

8 Climate Change

Then We made you heirs in the land after them, to see how ye would behave! (Qur'an 10:14)

Weather, seasons and climate: some definitions

Weather is the condition of the air around us at any one time: is it hot or cold, sunny or cloudy, dry or rainy, windy or calm? **Seasons** are regular changes in weather patterns (wind strength and direction, rainfall, etc) at different times of year. **Climate** is the typical weather experienced (calculated from measurements of rainfall, temperature etc), averaged over a very long time, in different seasons over many years. The **global climate** is the average across the world.

Climate, seasons and weather in Zanzibar – Zanzibar has a **tropical monsoon climate**; it is typically hot and humid. The seasons are driven by the 'monsoon' or 'trade' winds. From November to March, the wind blows from the north (kaskazi) bringing short rains (vuli) in November, followed by a hot dry season (kiangazi) from December to March. In April, the monsoon starts to blow from the south (kusi), **triggering** the long rains (masika) which last until May, followed by the cooler long dry season (kipupwe) until September.

The weather may change daily, but seasonal patterns are more predictable and do not vary much, while climate usually does not change noticeably within a lifetime.

What influences climate?

The sun – Almost all the energy that controls our climate comes originally from the sun.

The atmosphere – About half the energy from the sun that reaches the earth is absorbed by the land and sea, warming it up; the rest is reflected, mostly as heat. But the reflected heat does not all escape into space. Layers of naturally occurring gases in the **atmosphere** act like a blanket or glass roof to keep the heat in, and the earth warm. This insulating process is called the **greenhouse effect** and is essential to life on earth. The gases which cause it are known as '**greenhouse gases**' (GHGs). The most abundant GHG is carbon dioxide, produced by respiration, burning, and when plants and animals rot in air. Less abundant, but a stronger **insulator**, is methane which traps 20 times more heat than carbon dioxide. Methane is produced when plants decay without air, for example in waterlogged earth or in **landfill** sites. Another GHG is nitrous oxide released by soil when forests are cut down.

Latitude and altitude – In the tropics, near the equator (low **latitudes**), the sun is overhead and its rays shine straight down onto the earth, so more energy reaches the land. However, at the north and south poles (high latitudes), the sun's energy has to travel through more **atmosphere**, so the earth is much colder and covered in ice all year round. On very high ground such as the tops of mountains (high altitude) there are fewer layers of **atmosphere** to hold heat in, so the higher you are, the colder it gets. This is why there is snow on Mount Kilimanjaro, although it is in the tropics.

The oceans – The sea helps regulate temperature extremes by storing and moving heat. Coastal climates do not vary as much as areas inland. For example in Zanzibar the difference between daytime and nighttime temperatures is about 6 degrees, while in Dodoma it is 12 degrees cooler at night than in the day. Oceanic currents move warm water from the tropics to cooler parts of the world warming them up, and cold water flows back.

Life – Plants and animals influence climate. Plant tissues absorb carbon dioxide as they grow, and release it when they rot. So all living plants in the world's forests and oceans are carbon dioxide stores, keeping the GHG out of the **atmosphere** and reducing the **greenhouse effect**. Millions of years ago, many of the earth's forests were flooded, which slowed down decay. So as trees died, dead branches and leaves built up in layers in the swamps. Over time, the layers of plant tissue became compressed, and eventually fossilised to become coal, oil and natural gas. These '**fossil fuels**' have therefore stored this carbon dioxide and kept it out of the **atmosphere** for millions of years. Animals produce carbon dioxide through respiration, and when cows and termites digest plant material they produce methane in their guts, which is released when they belch or fart!

What do we mean by climate change today?

Climate change occurs when there is a change in *average* weather conditions over a long period, as shown by measurements of weather conditions from several years, seasons and locations.

How do we know climate is changing? – In a human lifetime, climate seems constant, but scientists have found much evidence that during the past millions of years, the earth has been both much colder and much hotter than today. In cooler parts of the world, there are rocks with fossilised tropical animals such as corals (like coral rag) in places that are now too cold for corals to grow, so those areas must once have been much warmer. **Glaciers** today carve valleys in rocks, and we find similar valleys in areas now too warm for **glaciers**, so they must once have been colder.

How do we measure climate change? – Scientists have been recording temperatures and rainfall around the world since 1850! There are now over 22,000 weather stations monitoring our climate across the earth and oceans. Satellites measure cloud cover and radiated heat over the whole planet, giving us very precise measurements of what has happened to the global climate over many decades. We can learn about the more distant past from permanent ice – in **glaciers** on mountains such as Kilimanjaro, or in the polar **ice caps**. Each year a new layer of ice is formed: a thick layer in cold years and a thin layer in warmer years. Scientists have counted ice layers back and measured their thickness to find out how climate has changed and how quickly over the past 800,000 years! We also measure the size of ice sheets and **glaciers**, and monitor sea levels, which rise and fall when polar ice melts and freezes: a **tidal** gauge outside Stone Town measures Indian Ocean sea levels.



The **ice cap** on Kilimanjaro in 1993 and 2000 – scientists estimate the ice will disappear by 2015 © NOAA

What have we discovered? – All the different data and measurements tell us the same thing: our planet is getting warmer. In the past 25 years the planet has warmed by 0.5°C. In Tanzania, the annual average temperature has increased by 1°C since 1960 and is projected to increase another 1°C by 2060; reflected in an average rise in Tanzania of 0.02°C per year. This may not seem much – it is too small for us to feel – but this pattern is repeated around the world: little steps add up to big changes. The data show that permanent ice is melting – both polar **ice caps** and **glaciers** are disappearing rapidly due to rising temperatures. Sea levels are rising as water from the melting ice flows into the oceans. Temperatures are rising more rapidly, and changes are happening faster than they ever have before. The **greenhouse effect** is getting out of control.



Rotting **takataka** in dumps releases methane, a greenhouse gas © Nell Hamilton

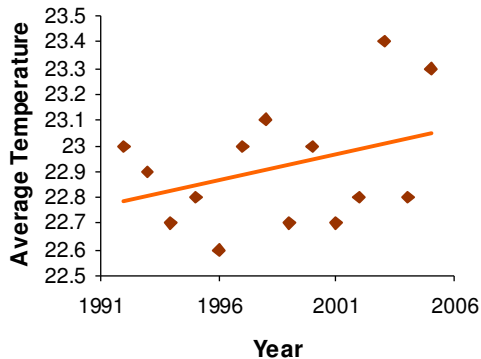
What is causing climate change now? – Natural forces will always influence climate, but they are not enough to explain the speed of climate change now. So what has changed?

Burning fossil fuels – When we burn **fossil fuels** (petrol, coal and natural gas) to cook, power vehicles or produce electricity for homes and businesses, the carbon dioxide that was stored by the plants millions of years ago is released. The global temperature started to rise 150 years ago: which is when humans first started burning **fossil fuels**.

Deforestation – As the human population of the earth increases, we need more and more wood, and land to grow crops on. Living trees absorb carbon dioxide during **photosynthesis** and store carbon in their tissues as they grow. When we cut forests down, they stop taking carbon dioxide out of the **atmosphere**, and when we burn the wood, we release the stored carbon back into the air. The population of Zanzibar is increasing at 3% per year, and deforestation is increasing – we cut down over 500 hectares of our forest every year.

Ulikua unajua...?

- A cow produces over 200 litres of methane every day!
- Tanzania is warming up by 0.2°C every 10 years



Agriculture – Removal of forest to cultivate land releases nitrous oxides into the **atmosphere**. People farm many cows and goats, which release methane, and when plants decay in rice paddies, and when food and plant waste rots in **landfills**, huge quantities of methane are produced.

Are humans really changing the climate of the whole earth? – Yes. Sadly, we are. Scientists are certain that the earth is warming, and this is largely the result of human activities, especially burning **fossil fuels**. Carbon dioxide levels in the **atmosphere** have increased by 40%, and methane levels have doubled since 1750 and could double again by 2050. Adding greenhouse gases to the **atmosphere** is like wearing more clothes – the gases trap more heat, the earth heats up, and the climate is changing.

How does climate change affect our environment – and us?

Extreme weather – **Storms**, droughts, floods and other extreme weather events, such as **cyclones** in the Indian Ocean, are becoming more frequent. Increasingly, forests, reefs, farms, towns and villages affected by them do not have time to recover between one **storm** and the next.

Higher temperatures and warmer oceans – Record high sea temperatures in recent decades have caused widespread **bleaching** of coral in the Indian Ocean, from which much has not recovered, with ongoing impacts on many socio-economically important reef-fish **species**.

Acidic oceans – Carbon dioxide from the air dissolves in the sea, making it more acidic, which can kill marine life (especially fish spawn), dissolve coral skeletons and stunt growth of shellfish.

Changing rainfall – In our grandparents' time, seasons were regular and predictable. But now the timing of seasons varies a lot, and in some years, in parts of East Africa, the rainy season has not come at all. When this happens, thousands, even millions, of people go hungry. In Zanzibar, all the water we drink comes from rainfall, which soaks into the ground. The coral rag acts like a big underground sponge, storing it. If we had a year without rain here, then large parts of Zanzibar would run out of fresh water to drink, and seawater would soak into the rock instead. Some coastal villages already have this problem. Those who can afford it buy in water from elsewhere, but most people can't afford to – and what if there were no fresh water anywhere?

Melting ice and snow – On Kilimanjaro, reduced snowfall due to climate change has resulted in 80% of the **ice cap** disappearing in the past 100 years. At this rate, by 2015 the ice will all be gone. The snow and **glaciers** of Mount Kilimanjaro act as a water tower, storing water that feeds several rivers as it melts during the dry season. As the ice disappears, the rivers are drying out, leaving nearby communities without water.

Rising sea levels – As polar and **glacier** ice melts into the sea, and the seawater itself expands as it gets warmer: the average sea level is rising. This will have significant impacts in low-lying coastal regions and islands such as Zanzibar. Sea level rise, on top of more frequent **storms**, increases coastal erosion: coastlines retreat and land becomes sea. Zanzibar is not yet affected, but other Indian Ocean islands are. Sea levels in Africa could rise by nearly 60 cm by 2100, which would seriously impact Zanzibar's coast.

Impact on biodiversity – Life on earth has survived climate change before, but historic changes were slow, and wildlife could adapt, by populations either spreading more to the north or south with each generation, or evolving to adapt to the new conditions. The change happening now is too fast for populations to adapt naturally, and if they could, farmland, roads and settlements create barriers preventing migration between wildlife-rich areas. Island populations of plants and animals cannot cross the sea, so if climate change brings too much or not enough water, or food **species** become scarce, many **species** will be unable to adapt and will disappear from Zanzibar; endemic **species** are likely to become **extinct**.

Tembea ujionee!

- Ask your grandparents if weather patterns have changed in their lifetimes.
- Visit hotels on beaches – are they leaving coastal vegetation to protect them from sea-level rise?

Impact on economic activities – We time sowing, planting and harvesting of crops according to the seasons. Heat-waves, droughts, or unseasonal rain can ruin our crops. Floods can **devastate** farmland and property, and widespread drought would cause terrible suffering. When **coral reefs** bleach and die, fish populations decline, and if Zanzibar runs short of water, it will not be able to support as many tourists. Many jobs will be lost.

How can we reduce the impact of climate change?

Reduce greenhouse gas emissions – Most greenhouse gases are produced by more developed countries, but we must still do our bit in Zanzibar. We can walk, or ride a bike or dala dala instead of driving, and take the ferry instead of flying. Those with a car or moped should make sure it is running well and burning fuel efficiently – no smelly black smoke! By buying products grown or made in Zanzibar, and made of local materials, we reduce fuel used to transport them. We can reduce methane emissions from rubbish dumps by making **compost** from plant and food waste (so it rots in air) instead of throwing it away – the **compost** will improve our soil and crops too! Plastic is made from **fossil fuels**, so making and burning it release harmful greenhouse gases. We must use less plastic, establish plastic recycling points in our communities, and use them! In the future, Zanzibar could generate all the electricity it needs from renewable sources such as solar, wind and **tidal** energy. Technology even exists to generate electricity from taka taka and sewage!

Reduce deforestation – Zanzibar's forests should be protected and restored. We can each use less firewood by using more fuel-efficient stoves instead of three-rock fires, and burning bio-briquettes instead of wood and charcoal. For building, we should choose timber from trees that grow quickly, harvested from plantations, not wild forests, and replant new trees to replace them.

And finally – Learn to Live with Climate Change – Of course we must all do our bit to reduce our contribution to climate change, but we have to accept that the climate is getting warmer and this will bring changes to the environment. So we must learn to live in a changing world. **Coral reefs**, **seagrass beds**, beaches, mangroves – all coastal vegetation – helps protect coastal property from the effects of **storms** and sea-level rise, so we need to treasure these **habitats**. New developments in coastal areas should be set back from the beach to allow for the **encroaching**



Mangroves help protect coastal communities from rising sea levels, **storms** and erosion © Rachel Hamilton

sea, and sand must not be taken from beaches. Vegetation inland should be protected and restored, so that rainwater is absorbed into the ground, instead of washing into the sea, taking soil and nutrients with it. We must collect rainwater, and not use water excessively. Farmers can choose drought-resistant crop varieties that need less water and the tourism industry should reduce its water consumption. **Together we can protect our beautiful islands for the future.**

Kitunze kidumu!

- Switch off lights, fans and a/c when you're not using them.
- Use energy-saving lightbulbs
- Don't leave taps running when washing dishes clothes. or yourself – use a bucket.