CAIE Geography Pre-U

3A: Meteorological Hazards

Essential Notes

Definitions, classification and distribution

A **hazard** is a potential threat to **human life** and **property** caused by an event. Hazards can be human caused or occur naturally (natural hazards). An event will only become a **hazard** when it is a threat to **people**. E.g. if a hurricane hit an uninhabited desert island it would not be classed as a hazard.

Methods of classification

There are different ways of classifying meteorological hazards.

- **By scale** eg. local or regional **and frequency**
- **By nature of the hazard** eg. wind, precipitation, temperature
- **By the scale of intensity for wind hazards** eg. the Saffir-Simpson scale
- **By wind speed for wind hazards** eg. depression, tropical depression, tropical, storms, tropical cyclones

Distribution

Tropical cyclones are mainly found in the tropics. They occur near the coast and are mainly on the east side. Tropical cyclones track away from the equator.

Areas that are at risk from **drought** are mainly found in the southern parts of the continent in areas surrounding deserts.

Areas at risk from **floods** are usually by the coast or by major rivers. Also occurs in areas which are affected by tropical cyclones. Floods occur in every continent.

Regional-scale hazards and their explanations and causes

Causes of the global distribution in relation to the global energy budget

- **Vertical transfers**: Heat energy can be transferred by four methods. By **conduction**, **convection**, **radiation** and by **latent heat**. The amount of heat energy is not evenly distributed across the Earth causing some to have a net surplus and some to have a net deficit of heat energy. This affects the climate of the area and so will cause different meteorological hazards.
- **Horizontal transfers**: As the Earth is not heated evenly, heat energy needs to be transferred from areas of surplus to areas of deficit. This occurs by the **tri-cellular model**, **ocean currents** and the **jet stream**. Areas within the **Hadley cell** of the tri-cellular model, so between the equator and 30 degrees north/south, are at most risk from cyclones and storms due to the correct sea surface temperature and rising warm, moist air from the equator.
- **Coriolis force**: Due to the rotation of the Earth, wind that moves from areas of high pressure to low pressure is **deflected**. This means that cyclones cannot occur at the equator as air is not being deflected.

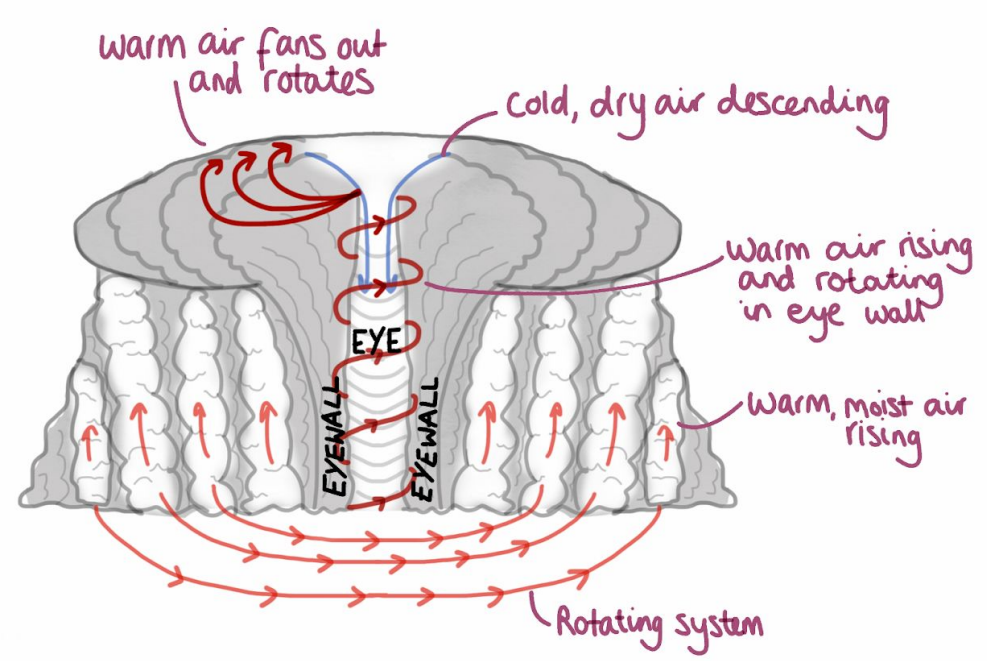
The formation of tropical storms and cyclones

There are certain **conditions** for a tropical storm to form and develop:

- **Temperature:** Ocean temperatures must be around **26 - 27°C** and at least 50 metres deep. Warm water provides the storm with **energy**.
- **Air pressure:** Must be in areas of **unstable air pressure** - usually where areas of high pressure and low pressure meet (**convergence**) - so that warm air rises more readily and clouds can form (this air must also be humid for cloud formation). Warm air rises because it is **less dense** than cold air.
- **Wind shear:** Winds must be present for the **swirling motion** to form, but not too strong or the storm system will be **ripped apart** in the early stages.
- **Rotation:** Tropical storms only form around the equator, but no less than **5° on either side**. The **Coriolis Effect** is the effect of the **Earth's rotation** on weather events. The storm spins because the Earth is spinning; but there is **no Coriolis Effect at the equator**, hence why these storms will only form a certain distance away from it.
- **A trigger:** a pre-existing thunderstorm, a spot of very high sea surface temperature, an area of low pressure and many other factors can act as a **trigger** for a storm to develop, which will only further develop when the **other conditions are present**.

Formation

1. **Warm, moist air rises**, leaving an area of **low pressure below**. This causes warm air from surrounding areas of higher pressure to **move into this low pressure area** and rise too. Overall, **warm air is constantly rising** and accumulating in the atmosphere.
2. When the warm air rises, it **cools**, condensing into **thunderstorm clouds**.
3. The whole system is spinning due to the **Coriolis effect**. In the **southern** hemisphere, the storms spin **clockwise**; in the **northern**, **anticlockwise**.
4. The **constant addition of energy** from the warm air causes the storm to spin faster and generate higher wind speeds. At **39 mph** the storm can be classed as a **tropical storm**.
5. The **eye** of the storm is in the centre. This is an area spanning around **30 miles wide** that is of **extremely low pressure** (can be 15% lower pressure than areas outside of the storm). Cool, dry air (cool from the higher altitudes and the moisture has been transferred into the system) descends in the eye, causing the weather to be relatively **calm and cloud free**. The more intense the storm, the clearer the eye.
6. Surrounding the eye is the **eyewall**, the most **intense and powerful** area of the storm. **Warm, moist air rapidly rises** here, with extremely **high winds and torrential rain**. When winds reach **74 mph**, it becomes a hurricane/cyclone/typhoon.



7. When the tropical storm reaches a coast, the **low pressure and high winds** will cause a large amount of sea water to be **taken into the system** and then released as a high wave called a **storm surge**.
8. When the storm reaches **land**, it no longer has a **supply of energy** (warm, moist air from the sea) and the eye eventually **collapses**. Heavy rain can persist for days.

Due to the **Bernoulli Principle**, which states that as there is an increase in the difference between pressures of two areas the movement of air increases, the big difference in pressures within the cyclone cause the wind speeds to be very high.

Seasonality of regional-scale hazards

As the conditions for tropical cyclones are so specific, they can only occur in certain times of the year when all the conditions have been met. This is usually just after summer when the sea surface temperatures are at their warmest and the difference between wind speeds with an increase in altitude is very low.

Droughts and floods rely on the extremes of levels of precipitation. In most places, precipitation levels vary seasonally along with temperatures which, if high, can decrease the levels of available water.

The changing nature of tropical cyclones

Tropical cyclones are getting stronger and lasting longer mainly due to the fact that the level of energy in the oceans is increasing due to **global warming**. They are also **moving more slowly along the ground** which means that they can cause more damage. Due to global warming and the melting of the polar ice, **sea levels are rising**. This will make storm surges caused by tropical

cyclones more dangerous. Each year there are similar numbers of tropical storms, however, more of these tropical storms are reaching cyclone status.

The changing nature of droughts

In **1950 1% of the land was affected by droughts, in 2000 this increased to 3%**. An increase in the global surface temperatures due to climate change is increasing the levels of evapotranspiration and so there is less surface water.

The changing nature of flooding

Deforestation means that the levels of **infiltration are decreasing**. **Rising sea levels** are causing increased levels of flooding in coastal areas. Increasing **urbanisation** means that there are fewer areas of land for infiltration to occur and people are also building on land which is **prone to flooding** as other areas have already been built on. An increase in atmospheric temperatures will mean that the atmosphere can hold more water, leading to more intense downpours.

Local-scale hazards and their explanation and causes

Tornadoes

Tornadoes are **vertical funnels of rapidly spinning air**. Their winds can be up to **250 miles per hour**. Tornadoes form when a **change in wind direction or speed creates a horizontal spinning effect** within a storm cell. This horizontal spinning is then **tipped vertically by strong updrafts** rising up through the storm clouds. They occur more in spring and summer and usually occur in the late afternoon.

Supercells are storms that contain updrafts that rotate about a vertical axis. They are formed when a moisture-rich, warm air mass collides with a cooler, drier air mass.

Hail

When **water freezes together in the upper regions of a thunderstorm cloud**. A droplet of water will freeze at a certain height in the storm cloud. It will then begin to fall but is pushed back upwards by strong updrafts. Another water droplet will then freeze onto it and it will begin to fall. This process repeats until it is too heavy to be lifted back up by the updrafts and it falls as hail.

Blizzards

A blizzard is when there is a **large amount of snowfall, with winds greater than 56km/hr and less than a quarter of a mile visibility**. It must also last for more than **three hours**. Blizzards usually form when cold polar air meets warm moist air. The cold air at ground level and the moisture-rich clouds above with warm rising air create the conditions needed for a blizzard.

Fog

Fog is a **thick cloud of tiny water droplets suspended near or at the Earth's surface**. These water droplets obscure visibility. There are two types of ways that fog can form: by advection or by infrared cooling. **Advection** is where warm air is pushed by winds along a cool surface. The moisture in the warm air condenses to form fog. Fog formed by **infrared cooling** occurs due to

changes in seasons and the absorption of heat by the land. In the summer the ground absorbs solar radiation. When the seasons change a cooler air mass collides with the warm moist air mass prevalent over the warm ground. This causes the water vapour to condense quickly and so forms fog.

Photochemical smog

Is formed when **ultraviolet light from the sun reacts with nitrogen oxides** in the atmosphere. It mainly occurs in densely populated, warm cities such as Beijing and Sydney.

Consequences and impacts

Primary hazards

- Storm surge
- Strong winds
- Collapse of buildings
- Flooding
- Injury and death
- Roads blocked
- Hospitals/schools damaged
- Hypothermia
- Transport disrupted
- Increase in road accidents
- Roof collapse
- Reduced visibility
- Respiratory problems
- Crops damaged

Secondary hazards

- Increase in the spread of diseases
- Landslides
- Increase in food prices
- Famine
- Increase in water-borne diseases
- Communications damaged
- Transport and trade disrupted
- Pollution of water sources
- No school
- Decrease in productivity
- The strain on the health service

Consequences

Economic consequences for HICs:
- Job losses
- Businesses collapse
- Lower productivity
- Cost to the insurance industry

Economic consequences for LICs:
- Reliance on aid
- Aid could undercut local prices and put local businesses out of business

Social consequences for HICs:
- Unable to go to work
- Homelessness
- Death and injury

Social consequences for LICs:
- Death and injury
- Spread of diseases
- Displacement/migration

Environmental consequences:
- Damage to habitats
- Air pollution
- Water pollution
- Debris
- Agriculture affected

Political consequences for HICs:
- Criticism of government
- Prioritisation needed which could be difficult and promote controversy.
- Media influence

Political consequences for LICs:
- Corruption from aid
- Instability

Management and mitigation

Mitigation vs adaptation

Mitigation is attempting to **stop the effects** of the hazard by trying to plan beforehand whereas adaptation is attempting to **live with a hazard** by altering lifestyles.

Modifying the risk

This involves **monitoring, prediction and prevention**.
- Forecasting and warning
- Land-use planning
- Reducing global warming

Modifying the hazard

This involves **preparation, protection and reduction of impacts**.

- Community preparedness
- Environmental control
- Design

Modifying the loss

This involves **rescue, relief and recovery**.

- Accept loss
- Aid
- Insurance
- Emergency services and disaster relief teams