THE CHALLENGE OF NATURAL HAZARDS

A NATURAL HAZARD is a naturally occuring event that threatens life or property.
↳ can be divided into types of hazard:

GEOLOGICAL
↳ to do with the earth
→ volcanoes, earthquakes, landslides, avalanches

ATMOSPHERIC
↳ to do with the sky
→ storms, floods, droughts, climate change.

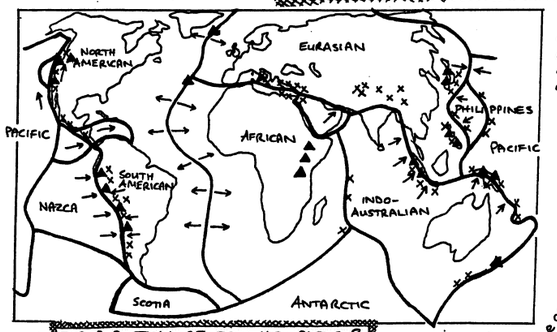
FACTORS THAT AFFECT HAZARD RISK

PHYSICAL
- TYPE OF HAZARD → some can be predicted and prepared for, e.g. storms.
- FREQUENCY → does the location have time to recover between hazards?
- MAGNITUDE → larger hazards do more damage.

HUMAN
- LEVEL OF ECONOMIC DEVELOPMENT → richer countries can predict, protect & prepare
- POPULATION DENSITY → high populations put more people at risk.
- CLIMATE CHANGE → may be making some hazards more common.

TECTONICS

→ plate movement
▲ volcano
× earthquake



DISTRIBUTION OF EARTHQUAKES & VOLCANOES IN RELATION TO PLATE MARGINS

VOLCANOES occur at destructive & constructive boundaries.

EARTHQUAKES occur at all three plate boundaries.

CONSERVATIVE MARGIN
1) plates move sideways past each other.
2) no gaps for magma so no volcanoes
3) huge friction so many earthquakes.
e.g. San Andreas, W. USA.

CONSTRUCTIVE MARGIN
1) plates move apart
2) magma rises to fill the gap
3) running lava so not very explosive and spreads out, allowing enough to create SHIELD volcano.
e.g. Mid-Atlantic Ridge

DESTRUCTIVE MARGIN
1) oceanic crust is denser so is pushed down (subducted).
2) carries with it unstable materials which work their way back through Continental Plate to erupt as a COMPOSITE (explosive) volcano.
e.g. West-coast of South America.

CONTINENTAL CRUST
↳ lighter, thicker (20-200km), cannot be destroyed.

OCEANIC CRUST
↳ denser, thinner (5-10km), created and destroyed at plate margins.

PROCESSES
1) CONVECTION CURRENTS, set off by the heat of the core, rise through the mantle and spread out under the crust, dragging the plates along.
2) SLAB-PULL ↳ the weight of the subducted oceanic plate being pulled into the mantle drags the rest of the plate with it.
3) RIDGE-PUSH → magma rising at Constructive Boundaries forms a ridge on the sea floor. As this cools it becomes denser, then slides away from the ridge, pushing the plates apart.
→ not really any hard evidence of this happening!

TECTONIC HAZARD NAMED EXAMPLES

HIC

L'AQUILA (2009)
- 6th April 3.32am
- 6.3 Richter

EFFECTS
- PRIMARY: 67,500 homeless, 1500 injured
  - * 308 deaths, mostly due to collapsed buildings
  - * US$11.4 million damages
  - * cultural sites collapsed, including Basilica of St Bernardino
- SECONDARY:
  - * broken water pipe near Paganica caused landslide
  - * Fewer students at university
  - * Fires caused more damage

RESPONSES
- IMMEDIATE: * 7 dog units, 36 ambulances & temporary hospital set up.
  - * British Red Cross £171k
  - * EU granted $553 million
  - * mortgages suspended
- LONG-TERM: * no taxes paid until 2010.
  - * discounts for students on fees
  - * scientists taken to court

LIC

GHORKA, NEPAL (2015)
- 25th April 11.56am
- 7.8 on Richter

EFFECTS
- PRIMARY: * 8,841 dead
  - * 16,800 injured
  - * up to 3 million homeless.
  - * damages up to $5 billion.
  - * 26 hospitals destroyed
  - * 50% schools destroyed (many more deaths if had been a school day).
  - * World Heritage Site Dharahara Tower destroyed.
- SECONDARY:
  - * 19 killed by an avalanche on Mount Everest.

RESPONSES
- IMMEDIATE: $126 million sent by UK's D.E.C.
  - * Tents provided for 500,000 people.
  - * Tricky to reach everyone due to mountains. 815,000 cut off by road.
- LONG-TERM:
  - * International conference in June to get technical support.
  - * Stricter building regulations
  - * 7000 schools to be rebuilt
  - * Heritage sites reopened by July to encourage tourists.

Primary are a direct result of hazard
EFFECTS
Secondary happen because of the primary effects

RESPONSES
↳ Long-term responses are into weeks, months or even years.
Immediate responses are within hours/days

WHY?
do people still live in danger areas?
1) They've always lived there, have a life and a job there
2) They believe there won't be another disaster soon or that the government will support them.
3) They rely on their location, e.g. tourist attraction, fertile volcanic soils or energy & heat from geothermal energy. (all apply to Iceland!).

MANAGEMENT

PROTECTION
- * earthquake proof buildings with flexible reinforcements
- * shut-off valves on gas & electricity supplies.

PREPARATION
- * training for emergency services
- * education of people (inc. schools)
- * government evacuation plans
- * keeping emergency supplies inc. food, water & blankets.

MONITORING
- * small earthquakes can suggest a larger one is coming
- * monitoring of gas escapes, ground temperature, shape of the land and small earthquakes can indicate an eruption

PREDICTION
- * for earthquakes this is impossible, but mapping previous quakes could suggest most likely next location → plan ahead.
- * quite good at predicting volcanoes these days

It's all about...

CAUSES
↳ the theory & processes that lead to the hazard.

EFFECTS
↳ things that happen because of the hazard.

RESPONSES
↳ what is done to help people after a disaster

EXAMPLES

MANAGEMENT
↳ what can be done to monitor, predict, prepare and plan for hazards.

WEATHER

Sun's energy hits at an angle so is spread over a wide area.
4) Coldest part of the earth is the poles. Air here sinks and moves south towards the equator.

POLES (very cold, and dry due to sinking air). HIGH PRESSURE

POLAR CELL — Winds going southwest (Northeasterly)

POLAR FRONT (changeable and wet due to converging and rising air). LOW PRESSURE

FERREL CELL — winds going northeast (Southwesterly)

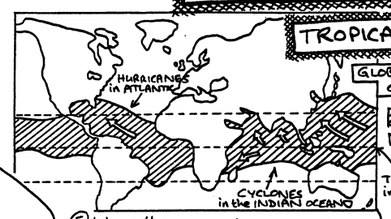
DESERTS (very dry due to sinking air) HIGH PRESSURE

HADLEY CELL — winds going southwest (Northeasterly)

EQUATOR — very hot & very wet (rising air) LOW PRESSURE

5) where the warm air from the south meets cold air from the north, the warm air rises, creating rain and changeable weather. (like the U.K.).

TROPICAL STORMS



GLOBAL DISTRIBUTION OF TROPICAL STORMS
- sea temperature above 27°C
- movement of storms.
- TYPHOONS in the PACIFIC OCEAN

CLIMATE CHANGE
↳ increased global temperature will mean:
- * DISTRIBUTION – more of the world will have warm enough oceans so storms will move further North & South
- * FREQUENCY – sea warmer for longer in the year so more storms.
- * INTENSITY – warmer water = stronger storms.

GENERAL ATMOSPHERIC CIRCULATION
1) They start in sea with temperature above 27°C.
2) The hot air rises and creates condensation and energy
3) Rising air creates low pressure, which sucks in air from surroundings.
4) winds on the equator move the storms to the west.
5) The spin of the earth caused the storms to spin.
6) As long as the sea stays over 27°C, the storm gets stronger.
7) Once the storm moves over land or colder water, it loses its power and disperses.

FORMATION OF STORMS
3) Once the air has cooled enough, it sinks. Sinking air warms as it sinks, absorbing more water. Therefore NO RAIN here (Desert belt).
2) In the upper atmosphere, the hot air spreads out and moves North and South (having dropped all its moisture as rain)
1) HOT AIR rises at the equator → this is the engine for the whole circulation → Hottest part of planet as the sun is concentrated straight down onto the surface.

NAMED TROPICAL STORM

TYPHOON HAIYAN
- Philippines
- 8th November 2013
- Category 5 with winds up to 315km/h.

EFFECTS
- PRIMARY: * 6300 dead.
  - * huge storm surge up to 5m flooded coasts.
  - * 5 million homeless
  - * 90% of Tacloban city destroyed.
  - * 3/4 farmers & fishermen lost their income → estimated $724 million
- SECONDARY:
  - * landslides blocked roads, and ferries & planes disrupted, slowing aid.
  - * 800,000 litre oil leak from damaged barge polluted mangroves.
  - * looting & stampedes caused 3 deaths.

RESPONSES
- IMMEDIATE:
  - * Philippines Red Cross provided basic food & water, with support from NGOs.
  - * Tacloban residents sheltered in stadium, which then flooded.
  - * $1.5 billion sent in aid.
  - * curfew to reduce looting at night.
- LONG-TERM:
  - * Oxfam supported replacement boats.
  - * "Build Back Better" scheme to learn from storm.
  - * improved warnings, "no build" areas and new defences.

PLANNING
- * training of emergency services
- * government evacuation routes to get people out
- * restrict future building in danger areas.

MONITORING
- * storms are tracked by radar and by satellites as they cross oceans.

PREDICTION
- * computer models allow the most likely path to be predicted.
- * gives people time to evacuate their homes, and protect as best they can. (boarding up windows).

PROTECTION
- * reinforced buildings to withstand winds
- * flood defences and houses on stilts to avoid damage (sea walls and levees).

U.K. EXTREME WEATHER EXAMPLE

STORM DESMOND
- * 3rd-8th December 2015
- * Northern England, Scottish borders & Western Ireland.

CAUSES
- * caused by an "atmospheric river" of moist air from the Caribbean stretching up into N. Atlantic

EFFECTS
- SOCIAL: * 3 deaths
  - * 5,200 homes flooded, but 61,000 without power due to flooded electricity sub-station in Lancaster.
  - * Cumbria NHS trust only running essential services. (Cumberland hospital in Carlisle running on generator)
- ECONOMIC: approx £400-£500 million in costs.
  - * loss of business for shops & employers.
- ENVIRONMENTAL: * landslide closed part of railway between Preston & Carlisle.
  - * waterfall flowing at Malham Cove for first time in Living Memory.

MANAGEMENT
- * £50 million from government for future protection (£5000 per house)
- * flood defences were overtopped, and then stopped water draining away

U.K. EXTREME WEATHER

- RAIN can cause flooding, damaging homes & businesses and disrupting transport, e.g. Cumbria (2009)
- DROUGHT → lack of rain leads to water shortages, e.g. 2003 drought across UK. & Europe caused ~29,000 deaths.
- STORMS → heavy winds can uproot trees and disrupt transport
  - → worse on the west from the Atlantic, e.g. late 2013.
- COLD → big impact on agriculture (can kill crops/animals) and disrupt transport, e.g. 17,000 trains cancelled in January 2014 due to cold.
- HEATWAVES → 2003 heatwave killed 20,000 people across Europe → record 38°C in Kent!

.... GETTING MORE EXTREME?

↳ The UK. has always experienced extreme weather, but there is evidence to suggest it is getting more extreme.
- → December 2010 coldest for 100 years → 4 months later April 2011 was warmest April on record.
- → March 2012 had hosepipe bans due to drought, but 2012 went on to be 2nd wettest year on record.
- → 2010-2014 saw more rainfall records broken than any previous decade, in only 4 years!

CLIMATE CHANGE

Throughout the Quaternary period (the last 2.6 million years), the earth has fluctuated between cold glacials lasting ~100,000 years and warmer interglacials of ~10,000 years
→ we are warmer today than we have ever been.

EVIDENCE
↳ ice cores can be drilled into Antarctica and layers of ice analysed back 400,000 years to tell use past temperatures
- the same can be done with ocean sediments analysing fossils back 5 million years.

CAUSES

HUMAN
- Humans cause climate change via the greenhouse effect where sun's energy is trapped inside the atmosphere
- FOSSIL FUELS → CO_2 from cars & industry
- AGRICULTURE ↳ cows & rice fields produce methane.
- DEFORESTATION ↳ cuts down trees that store CO_2

NATURAL
- ORBITAL CHANGES ↳ the way the earth orbits the sun changes on cycles over thousands of years → may cause glacials & interglacials
- VOLCANIC ACTIVITY ↳ large volcanoes create enough sulphur dioxide to block sunlight (e.g. Mount Pinatubo)
- SOLAR OUTPUT → the amount of energy from the sun varies, but probably not enough.

EFFECTS
- ENVIRONMENTAL
  - * shrinking ice caps
  - * rising sea levels
  - * coastal flooding
  - * coral reef bleaching
  - * loss of biodiversity
- PEOPLE
  - * deaths from heat & drought
  - * migration from coastal areas
  - * political tension over water.
  - * farming changes causing malnutrition.

MANAGEMENT

MITIGATION ↳ reducing the causes.
- ALTERNATIVE ENERGY PRODUCTION → e.g. wind farms. ↳ don't produce CO_2
- CARBON CAPTURE → capturing the CO_2 released and transporting it to be stored underground (usually in emptied oil & gas fields or unmineable coal seams.
- * PLANTING TREES → absorb CO_2
- INTERNATIONAL AGREEMENTS → e.g. Paris 2015, where 195 countries agreed to try to slow global warming
- CHANGING AGRICULTURAL SYSTEMS ↳ current farming zones need to shift, e.g. peaches in Southern England. ↳ G.M. crops e.g. drought resistant millet in Kenya.
- MANAGING WATER ↳ water meters for awareness, rainwater harvesting and better recycling of water.
- COPING WITH SEA LEVEL RISE ↳ physical barriers, e.g. Thames Barrier, or evacuation of areas.

ADAPTATION ↳ adjusting to the changes.