

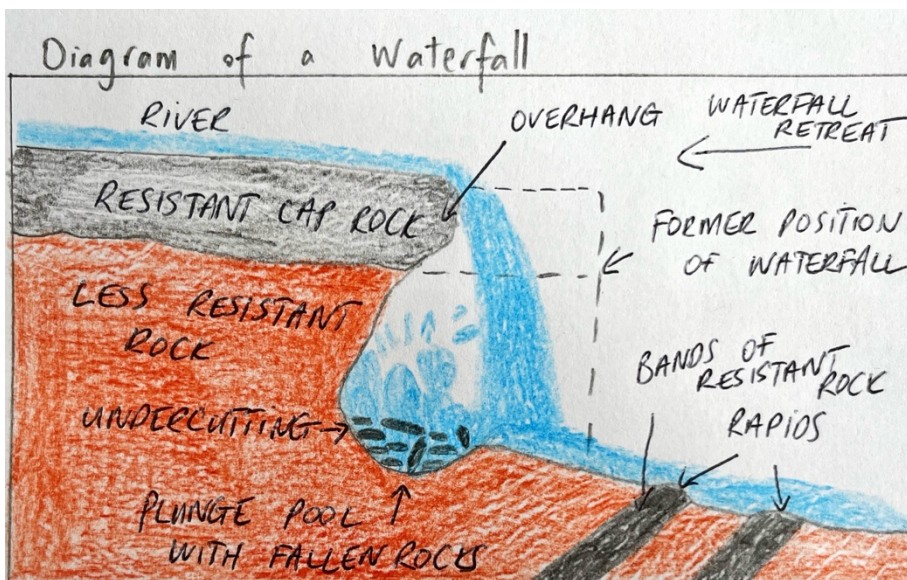
- (i) A = Normal fault B = Reverse fault
- (ii) C = Scarp D = Block mountain
- (iii) Tear fault
- (iv) Faulting occurs when rocks fracture under stress. The movement of rock along either side of a fracture is known as a fault. They usually occur along zones of weakness in the crust.
- (v) Caledonian and Alpine folding
- (vi) False

An example of a landform formed due to the processes of erosion is a waterfall. A waterfall is a point where there is an interruption in the river profile and the water makes a vertical drop. A waterfall can be found at the youthful stage of a river, where the river has a high velocity and a steep gradient. An example of a waterfall is the Pollaphuca Falls on the River Liffey.

In the youthful stage of the river, the river has very high velocity. Waterfalls develop when a river meets a band of softer, less resistant rock (limestone) after flowing over harder, more resistant rock (granite). As a result, differential erosion occurs, which means that erosion is occurring at different rates. The river quickly erodes the less resistant rock by hydraulic action, which is the physical force of the moving water, and abrasion, which is the river load eroding the river banks and bed. This steepens the gradient of the river.

As the falling water hits the soft rock on the river bed, it cuts out a deep hole called a plunge pool directly beneath the waterfall. The falling water also begins to undercut the softer rock of the waterfall, mainly by hydraulic action and abrasion, creating an overhang. The overhang, made up of the harder, more resistant rock, eventually breaks off and collapses into the plunge pool due to the instability. The load that falls into the plunge pool swirls around colliding with each other and further breaking into smaller pieces, this is known as attrition.

The process of undercutting and collapsing are repeated many times. As a result, the waterfall gradually retreats upstream in a process called headward erosion. This results in the formation of a valley with vertical sides, called a gorge. A waterfall is a temporary feature. Headward erosion will eventually undermine all the harder, more resistant rock, with the river flowing over a series of rapids. Eventually, the river will once again develop a regular profile.



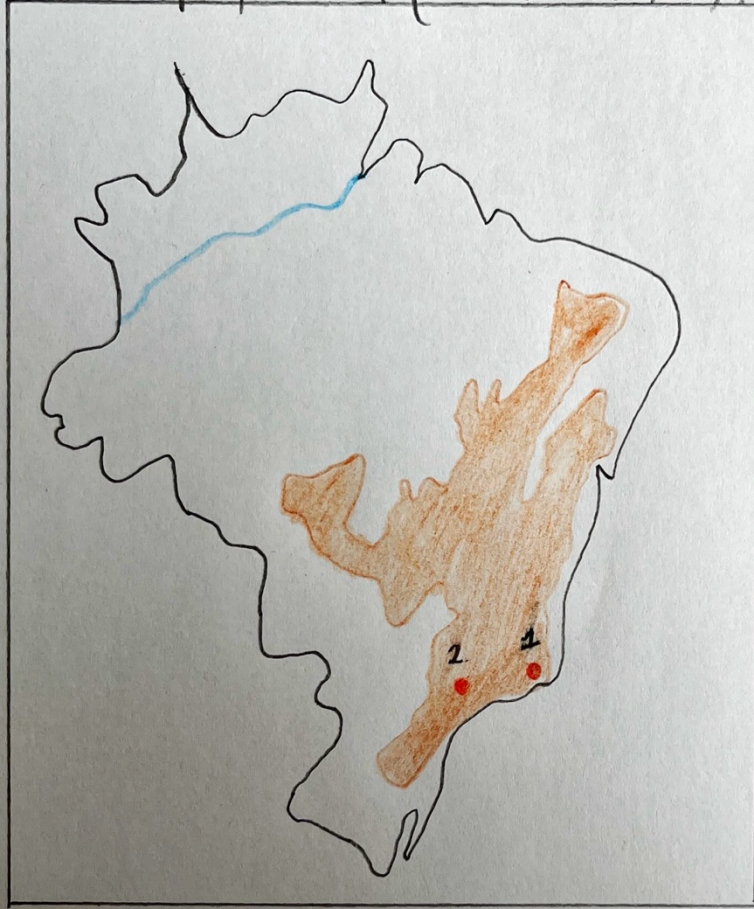
850 million years ago, the northwest of Ireland and Scotland were found on the North American plate and laid close to the equator. By about 400 million years ago, the ocean between them had closed and the two plates collided. The two parts of Ireland were joined together. The collision of the plates resulted in intrusive volcanic activity, when molten magma does not reach the Earth's surface and cools and solidifies deep within the Earth's crust.

An example of an intrusive feature in Ireland is the Leinster Batholith. A batholith is the largest of all plutons, with a surface area greater than 100 km². Batholiths formed as magma intruded into the crust forcing its way into the bedding planes of sedimentary rock. It pushed the sedimentary rocks out of the way and occupied the great arched folds that it created. The magma cooled very slowly to form the granite batholith. As hot molten magma came into contact with the surrounding sedimentary rocks, the intense heat and pressure changed them to metamorphic rocks, such as quartzite and schist. Weathering and erosion have removed much of the overlying rock, exposing the gently-sloping, dome-shaped mountains. Some are topped by tors. These are large blocks of granite with joints that have been enlarged by weathering. Lugnaquilla, at 925 metres, is the highest peak in the Wicklow Mountains. It stills has its capstone of resistant schist. This protected the underlying granite from erosion and has given it a steeper slope than the surrounding landscape. The Leinster Batholith occupies over 1,500 km² of the landscape including the Dublin Mountains, Wicklow Mountains and Blackstairs Mountains.



An example of an extrusive feature in Ireland is the Antrim-Derry Plateau extending over 4,000 km² and 350 metres in height. About 65 million years ago, The Eurasian-American plates began to split apart, creating a constructive plate boundary. The crust was stretched and thinned. Great cracks and fissures opened up. Lava poured out onto the surface to form a featureless landscape. The individual flows, varying in thickness from 5 to 40 metres, cooled to form basalt. As the plates drifted further apart, new continental crust formed and the Atlantic Ocean opened up. It was this volcanic activity, which resulted in the formation of the Antrim-Derry Plateau lasting 15 million years.

The Giant's Causeway is the most distinctive part of the plateau. It contains 60,000 hexagonal basalt columns that formed when molten magma cooled very slowly after being trapped in a river valley. As the lava cooled on the Earth's surface, it contracted around regularly spaced centres. The lower columns, buried deeper, cooled more slowly and formed a more uniform pattern than the upper flows. The lower columns are now exposed as a result of coastal erosion.

Sketch map of Brazil (Sub-continental)



Key

- Two named urban centres
 - 1 - Rio de Janeiro
 - 2 - São Paulo
- The course of a named river
 -  - Amazon River
- The outline of a named relief
 -  - Brazilian Highlands

Ireland experiences a mid-latitude climate, known as a cool temperate oceanic climate. The name of the climate suggests it is a maritime climate and is strongly influenced by its proximity to the sea.

The temperatures are mild all year round due to the cooling influence of the Atlantic Ocean to the west and the Irish Sea to the east. Summers are moderately warm as temperatures ranging from 15°C in the north west to 17 °C in the south east. The sea is cooler than the land in summer, keeping the temperatures moderately mild. Winters are mild with average temperatures ranging from 4 °C to 6 °C. Temperatures should be a lot colder theoretically, based on Ireland's 52-55 ° latitude north of the equator. However, the North Atlantic Drift is a warm current that reaches Ireland from the Gulf of Mexico and gives Ireland a much milder winter. The current keeps Ireland's coast ice free in winter. The current and the sea is the reason why the temperature range in Ireland is a mere 11 °C.

Precipitation is distributed throughout the year but it rains most in the winter. Rainfall is not evenly distributed throughout the country. Total annual precipitation varies from 800mm in the east to 2,500-2,800mm in the west. This is due to the upland relief in the west, which forces the air coming in from the sea upwards. It cools and condenses leading to heavy and frequent relief rainfall. The east of Ireland is in the rain shadow of the west, it is sheltered from the rain by the mountains of the west meaning less rainfall.

Ireland receives between 1,100 and 1,600 hours of sunshine each year. The sunniest months are May and June. During these months, sunshine averages between 5 and 6.5 hours per day. December is the dullest month of the year, with 1-2 hours of sunshine per day. The west of Ireland receives less sun than the east due to heavy cloud cover carried in from the Atlantic Ocean.

Equatorial, tropical and sub-tropical climates are experienced in Brazil. 10% of Brazil, in the northeast, experiences a semi-arid climate.

Tropical regions are close to the equator so temperatures are high. Brazil has an average temperature of 27 °C throughout the year. There are some regional variations in temperatures and precipitation levels throughout the year. The edges of the Amazon Rainforest are slightly cooler and drier in June and December. Along the east coast of Brazil, the climate is also affected by the cooling effect of the Atlantic Ocean. This is evident in Rio de Janeiro, with temperatures ranging from 21 °C to 23 °C in June, July and August. As regards to the amount of sunshine, the sunniest area of Brazil in the northeast sees 3,000 hours of sunshine per year compared to the lowest in the western Amazon, where there are 1,600 to 1,800 hours of sunshine per year.

This has resulted in many settlers attracted to the east coast of Brazil. Today, the majority of Brazil's population live in cities that are developed on the eastern coastline of Brazil, such as Rio de Janeiro, Sao Paulo and Curitiba, where cooler temperatures exist. The average rainfall in tropical regions is 1,000-1,800mm annually but can be higher. However, the northeast semi-arid climate experiences 500mm or less of rainfall annually and can even experience occasional droughts because of high evaporation rates. Most precipitation occurs from December to April. There are higher evaporation rates in the Amazon lowlands, causing heavy convective rainfall to occur resulting in 2,000mm of precipitation per year.

Two factors that have influenced the development of secondary economic activities in the Dublin region are labour and markets.

A large labour pool exists in Dublin. In 2016, 53,700 people were employed in manufacturing. Dublin has always been the recipient of inward migrants from other parts of Ireland, such as the west, because of the pull factor of opportunities the city offers. The population structure has a greater percentage of people in their twenties and thirties than other Irish regions because of inward migration of skilled young adults. Many highly skilled migrants arrived in Ireland from the United Kingdom, the European Union (EU) and South Asia to fill job requirements in the Dublin economy. After the eastwards expansion of the EU in 2004, many young Eastern Europeans came to Dublin. For example, Poland.

The quality of labour in the Dublin region is high. Ireland has one of the highest proportions of young people who have successfully completed third-level education in the EU, according to Eurostat. Eurostat is the statistical office of the EU, providing statistics on social and economic sectors. In Ireland, 58% of 30-34 year olds have completed third-level education followed by Luxembourg, Cyprus and Lithuania. In addition, Ireland had 12% of people leaving school early. In 2022, this figure has reduced significantly to 4%. Dublin has many universities and other third-level colleges in the Dublin region. These include Trinity College, University College Dublin (UCD), Dublin City University (DCU), the Technological Universities Dublin (TUD) and National College of Art and Design (NCAD) offering a wide variety of courses that prepare young people for the workplace.

Dublin's manufacturers have good access to markets. The motorway network radiating out of the M50 gives Dublin's manufacturers access to provincial urban centres in Ireland. However, the Irish market has reached 5 million people, which is 1% of the EU market with a population of 448.4 million people in 2023. Dublin-based manufacturers who want to expand must reach the export market.

Ireland, as an EU member state, has tariff-free access to the EU, one of the world's largest and wealthiest markets. Along with a low corporation tax of 12.5%, tariff-free access to EU markets is one of the main reasons why multinationals chose Ireland as a manufacturing base. EU markets, especially those in the core regions of the EU, are among the wealthiest markets in the world. High-value products from the Dublin region, such as Guinness and healthcare products are in demand in those regions. The Industrial Development Authority (IDA) has been very successful in attracting multinational corporations to come to Dublin and establish a manufacturing base. The Dublin region is home to many multinationals, including Pfizer pharmaceutical company in Clondalkin and IBM computer company in Mulhuddart.

Over many decades, Dublin manufacturers have established links with buyers in Britain and the EU. In this way manufacturers build up brand loyalty among their customers. Dublin's food processing, clothing, chemical and engineering companies export goods to the EU either through the UK or directly via Rosslare Harbour to France and onwards to EU destinations.

- (i) 1841
- (ii) 1961
- (iii) Increasing
- (iv) 8
- (v) – 21.12%
- (vi) Ireland's population has increased since 2011 due to migration. Since 2015, Ireland has experienced a net inward migration. This means that there have been more immigrants than emigrants.
- (vii) Natural change refers to the difference between births and deaths. It can be either positive or negative. If birth rates are higher than death rates it will confirm a natural increase in population. If birth rates are lower than death rates it will confirm a natural decrease in population.

An example of an urban centre with changes in urban functions over time is Galway City.

The Normans invaded Ireland in the 12th century and seized the land at the mouth of the River Corrib. A castle was built for protection. Over time, city walls were built. This provided a defence function to Galway City. The Normans, who had ties of culture, language and blood with France, began to trade with France.

The seafront at the mouth of the River Corrib offered a sheltered harbour ships and navigable approaches. Fourteen families came to dominate the commercial and trading life of the town including the Athy, Blake, Bodkin, Brown, D'Arcy families etc. The port's golden days were from the 15th to the 17th centuries. Galway City exported hides, wool and smoked and salted meat to France. Merchants imported textiles, brandy and wine. Galway became a distribution centre for imported goods. The city became a route focus for the distribution of imports and the transport of goods for export. The port was developed further in the 19th century with expanded docks and warehouses. Thousands of impoverished people left Galway port for the hazardous journey to North America during the Great Famine of the 1840s. The port declined greatly in importance in the 20th century as the ships became too big for the port to handle.

National primary education came to Ireland in 1831 with the Stanley Education Act. Religious congregations established secondary schools in the city as the 19th century wore on. Galway became a university city in the 19th century. As the only city with a university in the West, the city acquired a reputation as a city of learning. The university, now known as the National University of Ireland Galway (NUIG) had more than 17,000 students in 2017 and greatly boosts the urban population of the city during university terms. The services required by students and staff expanded over time to help the city grow further. Galway is also the main centre of Galway-Mayo Institute of Technology (GMIT). The regional hospital, University Hospital Galway (UHG), is a teaching hospital for medical students and nurses from the nearby university.

Today, Galway City is a major manufacturing centre. Galway and its immediate environs have become the location of a global cluster of medical device companies. These companies, such as Boston Scientific, are multinational corporations that have chosen to locate in Galway because of the Industrial Development Authority (IDA) and their grant incentives, a high quality of skilled workers and low corporation tax of 12.5%. A high proportion of workers in these companies have degrees from Galway's third-level institutions in engineering, biotech and other scientific fields which is a reason why these companies located in Galway. Galway has become a centre of excellence in medical devices and has acquired a global reputation in this field. The large number of workers in manufacturing has helped increase the population of Galway City to over 84,000, according to the 2022 census. Galway is now the third largest urban centre in the Republic of Ireland. Galway's airport ceased to function in recent years. However, the completion of the M6 from Galway to Dublin in 2009 was a major boost for manufacturing in Galway, as the city is now less than 2.5 hours from the M50 in Dublin.

Two challenges facing cities of the future is sustainable urban development and water supply.

Sustainable development means providing the needs of the present generation without jeopardising the needs of future generations. Cities consume huge quantities of the Earth's resources, including energy resources, metal, quarried materials and timber resources. Cities also produce vast quantities of waste, producing a large environmental footprint.

A sustainable city reduces its environmental footprint by reducing the amount of waste produced and fossil fuels burned. Cheap, frequent and reliable public transport becomes the preferred option for commuters, which greatly reduces air pollution. As much waste as possible is encouraged to be reduced, reused and recycled to prevent build-up of landfills. Green spaces are created from wasteland and derelict sites so that people can remain connected to the natural world. Sustainable cities are socially inclusive, with diverse cultures and languages in the neighbourhoods. The active involvement of the community is encouraged by urban authorities in urban decisions. Low-density urban sprawl is reduced by building compact residential districts from the city centre outward.

An example of a sustainable city is Hammarby, Stockholm in Sweden. A shallow pond is found in the urban centre, which is irrigated with a collection of rainwater run-off. Green spaces with herbs and shrubs attract bird and insect life. Traffic is absent from the central communal area, meaning improvement in air quality and safe for children to play. Combustible waste is incinerated in an incinerator to produce district heating and electricity, while organic waste is used to produce biogas.

Water is a renewable resource, but it is also precious. Providing water to cities in dry regions is a major challenge. Many regions have built desalination plants to provide water for urban centres. These require large quantities of energy. Even in Ireland, which receives copious amounts of rainfall, providing a sustainable water supply for Irish urban centres into the future requires costly investment.

The population of the Dublin region and the urban centres in the hinterland are growing. It is estimated that the population of Co. Dublin will reach over 2 million in the years ahead. Dublin has relied on the Poulaphuca works in Co. Wicklow for water supply for more than 70 years. The scheme is at full capacity, so a new water supply is needed for future demand.

Irish Water is planning to build a 170 km pipeline from the Lower River Shannon to Dublin, through the midlands. This will consume 2% of the waters of the River Shannon and provide 330 million litres of water per day. Irish Water hopes that the scheme will be in operation by 2025. The scheme will provide a sustainable water supply to Dublin, surrounding towns and all urban centres along the pipeline route for generations to come. There has been a lot of controversy about the decision to tap the River Shannon as locals complain and allege that 57% of Dublin's water supply escapes through leaks before reaching its destinations. Between 2008 and 2018, the Irish government has spent €100 million, or €10 million on average per year, to fix leaks. This is compared to the cost of the project in €1.3 billion.

This essay will explore climate, soils and flora in the Amazon Rainforest biome.

The Amazon Rainforest can be found approximately 5°N to 15°S of the equator. The rainforest experiences a tropical climate which influences the type of plants and animals that reside in the region. It is home to the greatest variety of biodiversity on the planet.

On average, the daily temperature is about 27 °C. With a temperature range of just 2 °C, there is very little daily or seasonal variation in temperature throughout the year. The diurnal range, which is the difference between day and night temperatures is greater than the difference between any of the seasons. As the Amazon Rainforest is close to the equator, the sun is always high in the sky. This results in intense solar energy hitting the surface. The sun shines for long periods of time. Each day has about 12 hours of sunlight every day, 365 days per year.

Annual precipitation exceeds 2,000mm, with rain falling throughout the whole year in the region due to the tropical climate. Rain occurs daily, with the heaviest falls in the afternoon. Two seasons can be identified, the very rainy season and the less rainy season (sometimes called the dry season). About 50% of the precipitation in the rainforest comes from its own evaporation and transpiration. The northeast and southeast trade winds converge in a low pressure zone close to the equator. Solar heating forces the warm, moist air to rise through convection. The air is cooled as it rises and condensation occurs, forming clouds in the process. This results in convectational rainfall, with thunderstorms and heavy rainfall.

The humidity level is permanently high due to the amount of water and heat. It averages 80%, with the higher humidity associated with the wetter months. The intense humidity is mainly due to the high rate of evaporation. The constant cloud cover also helps to keep the humidity high.

Tropical red soils, or latosols, make up the zonal soil associated with the Amazon Rainforest biome. At up to 30 metres in deep, they are among the deepest soils on Earth.

They are infertile soils that are low in nutrients, yet they can support a luxuriant cover of rainforest. The great depth of soil is the result of rapid chemical weathering of the parent material. The soils are infertile because they are strongly leached by heavy rainfall. Leaching is a process where minerals are washed out of the A horizon, or topsoil, and collect deep in the soil profile. The colour of the soils is determined by the minerals that remain. They are iron oxide, which gives a red rusty colour, and aluminium oxide, which gives a yellow colour. The minerals that are washed out collect deep in the soil profile to form an impermeable hardpan.

These soils lack silica and have low humus content due to the rapid breakdown of organic material. Various decomposers, such as insects, bacteria and fungi turn all dead plant matter to humus in a process called humification. The hot, humid conditions make tropical rainforests an ideal environment for bacteria and other micro-organisms. Plants quickly take up the nutrients from the O Horizon, or organic layer, the moment they are released if heavy rainfall does not wash them away. Therefore, the Amazon Rainforest has a very short nutrient cycle, taking a few days for decayed organic matter to be converted into humus and absorbed by vegetation. All life in the rainforest is based on decay.

Poor soil management, such as deforestation, intensive agriculture and industrialisation, coupled with heavy rainfall can lead to laterite soils developing. Laterite soils is a hard brick-like soil that is impossible to cultivate, when wet. It is formed when the soil dries up due to the absence of minerals. Due to the intense heat, it quickly turns to a brick-like structure.

Consequently, farmers can only make use of the soil for a maximum of two years once the Amazon Rainforest has been cleared, even when using the slash-and-burn technique. This is where forests are slashed, the stumps are burned and the ashes are mixed into the soil to increase short-term fertility.

Despite the infertile latosol soil in the Amazon Rainforest, it survives because the plant and animal remains soon decay in the warm, humid climate. In addition, hollow rooted trees quickly absorb nutrients released by decomposition. Most nutrients are stored in vegetation, when they die, they decay and are absorbed by the trees.

There is a great variety of vegetation, or flora, in the rainforest, supported by the climate and the soils of the region.

The biodiversity is so vast that it is estimated that in a 6km patch of rainforest, there can be as many as 1,500 species of flowering plants and 750 species of trees found. The high temperatures of about 27 °C, average rainfall of 2,000mm and permanently high humidity creates ideal conditions for lush plant growth.

The first layer of the rainforest is the emergent layer. These fast growing trees compete to reach sunlight. They range from 40 to 80 metres in height. In the emergent layer, trees are spaced wide apart with umbrella shaped outlines, which grow above the forest. Emergent trees are exposed to drying winds, they tend to have small pointed leathery leaves and waxy bark. They have shallow buttress roots, much of them overground. These prevent the tall trees from toppling over and increase the surface area from which the trees can draw their nutrients. The canopy layer is found 20 to 40 metres above ground level. Most of the flowering and fruiting of trees takes place here. The large leaves have a drip tip. This enables rainwater to run off quickly. Plants need to shed water to avoid the growth of fungus and bacteria in the warm, wet, tropical climate. Plants called epiphytes live on branches in the canopy. They obtain their nutrients from water and air rather than soil. These include mosses, lichens, orchids and ferns.

The understorey is found below the canopy layer. The trees are smaller and have evolved to live with less sunlight than trees in the canopy. They grow larger, wider leaves to capture any water or sunlight that trickles down. Young trees are found here, waiting for taller, older trees to fall and allow them to access sunlight to shoot upwards. The lowest layer consists of shrubs and the forest floor. The rainforest is very dark here. No more than 2% of the sunlight penetrates this far down. Few plants grow down there. Any vegetation consists of small shrubs and fungi that live off the thin layer of decaying leaves and other matter that has fallen from the trees onto the ground. Lianas are unusual in that they have their roots in the ground but wrap around trees to climb high into the canopy to reach available sunlight.