeastern Australia, there's been a 15 percent drop in rain during late autumn and early winter, and a 25 percent drop in April and May since the 1970s. In the southwest of Western Australia, there's been about a 15 percent decrease in rain during the cooler months since the 1970s.

Because of this lack of rain, the amount of water flowing in rivers has gone decreased significantly, up to 60 percent less in some places like the southwest of Western Australia and the Murray-Darling Basin. In Perth, where they collect water in dams, there's been almost 80 percent less water going into the dams since the mid-1970s. Average **annual** stream flow into Perth’s dams has decreased by nearly 80 percent since the mid-1970s.

**A quick look at dams**

A dam is a structure built across a river or stream to control the flow of water. The Canning Dam was initially the main water source for Perth from its completion in 1940 until 1961. This means that during this period, the majority of Perth's water needs were met by the Canning Dam. However, as the population of the Perth metropolitan area grew, the demand for water also increased. To keep up with this population growth and the increased water demand, the Serpentine Dam was constructed.

Currently, both dams play a role in supplying water to the Perth metropolitan area. The Canning Dam still contributes to the water supply, although it is no longer the primary source. Instead, the Serpentine Dam has become an important part of the water infrastructure. Together, these dams supply approximately 20% of the water needed for the current metropolitan area.

**Impact of droughts**

One of the most noticeable effects of droughts is their impact on agriculture. When there is not enough water for crops to grow, farmers experience reduced **yields**, leading to food shortages and rising prices. This can result in financial hardships for farmers and even threaten their livelihoods. Livestock, too, suffer from water and food shortages, leading to reduced productivity and health issues.

Droughts also strain water resources, causing reservoirs, rivers, dams, and groundwater supplies to **dwindle**. This reduction in water can lead to disagreements over who gets to use it, which can impact essential needs like drinking water and the operations of industries that rely on water.

Ecosystems face significant stress during droughts as well. Lower water levels in rivers, lakes, and wetlands threaten the habitats of aquatic species, leading to a decline in biodiversity. The risk of bushfires increases due to dry conditions, resulting in habitat destruction and loss of plant and animal species.

**Lesson 14: Volcanic Eruptions: Tambora**

**The Cataclysmic Eruption of Mount Tambora in 1815**

Mount Tambora, located on the Indonesian island of Sumbawa, is **infamous** for its cataclysmic eruption in 1815, one of the most powerful volcanic events in recorded history. This eruption had far-reaching consequences, not only locally but **globally**, impacting climate, agriculture, and societies around the world. In this report, we delve into the events leading up to and following the eruption, its immediate effects, and its long-term **repercussions.**

**Pre-Eruption Activity and Context**

Prior to the eruption, Mount Tambora was a dormant stratovolcano, standing at approximately 4,300 meters tall. The region surrounding the volcano was populated by several thousand people, primarily involved in agriculture and fishing. In April 1815, Tambora showed signs of volcanic activity, with increased seismicity and steam venting, signalling an **impending** eruption. However, these warning signs were not recognised as **precursors** to a catastrophic event.

**The Eruption**

On April 5, 1815, Mount Tambora erupted violently, with a series of explosions that ejected massive amounts of volcanic material into the atmosphere. The initial blast was heard hundreds of kilometers away, and ash and pyroclastic flows devastated nearby settlements. A pyroclastic flow is a hot (typically >800 °C), mixture of rock fragments, gas, and ash that travels rapidly (tens of meters per second) away from a volcanic vent or collapsing flow front. The eruption column reached heights of up to 43 kilometers, ejecting immense quantities of ash, sulfur dioxide, and other gases into the stratosphere.

**Immediate Effects**

The immediate effects of the Tambora eruption were devastating. Entire villages were **obliterated** by pyroclastic flows, and ashfall **blanketed** surrounding areas, causing widespread destruction of crops and livestock. An estimated 10,000 people were killed directly by the eruption, with many more dying in the subsequent months due to **famine** and disease. The eruption also triggered tsunamis that **ravaged** coastal communities, further adding to the death toll and destruction. The ash and sulphur dioxide released into the atmosphere caused dramatic changes in local weather patterns, leading to prolonged periods of darkness and cold temperatures.

**Global Impact**

The effects of the Tambora eruption were not **confined** to the region surrounding the volcano. The massive quantities of volcanic aerosols injected into the stratosphere had a significant impact on the global climate. The following year, 1816, became known as the ‘Year Without a Summer’ in many parts of the world, as temperatures **plummeted** and frosts occurred even in the midst of summer.

Due to the weather changes, crop failures were widespread across Europe, North America, and Asia, leading to food shortages and severe **economic** hardship**.**

**Lesson 15: The Lost City of Pompeii**

**Unearthing Pompeii: A Journey into the Past**

Nearly 2,000 years ago, Pompeii was a bustling city located in what is now southern Italy. But in the summer of A.D. 79, the nearby Mount Vesuvius volcano erupted. It spewed smoke and toxic gas 20 miles into the air, which soon spread to the town. Almost overnight, Pompeii—and many of its 10,000 residents—**vanished** under a blanket of ash.

In the ancient times of Rome, there was a city called Pompeii, nestled near a big volcano named Mount Vesuvius. People lived and worked happily in Pompeii, surrounded by **bustling** streets and colourful buildings.

But on a fateful summer day in 79 AD, the **tranquillity** of Pompeii was shattered by a sudden and violent eruption of Mount Vesuvius. The once-blue sky turned dark as ash and smoke **billowed** from the volcano's summit, casting a shadow over the city below.

As the eruption **intensified**, streams of molten lava flowed down the mountainside, causing fires and causing panic among the **inhabitants** of Pompeii. With little warning, the volcano unleashed a **torrent** of ash, rocks, and gases, blanketing the city in a thick layer of debris.

Amidst the chaos, the people of Pompeii frantically sought shelter and safety. Some attempted to flee the city, while others sought refuge within the walls of their homes. But as the hours passed, it became clear that escape was impossible, as Vesuvius continued to rain down destruction upon Pompeii.

In the aftermath of the eruption, Pompeii lay buried beneath a blanket of ash and rubble, its once-thriving streets and buildings ***frozen in time***. The city's fate remained unknown to the outside world for centuries, as nature slowly reclaimed the land and memories of Pompeii faded into **obscurity.**

For many years, Pompeii was buried under all the volcanic material, forgotten by the world. But many years later, in the 18th century, people rediscovered Pompeii. They **excavated** the ash and rubble and found the ancient city preserved underneath.

Visiting the ruins of Pompeii today is like going back in time. The layers of ash actually helped preserve buildings, artwork, and even the forms of bodies of people as they **decomposed** and left holes in the ash. All that allowed experts to fill in the details that might not have survived at many other ancient sites.