


A-Level H2 Geography Notes

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2020 (CLTs Not Done)
For Syllabus 9751 [For Release Online]

Chong Zheng Xuan

To the Reader:

Hello my fellow H2 Geographer reading this!

There has been a lack of notes online for H2 geography and I thought this may be of help. Please note that I am neither a trained professional to teach A level geography nor am I some type of geog god, I am just a student like you that has gone through 2 years of reading stacks and stacks of school notes and tutorials.

This set of summary notes are a shortened version of the content required for A levels and it is the **absolute bare minimum** that I believe is needed to do decently for exams. I do have to admit, I have more examples and points of evaluation when I studied for my A levels that i did not include here(im sorry) but to respect the work and the hours that my school teachers have put in to plough through examples and readings, I do not feel like it is right to share all the content out online for everyone so freely. **Note that every school teaches geog differently**- therefore please do not be alarmed if the content here is different from what you learn in school, consult your teachers and departments, they know *much much much much much* more than me!

To protect my work and others from being scammed, I would kindly request the readers to **NOT PASS THIS OFF AS YOUR OWN WORK** and sell them out as yours-- I have purposely included minor errors in every chapter and I have a recorded sheet of all of them. **Yes, I can and will be able to prove it's my work if you sell this.**

Other than that, I hope I make studying this subject less painful and more enjoyable, I wish all of you all the best in your geog adventures!

Chong Zheng Xuan, 2020.

Content Page

1	**Factors Affecting Temperature**

A. Distinctive characteristics of the tropics based on the Köppen–Geiger climate classification system. - humid tropics: tropical rainforest (Af), tropical monsoon (Am) and tropical savanna (Aw) - arid tropics: sub-tropical steppe (BSh) and tropical desert (BWh)	

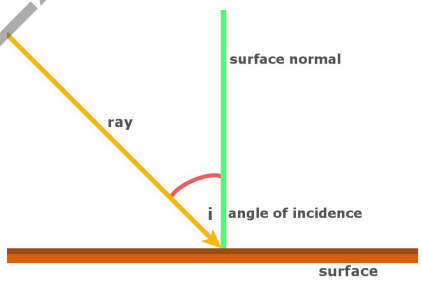
Latitude

Refers to the **angular distance north or south from the equator of a point on the earth's surface.** Affects the angle of incidence and the amount of atmosphere in which insolation needs to pass through.

1. Angle of Incidence

Due to the spherical nature of earth, the angle of incidence is the lowest at the **subsolar point (SSP)**.

- The **subsolar point** is the point **receiving perpendicular insolation**, where the intensity of insolation is greatest.
- intensity of insolation decreases as the distance from subsolar point increases as
  - the area in which the same amount of insolation is spread across increases
  - Known as **beam spreading**

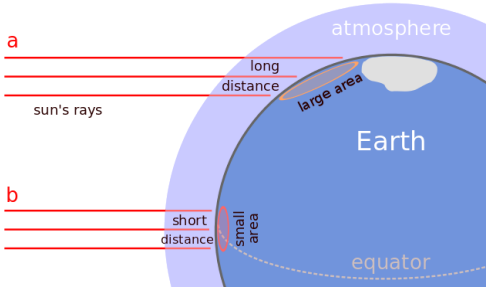


Due to the tilt of the earth, the SSP moves from the Tropic of Cancer(23.5˚N) to the Tropic of Capricorn(23.5˚S) annually.

2. Amount of Atmosphere

As A_a is larger than area A_b, the **amount of atmosphere** that is needed to be infiltrated through by the insolation before reaching the earth's surface is lower at lower latitudes.

- Leads to less absorption, scattering and reflection
- Beam depletion is minimised.

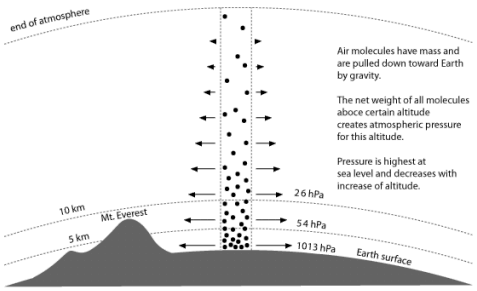


Altitude

Refers to the height above sea level

➢ Affects temperature by lower atmospheric pressure and heating at surface

1. **Effect of Atmospheric Pressure**



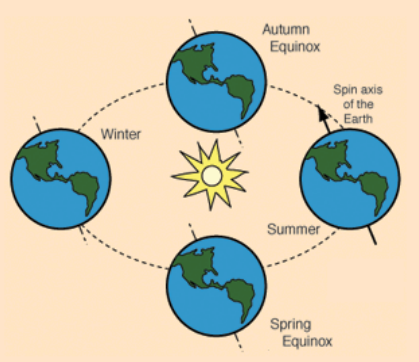
Due to the **earth's gravity**, molecules of air are closer to the ground, there is lesser air molecules up at higher latitudes, so there is **lesser heat trapped** by the air molecules at higher altitudes.

2. **Effect of Surface Heating** (more impt)

The air is mainly heated by terrastrial longwave radiation (infrared radiation).

- As the distance from the ground increases, the further the air molecules are away from the heat source of the ground.

Axial Tilt



There is a 23.5˚ angle between the earth's equatorial plane and orbital plane.

- Influences seasons by influencing the
  - Latitude of SSP at different parts of the year
  - Length of daylight in which a location receives
  - Locations at 0˚ has equal lengths of day & night
    - As such has no seasons

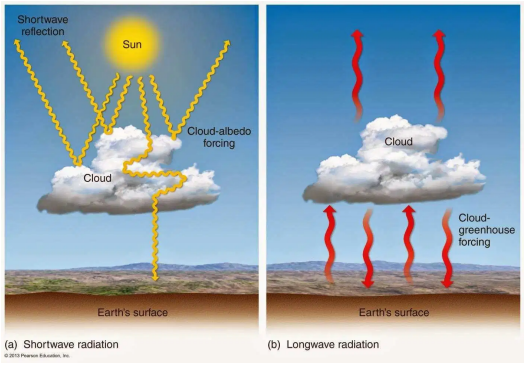
Cloud Cover

Affects the **diurnal temperature range** of a location.

During the day:

Clouds **reflect and scatter** incoming insolation.

- reducing the insolation received at the earth's surface.

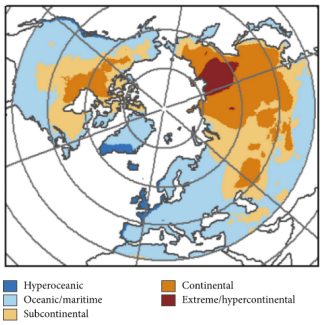


During the night:

Clouds **reflect outgoing terrestrial longwave radiation back to the earth** in a process of counter radiation.

High cloud cover results in warmer nights and cooler days, resulting in a lower DTR.

- The converse is true as radiation can enter and exit earth's surface unimpeded.



Continental and Maritime Effect

Affects annual temperature range, seasonality of temperature and DTR.

- Also affects the **migration of meandering intertropical convergence zone (ITCZ)** [chapter 3]

Oceanic Locations	Continental Locations
• Water has a higher specific heat capacity • As such it heats up and cools down slower • Water acts as a regulator of temperature • Air above the sea is warmer during winter and cooler during summer	• Land has a relatively lower specific heat capacity • Heats and cools faster • It makes the minimum and maximum temperatures of the area more extreme
Results in warmer winters & cooler summers	Resulting in cooler winters & warmer summers.
Results in less seasonality in temperature, lower diurnal temperature range and lower annual temperature range	More seasonality in temperature, higher DTR, higher ATR.

There are also other factors that affect a location's temperature like the presence of the aspect effect, albedo, warm/cool ocean currents, El Niño and more.

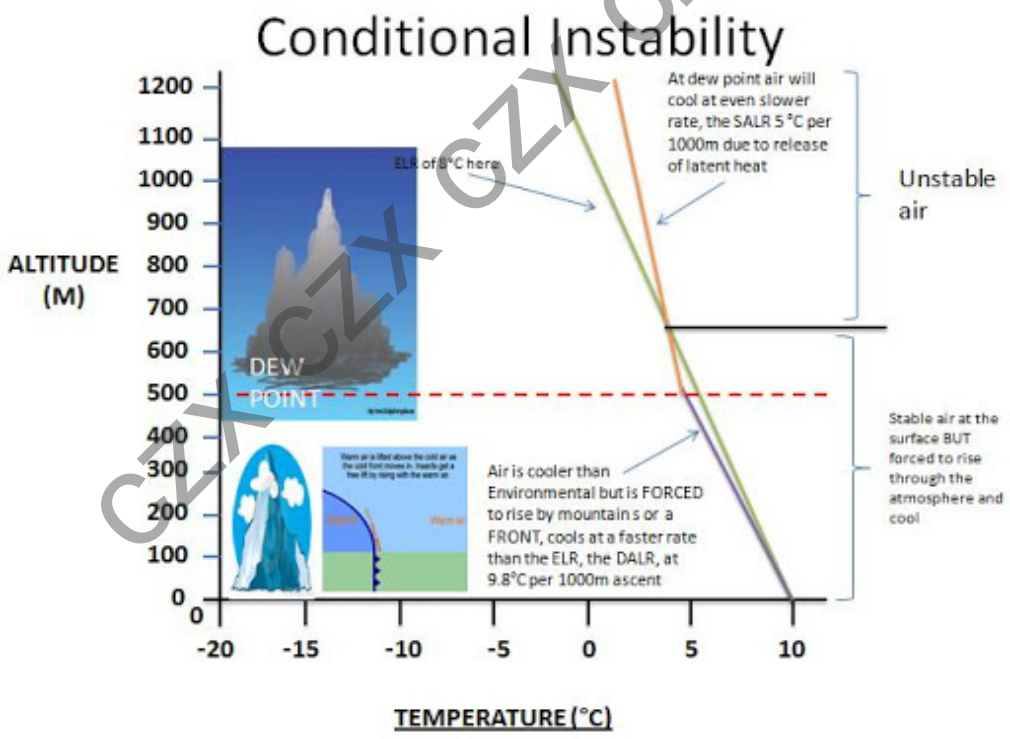
2	**Factors Influencing Rainfall**

A. Other factors influencing rainfall - topography: orographic rain - local heating: convectional rain - impact of ocean currents on sea-surface evaporation - the effect of continentality	

Atmospheric Stability

Refers to the **tendency** of an air parcel to either **remain in place or change vertical position.**

- **Air parcel is considered stable** if it is
  - **cooler and hence denser than surrounding air**, **resisting displacement upwards**, tending to return to its starting altitude when disturbed.
- An air parcel is **unstable** if it is
  - **warmer and hence less dense than surrounding air,** tending to **continue rising** until it reaches an altitude where the surrounding air is of similar temperature and density

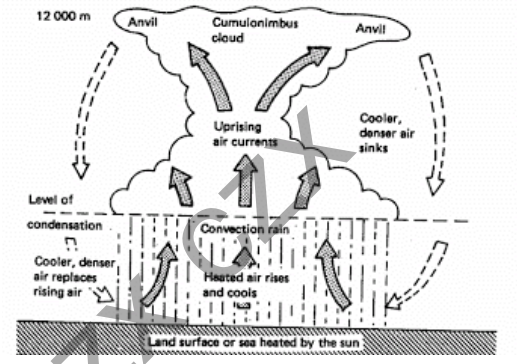


Types of Rainfall

The process of the formation of clouds and thus rain is similar for all 3 types of rain which is the following process:

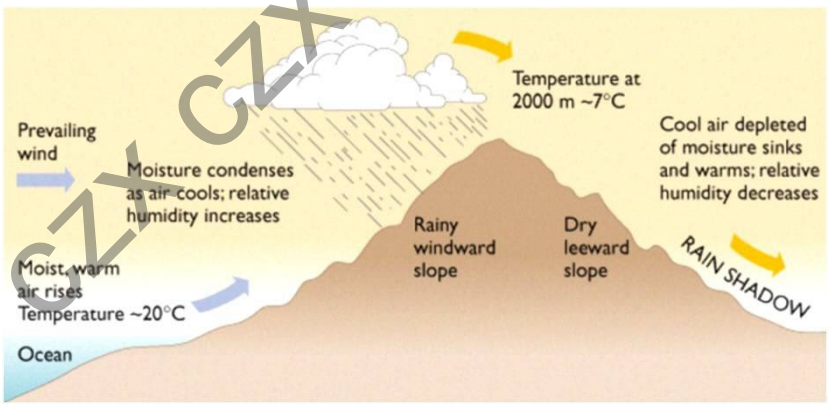
"As the air parcel **rises**, **expands** due to **low pressure in higher altitudes** it **cools adiabatically.** It then reach **dew point temperature** with a **relative humidity of 100%**. It then undergoes **active condensation** in the presence of **cloud condensation nuclei** and forms clouds."

1. Convectional Rainfall



- The earth's surface absorbs the **short wave radiation from the sun.**
- The earth's surface **heats up the air layer** near the ground by emitting terrestrial **longwave radiation**
- Air parcel **expands**, becomes **less dense and rises**.
- ***<VOMIT THE PARAGRAPH ABOVE>***
- This forms **cumulonimbus** clouds that cause heavy rains and lightning.
- Common in warm and heated areas (Tropics).

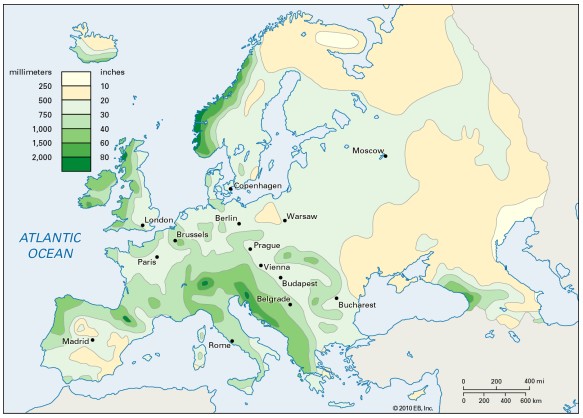
2. Orographic Rainfall



- The onshore warm moist wind (due to sea surface evaporation) reaches land and is encountered by a barrier like a mountain.
- The **stable air parcel** is then **forced** by the prevailing wind to **rise against the gradient of the mountain.**
- This is known as the **windward** side
- ***<VOMIT THE PARAGRAPH ABOVE>***
- The rain then **rains mostly over the windward** side, leaving the **leeward side with little to no more rain**.

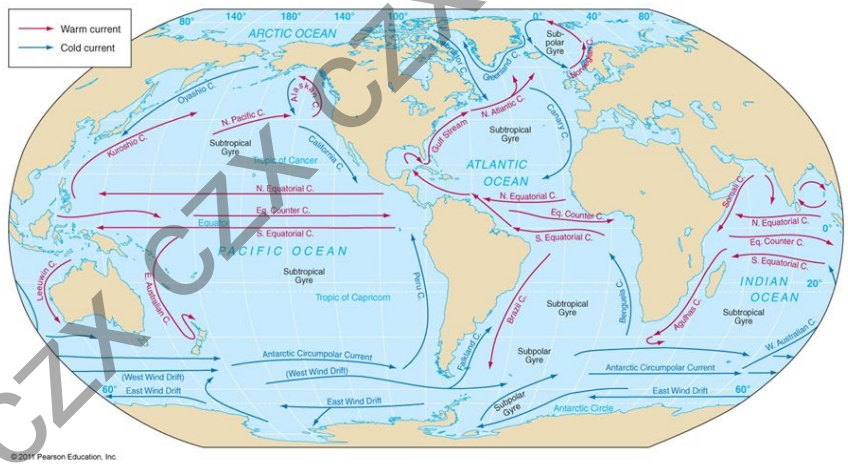
Factors affecting Rainfall

1. *Effect of continentality*



Distance from the sea contributes to the **aridity** of an area.
Maritime locations have generally **more rain** than continental interiors as **continentality limits** the **amount of water** that can be **carried across the land** by wind.
This causes areas in **North America** and **Central Asia** to have **dryland conditions** as well as **deserts** to **form** like the **Sahara Desert, Africa** and **Gobi Desert, Central Asia** **(China & Mongolia)**.

2. *Ocean Currents*



Ocean currents are a big component in the transfer of heat on earth, and they move **warm waters poleward** and **cold waters towards the equator**. They **regulate air temperatures** and **precipitation patterns** along *coastal* localities. The dominant pattern of current flows are also called **gyres**.

In the northern hemisphere, the subtropical gyres flow **clockwise**. There are warm currents like the **Gulf Stream** which flows along **North America**, is part of the bigger **North Atlantic Drift**. This North Atlantic Drift also keeps the coastal areas of the **United Kingdom warmer and wetter**, due to **higher sea surface temperatures,** more **sea surface evaporation** and thus *(vomit the rain formation paragraph)*. Another warm current is the Kuroshio current that flows near Japan.

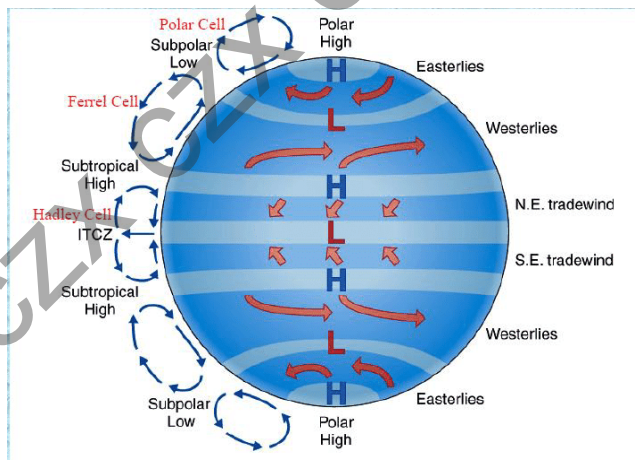
In the southern hemisphere, the subtropical gyres flow **anti-clockwise**. There are cold current that flow towards the equator, like the **Peruvian current** near **Peru** which keeps the area **arid** as **sea surface temperatures** are low due to the **cold current chilling** the **lower air** which **suppresses sea surface evaporation**. This cold temperature also causes the air parcel above the sea to **resist uplift** as it is **stable**. The Peruvian current intensifies the aridity of the Peruvian and Chilean coast. The **Atacama Desert** is transformed into a **cool dry location** that is **even more dry than polar regions**.

3	**Effect of Atmospheric Circulation on Tropical Climates**

A. Effect of atmospheric circulation on tropical climates - redistribution of surplus solar radiation by the Hadley Cell, including the convergence of trade winds at the Intertropical Convergence Zone (ITCZ), and the resultant effects on atmospheric stability and rain formation - seasonal variations in wind direction: Asian and African monsoons - weakening of the Walker Circulation and the El Niño Southern Oscillation (ENSO) phenomenon	

Three Cell Model

There is a **redistribution of surplus radiation/insolation** by the **Hadley Cell.**



There are 2 areas of pressure that are caused by temperature:

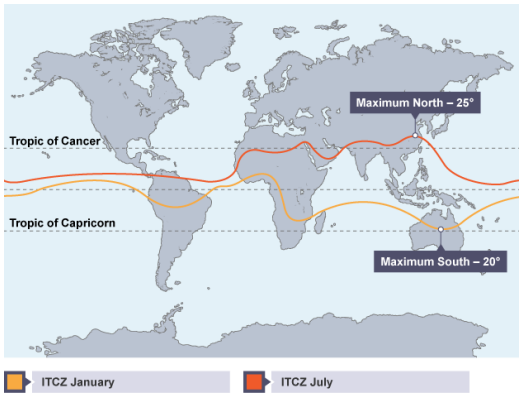
- Equatorial low pressure zone caused by high temperature at the equator.
- Polar high pressure zone caused by the low temperatures at the poles.

Due to Earth's rotation, there is a dynamic circulation of air caused by 2 pressure belts:

Intertropical Convergence Zone (ITCZ)

The ITCZ is an area of **low pressure** that is elongated and undulating which encircles the planet.

- This is created by **high levels of insolation** **and** **consistent daylength** by the sun which provides a **large amount of energy** to warm the earth's surface and
- cause air to be **less dense**, **rise** and **expand**, forming areas of low pressure.
- Moist NE and SE trade winds converge along the ITCZ



The ITCZ **migrates** along with the **SSP.**

- The extent of migration can be affected by the **differential heat capacity of ocean and land surfaces**.
- ITCZ is found on higher latitudes over land as compared to over oceans.

Subtropical High Pressure Belt (STHPB)

The STHPB occurs between 20 - 35 ˚N/S.

- air meeting the tropopause and moving poleward, where the
- cool, dry air is dense and thus descends towards the earth's surface
- **Subsiding dry air is compressed and undergoes adiabatic warming**
- which form masses of high pressure systems.

This is formed by the **falling arm of the Hadley Cell** and brings **low rainfall**, dry spells to certain regions while migrating with the ITCZ.

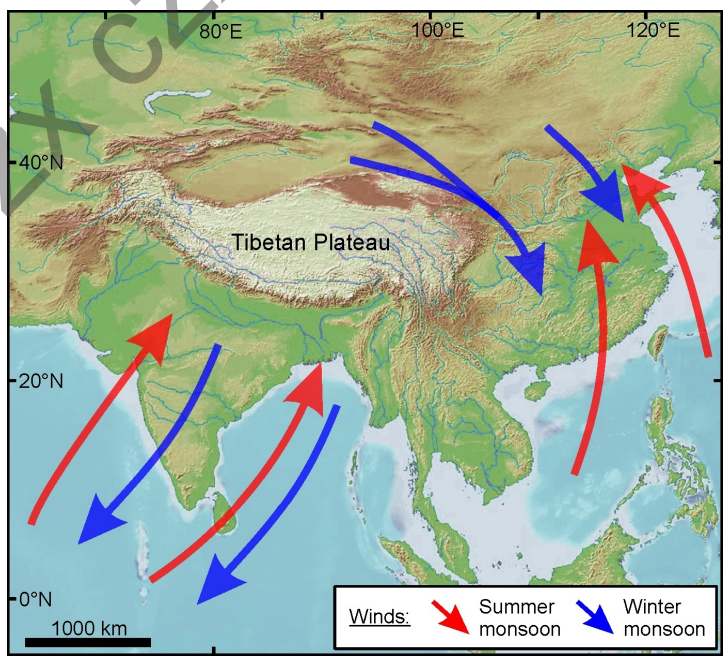
Together, the **ITCZ** and **STHPB** make up the **Hadley Cell.**
When talking about the air stability affecting rainfall, refer to the next chapter on atmospheric stability.

Monsoons

Monsoonal winds are **large scale winds** that have a seasonal change in direction. Generally, these changes are due to **differences in temperature** and thus **pressure** over landand ocean bodies.

Asian Monsoon

A. Southwest Monsoon (Summer in North)



1. **SSP** in **June-September** in **North** Hemisphere, **ITCZ is far up north**
2. **STHPB** is in the **Indian Ocean**.
3. This produces a *pressure gradient force*
4. Causing winds to move from the southern hemisphere to the northern hemisphere.
5. As it **moves over the indian ocean**, the warm winds **pick up moisture** through **sea surface evaporation**.
6. Winds are then **deflected to the right** in the **northern** hemisphere due to **coriolis** effect
7. The winds upon reaching the **Indian subcontinent** split into the *Bay of Bengal Branch* and the *Western Ghats branch*.
8. Along the *Bay of Bengal*, the winds travel over the **indian continent** as even more moisture is picked up from the bay of bengal. Moisture is then deposited in the southeastern portion of India. The presence of the Himalayas also encourages orographic lifting along the northeastern coast.
9. Along the western Ghats, the winds are forced to rise against the mountain range and thus promotes orographic lifting and creates heavy rain.

B. Northeast Monsoon (Winter in North)

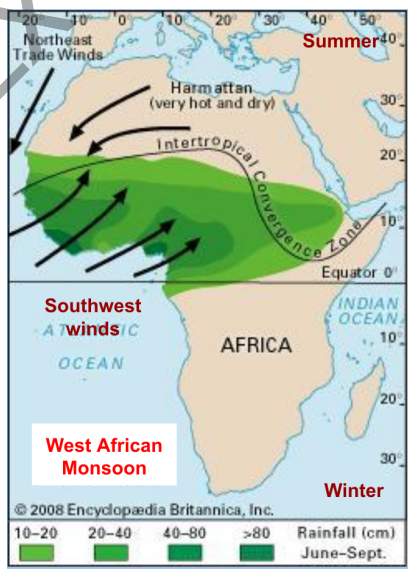
1. SSP in the Southern Hemisphere between Nov - Feb, ITCZ migrates south along with it.
2. High pressure develops over Siberia and the Asian continent.
3. Low P conditions along the ITCZ in the S.H, PGF is generated.
4. Winds blow from the Siberian high pressure cell in the S.H, but are deflected left in the southern hemisphere by the Coriolis effect, blowing as northeast winds in the N.H.
5. As NE winds blow over the dry Asian continent, the wind is dry and brings little rain to northern India.
6. However, some winds that blow over the Bay of Bengal picks up moisture and brings wet conditions to areas such as Sri Lanka and Southeast India.
7. This results in the primarily dry monsoon in South Asia.

African Monsoon

The african monsoon consists of the East African Monsoon and the West African Monsoon.

A. West African Monsoon (Summer NH)

1. Between June - September, Northern Hemisphere experiences summer, so SSP is in the north.
2. ITCZ migrates north, resulting in a pressure gradient force between the Atlantic Ocean and the African landmass.
3. Winds are attracted to the low pressure conditions along the ITCZ, blowing as **Southwest winds.**
4. The warm winds over the **atlantic ocean** pick up moisture by sea surface evaporation, and get deflected right in the north hemisphere by the coriolis effect.
5. Moist air is warmed by the african landmass, *rises and expands as it cools adiabatically. When the air parcel reaches saturation at dewpoint temperatures, condensation occurs. Water droplets collide, coalesce and form clouds.* Some rain is brought to western coast of the African continent.

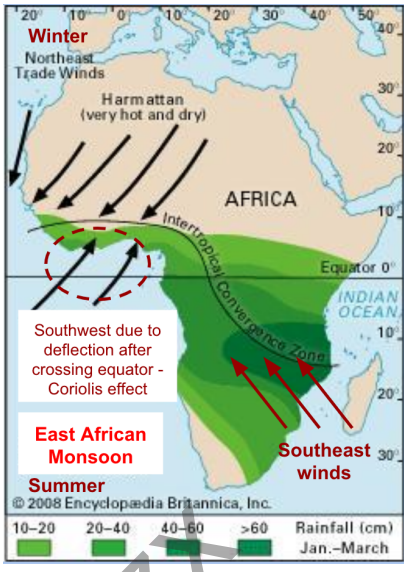


6. However, the monsoon is more dry than the Asian Monsoon due to the **Harmattan winds** in Northern Africa. Northern Africa does not experience much rainfall as the **northeastern winds** blow over the very hot and dry continent where the Sahara desert and the Sahel region is located.

B. East African Monsoon (Winter NH)

1. In December to March, the Southern Hemisphere experiences summer, SSP is in the SH.
2. ITCZ migrates south, resulting in a pressure gradient force between the Indian Ocean and the African landmass.
3. Winds from regions of high pressure are attracted to the low pressure conditions along the ITCZ.

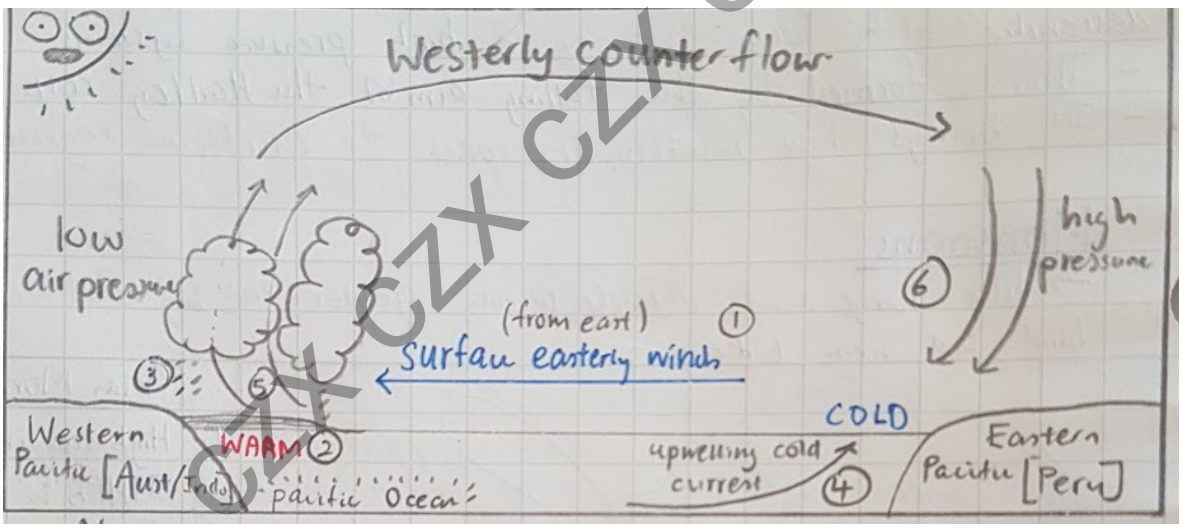
4. The winds blowing over the indian ocean in the southern hemisphere are deflected left by coriolis effect, thus blowing as **southeast monsoon winds.**
5. These winds bring along moisture from the Indian Ocean.
6. Moist air is warmed by the African landmass, *rises and expands as it cools adiabatically. When the air parcel reaches saturation at dewpoint temperatures, condensation occurs. Water droplets collide, coalesce and form clouds.*
7. Results in some rainfall that occurs in East Africa.
8. Winds relatively dry and either convergence or orographic uplift is required for precipitation
9. Rainfall over Africa is not uniformly distributed. **Eastern mountain slopes of Madagascar,** first reached by **SE winds from the indian Ocean** in the SH summer, receives **higher rainfall** than the continent of Africa. Orographic conditions cause a general increase in rainfall.



El Niño Southern Oscillation (ENSO)

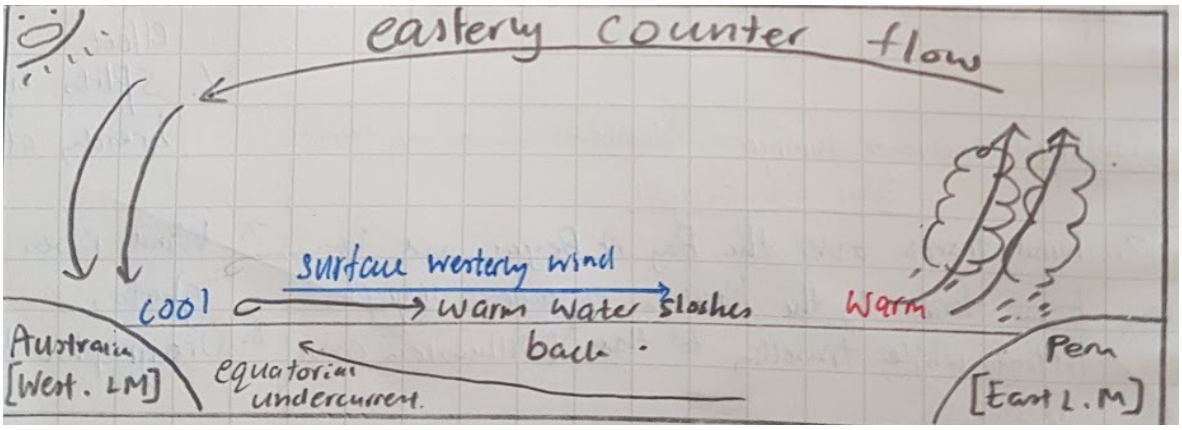
1. Walker Circulation

It is a model of air circulation generated by northeast and southeast trade winds.



1. The easterly winds push warm water along the equator along the Pacific Ocean.
2. This causes warm water to accumulate along the western land masses like Australia and Indonesia.
3. Sea surface temperatures (SST) above the western pacific is higher than the eastern pacific by 4˚C.
4. Water pushed to the west is returned by an upwelling of deep ocean current at the eastern landmass, Peru.
5. The high SST brings rain along Australia and Indonesia
6. Low SST brings descending air and high pressure which causes clear and arid conditions along Ecuador and Peru.

2. El Niño



1. The easterly trade winds **weaken** or even reverse.
2. **Warm water** accumulated in the western pacific **sloshes back east**.
3. Warm water pool is carried east
4. Warmer SST over Eastern Pacific and rain occurs over South America.
5. Descending air is found now in western pacific in Southeast Asia, resulting in droughts.

This phenomenon occurs every 3-7 years and lasts for 12-18 months.

4	**Tropical Climates Based on the Köppen–Geiger Climate Classification System**

A. Distinctive characteristics of the tropics based on the Köppen–Geiger climate classification system.

- humid tropics: tropical rainforest (Af), tropical monsoon (Am) and tropical savanna (Aw)
- arid tropics: sub-tropical steppe (BSh) and tropical desert (BWh)

Summary Table of Climate Types

Climate	Characteristics	Explanation	Example
Tropical Rainforest (Af) *10˚ N/S*	**[Temperature]** **MAT**: Above 18 ˚C **Seasonality**: No **ATR**: Small; < 3 ˚C **DTR**: Small; ~10 ˚C	- Low latitude: low angle of incidence + low amount of atmosphere - Length of day/night constant throughout year	**Singapore (1˚N)** MAT: 27.0 ˚C ATR: 2.0 ˚C DTR: 10 ˚C TAR: 2400 mm *ITCZ passes by twice a year*
	[Rainfall] **TAR**: > 1500 mm **Seasonality**: No	- Under influence of ITCZ most/all year	
Tropical Monsoon (Am) *5-25˚ N/S*	**[Temperature]** **MAT**: Above 18 ˚C **Seasonality**: Yes, *warm-wet* **ATR**: Small; 3-6 ˚C **DTR**: Small; up to 25 ˚C	- Temp higher during wet season as SSP overhead - Temp lower during dry season as SSP is in other hemisphere	**Chittagong, Bangladesh (22.3˚N)** MAT: 26.0 ˚C ATR: 9.0 ˚C TAR: 2800 mm (wet): 750 mm (dry): 6 mm *Affected by asian monsoon*
	[Rainfall] **TAR**: > 1500 mm **Seasonality**: Yes, short dry, 1 or more months receiving less than 60mm	- Axial tilt → SSP → ITCZ → pressure diff. → pgf → coriolis → sea surface evaporation → rain - Axial tilt → SSP is away → explain STHPB → aridty	
Tropical Savanna (Aw) *5-30˚ N/S*	**[Temperature]** **MAT**: Above 18 ˚C **Seasonality**: Yes, *warm-wet* **ATR**: Small; 3-10 ˚C **DTR**: Small; up to 25 ˚C	- SSP migration (see Am climate)	**Lagos, Nigeria(6.5°N)** MAT: 27.0 ˚C ATR: 3.4 ˚C DTR: - TAR: 1700 mm (wet): 380 mm [June] (dry): 25 mm [Jan] *Influenced by STHPB*
	[Rainfall] **TAR**: > 1000 mm **Seasonality**: Yes, dry season consist of 4-6 months receiving less than 60mm	- Migration of Pressure Belts (see Am climate)	

Sub-Tropical Steppe (BSh) *Periphery of deserts, Poleward of tropical climates*	**[Temperature]** **MAT**: Above 18 ˚C **Seasonality**: Yes **ATR**: Large; 20-30 ˚C **DTR**: V. Large; 20-50 ˚C	- SSP Migration (see Am climate)	**Kayes, Mali (14.5˚N)** MAT: 29.3 ˚C ATR: 10 ˚C DTR: - TAR: 640mm (wet): 210 mm (dry): 0 mm
	[Rainfall] **TAR**: 250 - 500 mm **Seasonality**: Yes, some months above 60mm	- Under influence of STHPB most of the time - Wet when ITCZ ahead or when cyclones occur	
Low Latitude Desert (BWh) *10-30˚ N* *20-30˚ S*	**[Temperature]** **MAT**: Above 18 ˚C **Seasonality**: Yes **ATR**: Large; 20-30 ˚C **DTR**: V. Large; 20-50 ˚C	- SSP Migration (see Am climate)	**Cairo, Egypt (30˚N)** MAT: 21.3 ˚C ATR: 14 ˚C DTR: - TAR: 18 mm
	[Rainfall] **TAR**: < 250 mm **Seasonality**: No, all monthly ppt totals below 60mm, convection during summer is unreliable	- Under constant influence of STHPB - Low altitude convection is unreliable	

Legend

Mean Annual Temperature → MAT
Diurnal Temperature Range → DTR
Annual Temperature Range → ATR
Total Annual Rainfall → TAR
Pressure gradient force → pgf
Wet month rainfall → (wet)
Dry month rainfall → (dry)

5	**Past Climates**

A. Past Climates - Pleistocene - Holocene including the desiccation of pluvial lakes	

Pleistocene Epoch

Refers to a period of great climatic instability.

- Characterised by frequent fluctuations of warming (interglacials) and cooling (glacials) of the earth's atmosphere
  - Cooling → glacials → promotes the growth of ice sheets up to 3km thick
  - Warming → interglacials → retreat of ice sheets → correlates to sea level rise
- Above 2 effects took place over 20 cycles

Eon	Era	Period		Epoch	Start Date (mya)
Phanerozoic	Cenozoic	Quaternary		Holocene	0.01
				Pleistocene	1.64
		Tertiary	Neogene	Pliocene	5.2
				Miocene	23.3
			Paleogene	Oligocene	35.4
				Eocene	56.5
				Paleocene	65

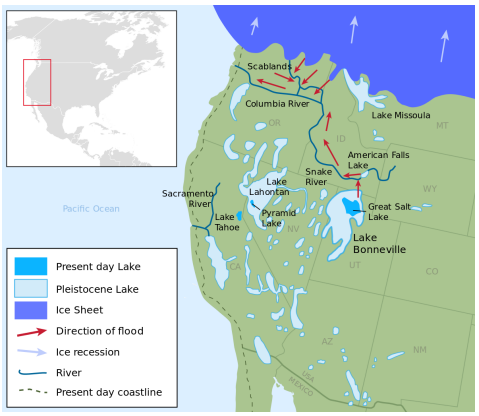
Holocene Epoch

- 11700 years ago until today
- Relatively warmer period
- Caused a major retreat of ice sheets
- Wetter climates
- Also involved the desiccation of pluvial lakes.

Pluvial Lakes

A pluvial lake is a body of water that has accumulated in a basin because of greater moisture availability.

- Formed when warm air from arid regions met chilled air from glaciers, result in uplift and thus precipitation which filled up drainage basins.
- This drying up/desiccation of the lakes are a result of the warming of the holocene.
- Once a pluvial lake dries up, they are known as **paleolakes.**
  - Lake Bonneville in Utah, United States shrunk from 29000 km^3 to form the Great Salt Lake at 4400km^3
  - There were also pluvial lakes in the Sahara



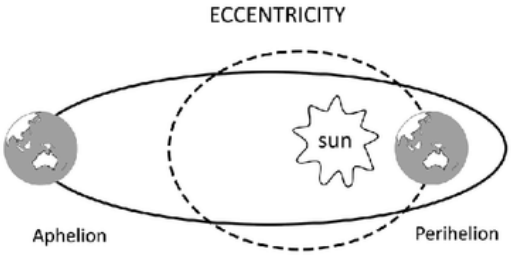
Reasons for Changes in Pleistocene - Orbital Forcings

Note that the interplay of these 3 factors promotes glaciations.

1. Eccentricity

Refers to the shape of the earth's orbit about the sun.

- Refers to how **circular the orbit** is around the sun
- 100 000 year cycle of low eccentricity (circular orbit) to high eccentricity (elliptical orbit)
- Affects distance of the Earth at Perihelion(nearest to sun) and Aphelion(furthest from sun).
    - High eccentricity can cause the deviation of insolation received to be **20-30%**
    - Makes the seasons more severe at high eccentricity.



Reduced seasonal contrast promotes ice sheet growth

- Warmer winters → capacity of air to hold moisture increases → more snowfall
- Cooler summers → less snowmelt
    - Together these two effects lead to the growth of ice sheets and promotes glaciation.

2. Obliquity

Refers to how the **tilt of the Earth's axis** varies over time.

- 41000 year cycle where the tilt of earth varies from 21˚ to 24˚
- Increase in angle of tilt → increased seasonal variation in solar energy → increased difference in insolation received between lower and higher latitudes → increased intensity of seasons.

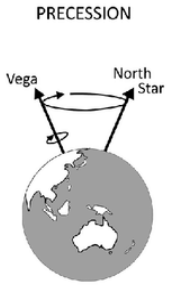
Reduced seasonal contrast promotes ice sheet growth

- Warmer winters → capacity of air to hold moisture increases → more snowfall
- Cooler summers → less snowmelt
    - Together these two effects lead to the growth of ice sheets and promotes glaciation.

3. Precession

Refers to the change in the **orientation of the Earth's axis**.

- 23 000 year cycle
- Earth's axis wobbles due to gravitational pull by the sun and moon
- **Affect the extent of effect** of Eccentricity and Obliquity on the different hemispheres.



- When axis is facing **Polaris**
    - North Hemisphere experiences summer at aphelion, S.H. experiences winter at aphelion → NH summer is cooler.

  - SH experiences summer at perihelion → NH experiences winter at perihelion → NH warmer winter
  - As such, SH has more extreme seasons while NH has milder seasons.
- Precession value affects the hemisphere experiencing more extreme seasons.
- NH is climatically more important than the south as the north is dominated by larger continental mass on which glaciers can be built.

Internal Feedback Mechanisms

1. Albedo - Sea Level

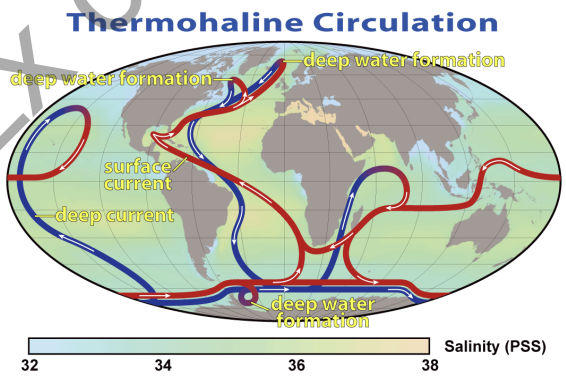
Albedo is the reflectivity of the earth's surface.

- A high albedo results in more insolation reflected to space.
- When ice sheets expand → albedo increases → temperatures decrease → form more ice sheets…
- When ice sheets melt → albedo decreases → temperatures increase → further melting of ice sheets...
  - This is known as a **positive feedback loop**

2. Meltwater Driven Ocean Circulation

We are focusing on the deep ocean current known as the thermohaline circulation system.

Thermo-: temperature gradient
-haline: salinity



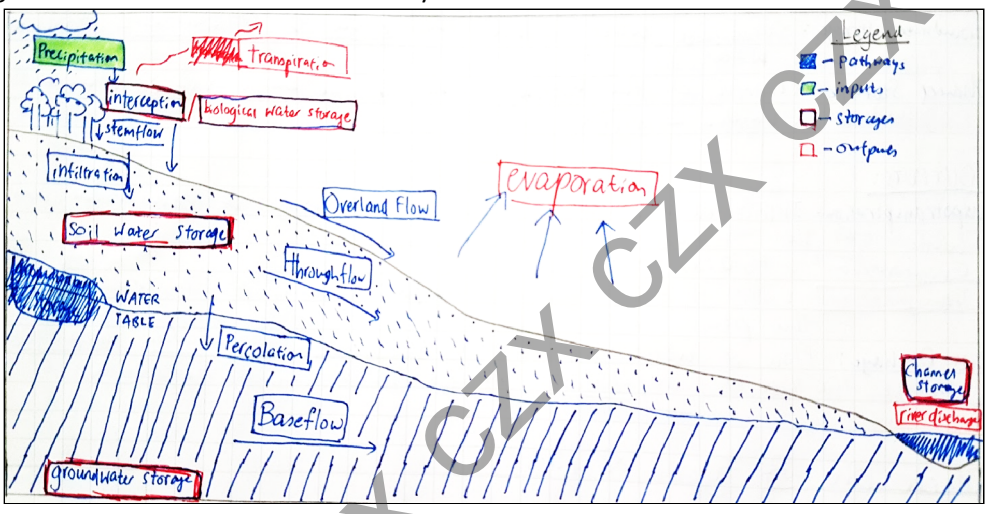
1. Ocean currents are driven by differences in water density, controlled by temperature and salinity.
2. In the earth's polar regions, the ocean water gets very cold and forms sea ice, leaving salt behind, causing surrounding water to get saltier.
3. This saltier water is more dense and sinks.
4. Surface water is pulled in to replace the sinking water, which in turn becomes cold and salty enough to sink, perpetuating the cycle.
5. Some scientists believe that the melting of ice weakens the thermohaline circulation which slows down the atmospheric circulation of CO_2 to weaken and the redistribution of heat from the tropics to the polar regions.

- Affects the CO_2 levels of atmosphere
- This is a **negative feedback loop :/**
- Plants die in the ocean → fall to bottom → bring absorbed CO_2 with them → lower atmospheric CO_2 → less greenhouse effect → temperatures decrease

6 Drainage Basin Water Balance

A. Drainage basin water balance - input: precipitation - pathways: overland flow, infiltration, percolation, throughflow and baseflow - water stores: interception and biological water storage, soil water storage, groundwater storage and channel storage - output: evapotranspiration and river discharge	

A drainage basin is an area of land drained by a river and its tributaries.



$$P = E + R \pm \Delta S$$

P = Precipitation
E = Evapotranspiration
R = Streamflow/Discharge
△S= Change in storages

*follows the principle of conservation of mass

Inputs

Precipitation: water is **introduced** into the system as rain, snow, hail or sleet.

Pathways

(lateral flows)

1. **Overland Flow** : Water that **does not infiltrate into the soil** run quickly over the ground surface

- Can act in different forms,
  - as unconcentrated sheet flow
  - Which can erode to form small channels known as rills
  - converging to form gullies
  - gonverging to form wadis

- Can be either due to **Infiltration Excess Flow**/Hortonian Overland Flow or **Saturation Overland Flow.** *(considered storm runoff generation)*
    - IEF is due to rainfall intensity exceeding infiltration capacity of the surface
    - SOF is due to soil being fully saturated and so **infiltration rate is reduced to almost 0**
        - Can involve the rise of water table to surface

2. **Throughflow**: refers to the lateral movement of water through the unsaturated zone/zone of aeration.

3. **Baseflow**: It is a **very slow** flow of water involving the seepage of groundwater in the zone of saturation.

(downward flows)

1. **Infiltration**: is the process where water enters the soil become moving downward through percolation.
    - Affected by soil saturation/rain splash blocking the soil pores with other minute particles/clay swelling in soil
2. **Percolation**: is the flow of water from the soil into underlying rock under the influence of gravity.
    - Involves the movement from the soil moisture storage into groundwater storage.

Water Stores

1. **Interception and Biological Water Storage**: precipitation is caught by vegetation and is stored on the canopy

2. **Soil Water Storage**: Water that has infiltrated the ground and enters the zone of aeration.
    - The zone of aeration refers to the zone in which open pores in soil are filled with air.
    - Just above water table

3. **Groundwater Storage:** refers to subsurface water within the zone of saturation
    - The zone of saturation refers to the zone in which pores in soil are filled with water.
    - Below the water table

4. **Channel Storage:** Refers to the channels at the bottom of the drainage basin which store water.

Outputs

1. **Evapotranspiration:** Intercepted water from plants in canopy may be evaporated or water can be removed by transpiration.
    - Evaporation involves a state change in water from liquid to gas
    - Transpiration refers to the loss of water vapour from the stomate or minute pores of the leaves in plants to the atmosphere.

2. **River Discharge:** Flow of water contributed by precipitation,
    - overland flow,
    - throughflow through the side of the river and
    - base flow through the bottom of the river.

7 Fluvial and Runoff Processes

A. Fluvial and runoff processes - fluvial processes: erosion, transportation and deposition - storm runoff generation: infiltration excess and saturation overland flow	

Erosion - HASA

1. **Hydraulic Action**
   - Force of shear stress is applied to the material by running water
   - The force causes a **squeeze and release** action on the rock
   - This loosens the rock, allowing running water to **dislodge** the unconsolidated material
     - Useful when there are non-cohesive gravel like material
     - Or for porous or cracked or jointed rock

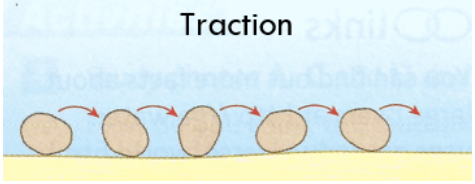
2. **Abrasion**
   - Rocks lifted up by the river may mechanically **grind and carve** the streambed.
   - Coarse bedload can help to scour the channel
     - Useful when river carries a lot of load

3. **Solution**
   - Rocks are dissolved and are carried as solute load
     - Rocks like limestone get dissolved by weak carbonic acid to form aqueous bicarbonate and calcium ions
   - Almost all rocks are soluble to some extent *(um yes but not really)*

4. **Attrition**
   - Sediments in the river knock onto each other or the river bed
   - Becoming rounder and smaller
   - There is a reduction in sediment size down the river

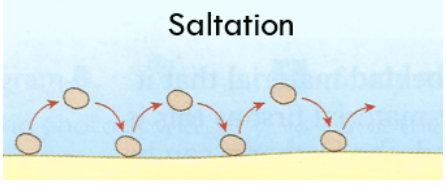
Transport - TSSS

1. **Traction**



   - Transport of large particles
   - Under the hydraulic force of water, the **coarse bedload rolls and slides in a discontinuous motion along the river bed.**
   - The friction of the riverbed causes the speed of water flowing near it to be low
   - The water above the stream bed increases in speed as it gets further from the river bed
   - This causes the particles to roll in a sliding motion

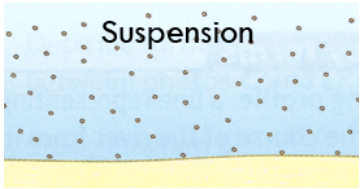
2. **Saltation**
   - Particles are uplifted into the channel flow by turbulence.



- Once raised, the particles are transported downstream in **arc-shaped trajectories** by gravity pulling them back to the riverbed
- The falling rocks may impact other particles and also sets them into motion
- These particles are too large to be in suspension.

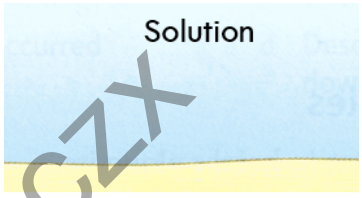
3. Suspension

Transportation of clastic sediment like silt and clay



- The river of high enough velocity holds up unconsolidated material by turbulence
- The suspended load is held aloft in the stream
- Deposition only occurs when the stream is near zero

4. Solution



- Dissolved load of a stream
- Refer to previous answer for solution
- Main contribution is **chemical weathering.**

Deposition

Result of loss of stream energy.

- Loss in velocity → not enough speed to keep the particle in suspension
- Loss in discharge levels → decrease input to drainage basin like snowmelt
- Example is when a river overflows its channel → flow widens → slows down → results in aggradation/deposition on the adjacent floodplain → forms natural *levees*

Storm Runoff Generation

- **Infiltration Excess Flow**/Hortonian Overland Flow
  - IEF is due to rainfall intensity exceeding infiltration capacity of the surface

- **Saturation Overland Flow**
  - SOF is due to soil being fully saturated and so **infiltration rate is reduced to almost 0**
  - Can involve the rise of water table to surface

8 Variations in River Channel Morphology

A. Variations in river channel morphology - factors affecting channel morphology: discharge and sediment regime - drainage density and channel patterns - river equilibrium and longitudinal profile	

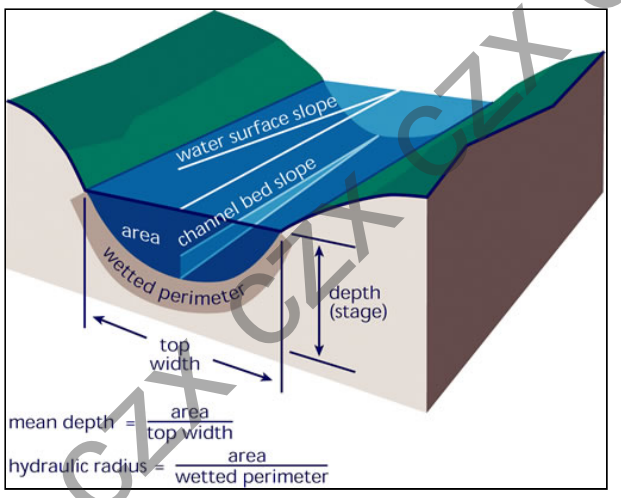
Introduction

Channel morphology refers to the structure and form of the river channel. It is mainly determined by factors like discharge, sediment regime, the nature of flows and vegetation.

Channel Morphology

Channel Morphology refers to the structure and form of a stream's channel expressed by its **cross-sectional profile.**

This includes the width, depth, wetted perimeter, shape of cross-section and channel gradient.



A. Channel Width and Depth

Channel width refers to the shortest distance that is approximately at right angle of streamflow from one edge of the river channel to the other.

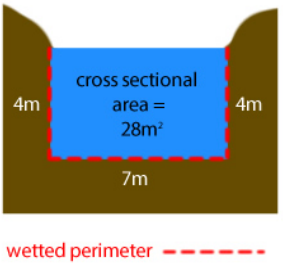
- Can change with discharge amount

Channel depth is the vertical distance from the channel bed to the surface of the water.

- Expected to increase downstream
- Line of maximum depth along a river channel is known as a streams ***thalweg***.
- The thalweg is the *zone of maximum velocity in a stream.*

Width/depth ratio is used to understand **channel efficiency**, typically expressed as (width)1:X(depth)

- Channel efficiency is the proportional losses of energy by friction between the flowing water and the channel bed/banks compared to the losses within the water.
- **Higher the ratio, the more inefficient** the stream as more width than depth → more energy lost as friction



B. Hydraulic Radius

The hydraulic radius of a channel can measure the effects of friction on stream energy.

$$R = \frac{cross\ sectional\ area}{wetted\ perimeter}$$

The most effective cross-sectional shape is one that minimises energy loss through friction between flowing water and the channel banks

- The value of hydraulic radius is large → greater efficiency → less friction
- Value is small (more perimeter) → lower efficiency → more friction

C. Channel Slope / Gradient

The channel slope is the change in elevation over the horizontal distance travelled by the river.

River Energy and Velocity

Here are some ideas which relate the ideas of channel morphology.

A. Discharge

$$Q = VA$$
$$Q = Discharge$$
$$A = Cross\ Sectional\ Area$$

Discharge is the volume of water passing through a given point in a given time.

B. Manning's Equation

$$V = \frac{1.49\ R^{\frac{2}{3}}\ s^{\frac{1}{2}}}{n}$$
$$R = Hydraulic\ Radius$$
$$n = roughness\ coefficient$$

The coefficient of roughness(n) is large when the sediment is large → higher friction value
Despite that there is an anomaly: Average stream velocity of rivers tend to increase/remain constant downstream from the source despite the usual decrease in gradient.

- Water flows more efficiently in larger channels → less friction → increase in V downstream

C. **Stream Power (Ω)**

$$\Omega = \rho g Q s$$
$$\Omega = stream\ power$$
$$\rho = density\ of\ fluid$$
$$g = gravitational\ acceleration$$
$$s = channel\ slope$$

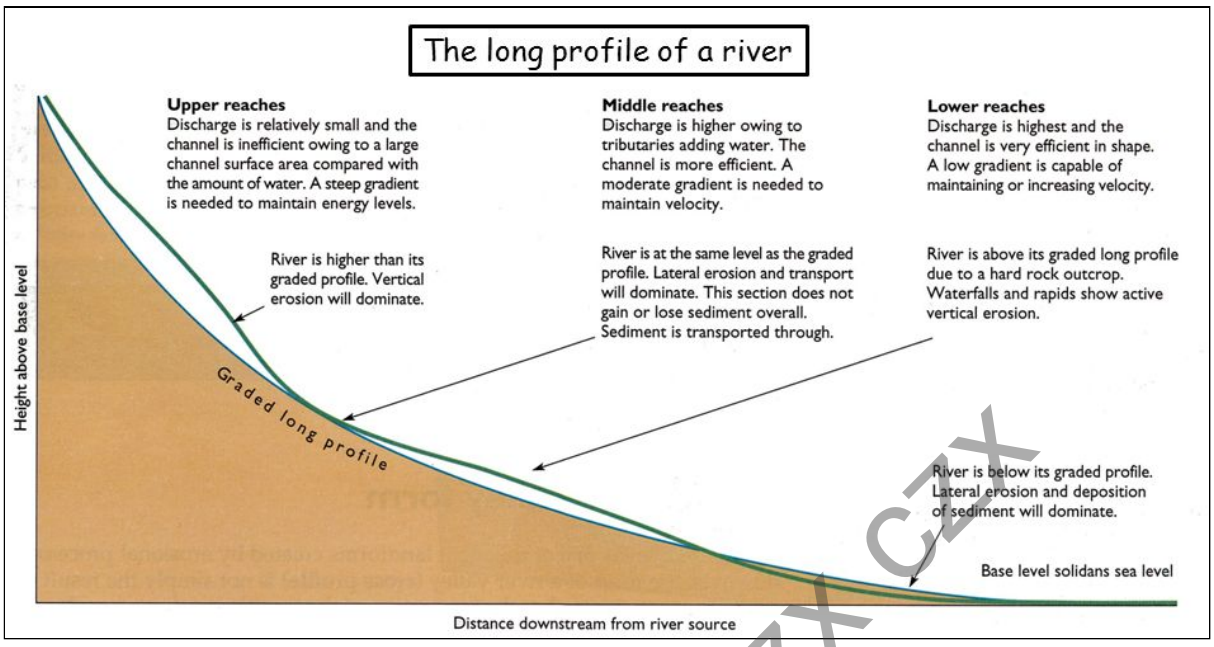
Stream power is the capacity of a stream to do work.

River Equilibrium and Graded Long Profile

Rivers are systems in dynamic equilibrium. It balances water flow and sediment transport.

- form and shape of a river varies across space and time
- Free-flowing rivers tend to **reach a state of equilibrium** by **processes of erosion, transport and deposition** to allow for the river to **flow and carry sediment delivered by its tributaries**.
- Ensures that ultimately the river will operate on the condition that the total energy in a stream is exactly sufficient to be expended on transporting load and water
- Rivers are sensitive to changes in **hydrologic characteristics** like the nature of flows, sediment regimes, changes in bed and bank resistance.

River equilibrium is reflected in a "graded stream", a stream that has a "graded profile" as seen in the smooth concave curve.



- **Upper Course** (nearer to the source)
  - Relatively low discharge
  - Vertical elevation provides **sufficient energy**(gravitational→ kinetic) for **vertical erosion** via hydraulic action. (more properly illustrated is that dU/dx would be higher upstream than downstream)
  - **less lateral erosion**
  - forming a **straighter, steeper channel** (with lower discharge near the source)
  - River channels often form near mountains
  - Meanders cannot form easily due to lower Q

- **Lower Course** (Nearer the mouth)
  - Vertical elevation decreases
  - lesser change in GPE (dU/dx would be lower)
  - **less vertical erosion → less steep**
  - Due to greater discharge from contributions by tributiaries, KE↑
  - greater **lateral erosion** occurs
  - Wider channels
  - Meanders start to form over time(KIV) → increasing sinuosity and making gradient less steep over time

In reality, flatter and steeper sections exist on a river's long profile (rather than smooth concave profile). **Steeper sections** start as **knickpoints** possiblly resulting from outcrops of hard rock, action of local tectonic movements, or sudden changes in discharge.

- Outcrop of hard rock occurs when water flows from resistant to less resistant rock.
- less resistant rock is eroded away relatively rapidly → leaving behind the more resistant rock → erodes relatively slowly
- locally steepening the gradient to form a waterfall or section of rapids.
- Change in base level due to tectonic movement or change in sea level causes river rejuvenation, the renewal of erosive activity of the river.

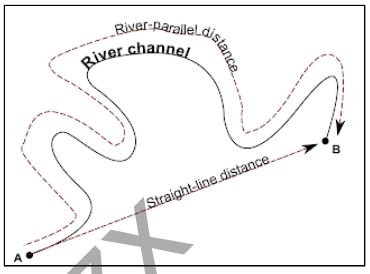
When river channels are altered under naturally dynamic hydrologic conditions, the river readjusts itself with respect to dimension, profile and pattern to reach its former balance or equilibrium.

- Human action has affected the flow of water in the river (link to transboundary) like through the building of dams which changes the morphology and sediment regime of rivers.

Channel Patterns

There are two classifications of rivers, single channelled & multi-channelled.

Single Channelled Rivers



The two types of single channeled rivers differ by their sinuosities. Sinuosity is the measure of how irregular the stream's path is and it is equal to channel length/straight line distance between the start and the end of the portion of river measured.

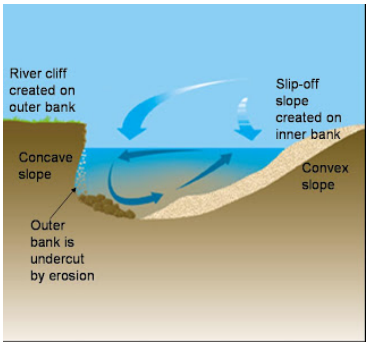
1. **Straight Channels**

Occurs when the sinuosity is close to 1.0

- Low width depth ratio
- Low gradients
- The straightness may be due to geographical controls like faults in bedrock.

Example: Irrawaddy river, Myanmar turned from a meander to form a straight gorge along Sagaing Fault.

2. **Meanders**



Sinuosity is more or equal to 1.5

- Gentle gradient
- Unique features of cut banks and point bar deposits

Forms due to the presence of alternating shallows and deeps called **pools and riffles**.

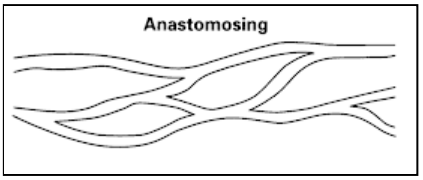
1. Acceleration and deceleration of flow can lead to erosion and deposition to occur within the channel forming the pool and riffle sequence
2. Rivers efficiency is higher in the deeper pools as energy and power are increased.
3. Rivers efficiency lowers in riffles due to more friction with the riverbank
4. Combination of gaining and losing efficiency causes the **flows to be uneven**
5. Maximum flow is **concentrated on one side of the river**.
6. This water speeds up and increases in turbulence, developing a corkscrew-like current known as a helicoidal flow.
7. The helicoidal flow spirals from bank to bank, eroding the river bank laterally by **abrasion and hydraulic action** in pools. These forms concave **cut banks**.
8. then slows down and the material eroded is deposited in the next bank as convex **point bar deposits.**
9. Makes the geometry of the cross section assymmetrical and narrow.
10. The continuous erosion and deposition exaggerates the bend and increases the sinuosity of the channel to 1.5 to make a meandering stream.
11. Extended meanders can erode away the ridge between two meanders and reduce the sinuosity, thus forming an oxbow lake.

All these changes in channel processes and morphology are a reflection of a channel adjusting itself according to available load and energy to achieve equilibrium.

Example: Lower Reaches of the Amazon River

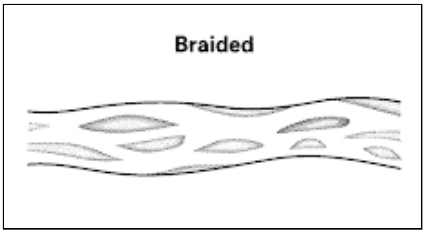
Multi-Channelled Rivers

3. Anastomosing Rivers



Rivers formed due to avulsions, where flow is diverted out of an established channel into a new permanent course on an adjacent floodplain.

4. Braided Rivers



Involves a subdivision of water flow due to a separation of main channels into interlocking channels by islands known as mid-channel bars.

Made of incoherent sand and gravel.

1. During periods of high discharge, river energy is high, so more sediment is entrained as bedload.
2. High discharge is **turbulent** and causes **lateral erosion of river banks** which cause the channel to widen.
3. During **periods of low discharge**, river energy decreases, so the overloaded river would undergo deposition to form mid-channel bars.
4. The coarse bedload would deposit in the channel, which disrupts the river flow and cause velocity to decrease downstream.
5. The fine sediment get deposited around the course bedload forming mid-channel bars.
6. Result in bars of sand and gravel forming.
7. The river is narrowed and so it increases the velocity of the river to transport load
8. As discharge decreases further, the water level falls, exposing the mid-channel bars.
9. This may get washed away by the next season of high discharge or may get stabilised by plants to form islands.

Example: Brahmaputra-Jamuna River, India

Factors Affecting Channel Morphology

1. Discharge

Discharge is the volume of water passing through a portion of a river at a given time.

- When the river increases in Q and velocity in stream increases → ability of the stream to carry load increases → amount of stream energy increases → capacity for river to do work/erode increases
- In humid tropics → discharge downstream increases due to contributions by tributaries.
    - GPE (better illustrated as dU/dx) is higher at upper course, but has lower Q, so vertical erosion is present
    - Mid/lower course, lesser GPE but higher Q → greater kinetic energy → lateral erosion → wider and deeper channels downstream

- Has implications on the type of channel patterns formed
    - Consistent high Q value → favours meander formation
    - Variations in Q values → favours brading

- In arid tropics → rain is intense and short → erosion of channels occur at high Q → when Q falls/ceases → deposition occurs to large extent → leads to shallow channels with mid channel bars.
    - Produces ephemeral channels

2. Sediment Regime

The sediment regime of a river refers to the nature of the dominant sediment processes that occur in the river.

- Controlled by factors like grain size, sediment supply and prevailing flow conditions
- Can change in response to a change in these factors
- Generally erosion occurs in higher reaches of the river, while deposition occurs at the lower reaches → processes signal the channel trying to maintain maximum efficiency.

Sediment Nature	Explanation
Clay and silt (coherent)	● **Cohesive** channel deposits ● **Resistant to erosion**. ● Clay and silt are small in size and are transported in **suspension**. ● As such, rivers need **high velocity**. ● **Narrow and deep channels** with a larger hydraulic radius are needed to achieve **high velocity flow.**
Sand and gravel (incoherent)	● Sediment is larger in size and so is transported as **bedload**. ● Wide and shallow channel increase the **turbulence and hydraulic lift needed** ● To transport load by **saltation** ● This turbulence also causes **lateral erosion**. ● Thus forming **shallow and broad channels**.

3. Nature of Flows

The nature of flows affect the type of channel patterns/morphology that is formed.

- Laminar flow → rare, but in straight channels.
- Turbulent flows → irregular vertical and lateral movement of water to form eddies and swirls → most common and allows for lateral erosion in braided channels
    - can become helicoidal flow if in a channel of alternating pools and riffles.
- Helicoidal flow → corkscrew like current → in meanders to allow for the concave cut bank and convex point bar deposit to form.

<u>Drainage Density</u>

Drainage Density(DD) is the measure of how frequently streams occur on the land surface.

- Total stream length/total drainage basin area
- Shows the drainage efficiency of an area
- Low infiltration rates → higher rates of overland flow → higher DD

Affected by:

1. Climate

High rainfall intensity → high volume of water over a short time.
Ceteris paribus → results in high DD

- Areas with high DD occur in regions with marked seasonal precipitation regimes like the Aw or BSh climates.
- Humid tropics like Af climates → DD is not high as there tends to have a large amount of dense vegetation

2. Vegetation

Vegetation can bind to soil surface layers → increase infiltration rates into the ground by interception and stemflow.

- Slows rate of overland flow by preventing flows from concentrating on definite lines → eroding small rills which may develop to stream channels
- Stores water as biological water storage.

3. Geology

Degree of rock permeability may affect DD.

- Crystalline igneous/metamorphic rock → low porosity and permeability.
- Rocks of high secondary permeability like limestone → high infiltration capacity through joints → low drainage density
- Slope angle of an area can cause higher speeds which can cause more fluvial erosion which can form more streams as less infiltration may occur.

4. Anthropogenic Factors

Urbanisation has caused land surfaces to change from vegetated surfaces to impervious ones like cement → increases DD.

Deforestation → decreases vegetation → blah blah blah blah blah → increased DD

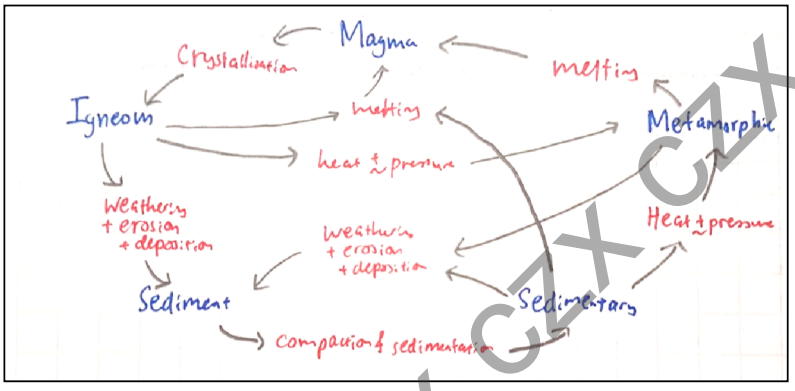
1.1.3 Geomorphic Processes in the Tropics

9a	Rock Cycle

A. Rocks, weathering and soil-forming processes - rock cycle and rock types: igneous, sedimentary and metamorphic	

The Rock Cycle

The **rock cycle** shows the movement of material through space and time as it is transformed from one rock type in one location to other rock types in other places.



Igneous Rocks

An **igneous rock** is one that **solidifies** and **crystallises** from molten magma or lava.

- Can be extrusive or intrusive

Extrusive Igneous Rocks

- Magma extrudes out of the surface (now called lava)
- while still in the molten stage the lava **cools and crystallises rapidly**, forming smooth and **fine grained** rocks
- Common extrusive igneous rocks include **basalt, andesite and rhyolite**

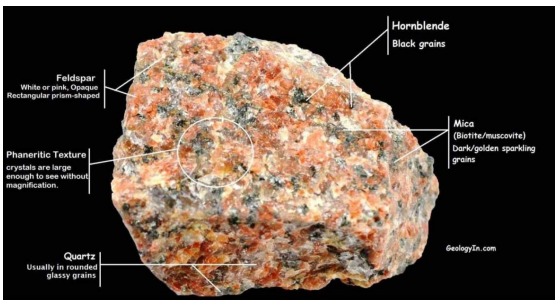
- Example: **Basalt**
  - **Hard, fine grained** rock formed at the surface, made up of **small crystals** undergoing quick solidification above or close to earth's surface
  - Low in silica, rich in Fe and Mg, *consists of olivine and pyroxene which may exceed more than 50%*
  - ***Higher specific density*** *and* ***darker*** *colour than granite*
  - Presence of **vertical and hexagonal columnar joints** due to rapid cooling and contraction
  - **Highly permeable** (due to joints), and hence highly susceptible to decomposition

Intrusive Igneous Rocks

- **Complete crystallisation** happens **before** the magma reaches the surface
  - forming intrusive igneous rocks, since these rocks force into existing rocks

- They form **large crystals** and **coarse grained** rocks due to the **slow** rate of cooling and crystallisation

- Example: **Granite**
  - Formed at great depth under very high pressure
  - Made up of low-temperature minerals
    - **Quartz** (hard clean and glassy grains)
    - **Feldspar** (hard pinkish grains)
    - **Mica** (small silvery white or black, soft scaly flakes)



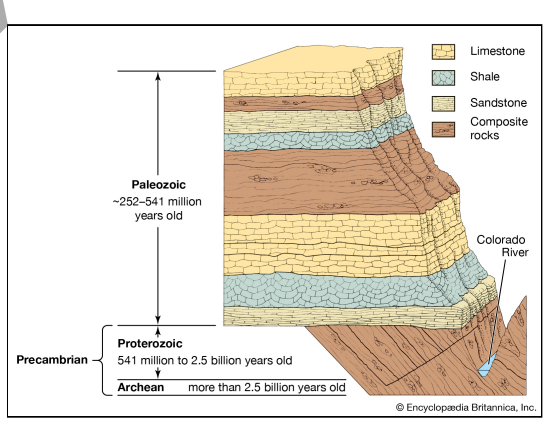
  - Possesses **large crystals** due to slow cooling at a great depth
  - Very hard rock, resistant to erosion and weathering
    - **Orthogonal jointing** develops upon cooling of granite (3 sets of joints, with 2 vertical sets that cross at right angles and a third set that is horizontal), that dissects massive granite into cuboidal blocks
  - **Low in porosity** due to crystalline nature
  - Relatively permeable due to the **jointed** nature of the rock, and where jointing is high, **permeability is high**
    - (**high secondary permeability** i.e. water moves easily via the joints of the rock, but not through pore spaces)

Sedimentary Rocks

Sedimentary rocks are formed from the **accumulation of sediments**.

Diagenesis occurs when sediments are in unstable conditions, causing clasts/organic material to be bound together, forming into sedimentary rock.

The transformation involves several different processes.



- **Compaction**
  - Sediment is **squeezed** by the **pressure** of overlying sediment; **water is lost** as **permeability and porosity drops**
  - for very fine sediments like *clay*
  - Helps to **establish attractions** between particles due to slight electrical charges

- **Cementation**
  - Minerals crystallise in pore spaces from circulating fluids, cementing grains together
  - Water with dissolved ions enter pore spaces from circulating fluids.
  - The ions then **crystallise new minerals** between the grains, and these newly formed crystals become enmeshed with each other
  - As in recrystallization, it forms a **cohesive, harder mass**
  - Cements commonly present include $CaCO_3$ and FeO or SiO_2 cement

- Some rocks like sandstone are made of quartz and thus are resistant to weathering.
- Most ways to break down the rock is by attack on cement via hydrolysis or carbonation *(work out the chemistry yourself)*

- **Lithification**
  - Refers to compaction and cementation of sediments.

- **Recrystallisation**
  - Some minerals change in shape and size due to surface environment characteristics
  - They then **recrystallize** to mesh themselves together, locking the particles together
  - As such, the entire structure harder and stronger
  - Example: **CaCO3** is aragonite in the ocean, and when it comes into contact with rainwater, it turns into calcite; crystals grow larger due to this transformation since calcite takes up more volume per molecule

Characteristics of Sedimentary Rocks

- Sedimentary rock have **strata or beds** as sediments are laid down horizontally
- Top or bottom of any bed is a **bedding plane** which separates individual strata and signifies a **cessation of deposition for a period of time**
- Can be **clastic, chemical or biogenic**

1. Clastic Sedimentary Rocks

Formed from **compaction and cementation** of fragments of pre-existing rocks called clasts.

- Dominated by sands that **are most resistant to weathering**
  - Like feldspar and quartz

- Example: **Sandstone**
  - *3 major types of sandstone: quartz, arksonic, and lithic*
  - consists of sand-sized minerals (like feldspar and quartz),
  - resistant to weathering as sand grains get cemented together
  - **Horizontal/tilted bedding planes** are observed in sandstones
  - High porosity
  - High permeability along the bedding planes

- Example: **Shale**
  - consists of feldspar, quartz, calcite and clay minerals, from mud
  - gets compacted into rock and cleaves when weathered
  - soft
  - weathers and erodes rapidly into a gentle slope
  - well stratified, with layers thinner and closer
  - well-marked bedding with possible joints

- Impermeable unless strata is steeply inclined
  - causing bedding planes to be exposed, allowing water penetration

2. Chemical Sedimentary Rocks

Derived from **dissolved minerals → transported in solution → precipitated from solution → crystallised**

- Visibly crystalline, angular,
- light in colour, banded in appearance
  - Example: **Halite (rock salt) & gypsum**

3. Biogenic Sedimentary Rocks

Formed **directly or indirectly by actions of animal of plant organisms**

- usually derived from body parts of organisms
  - Hard skeletal parts comprising of bioclastic, biogenic sediments, and soft tissues produce organic bioclastic sediments
    - **Stagnant, oxygen poor environments** are necessary for the accumulation of organic sediments; lithification is achieved via compaction

- Example: **Limestone**
  - Made up of calcite, $CaCO_3$
  - Made from **broken down shells** of millions of the tiny animals living in the sea from the past
  - **Presence of bedding planes and vertical jointing** which cut at right angles
    - allowing water to enter via these fissures → concentrating solution weathering in joints (link to karst)
  - **Low porosity** (exception: chalk)

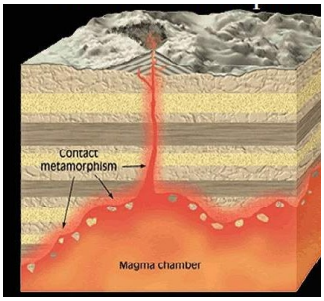
Metamorphic Rocks

Metamorphic rocks are formed when an igneous/sedimentary rock undergo **physical or chemical changes** under **immense pressures and high temperatures**.

- This forms rock that has changed in texture and structure.
- High temperatures and high pressures → mineral of the parent rock are reconstituted into different mineral variaties
  - **recrystallization** occurs
- More compact than original rocks → resistant to weathering and erosion

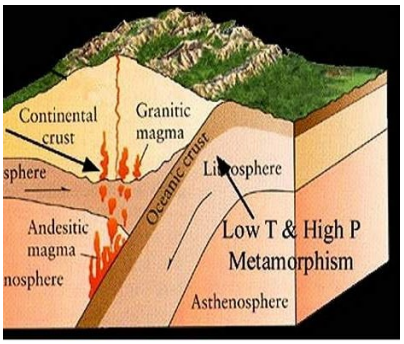
Contact Metamorphism

- Occurs when rock comes into contact with **a source of extreme heat**, like an igneous intrusion, causing changes by **high temperatures alone. [no pressure]**
- Chemical content of the rock does not change, water can be driven off → minerals can be broken down or recrystallised.



Regional Metamorphism

- Occurs when large areas are subject to the forces associated with a **plate boundary**
    - *As plates converge, sedimentary rocks that form ocean trenches neighbouring a subduction zone are subject to high pressures*
- Due to **increasing both pressure and temperature**
- Leads to **metamorphic grading**
    - Rocks with a **layered or banded appearance**, known as a **foliated texture.**



Metamorphic Grade

Metamorphic grade refers to the relative temperature and pressure conditions under which metamorphic rocks form.

- Examples: **Marble** (parent is **Limestone**)
    - Formed by the metamorphism of **limestone** by heat **and pressure**
    - Made of calcite or dolomite crystals, $CaCO_3$
    - crystalline texture

- Examples: **Quartzite** (parent is **Quartz**)
    - from the metamorphism of pure **quartz sandstone**
    - Made of firmly cemented quartz grains
    - Individual quartz grains have **recrystallized along with cementing** material to form an **interlocking mosaic of quartz crystals**
    - Medium grained
    - Low porosity

Cleavage(ehem in GEOG terms) refers to the tendency of a mineral to break along flat planar surfaces as determined by the structure of its crystal lattice.

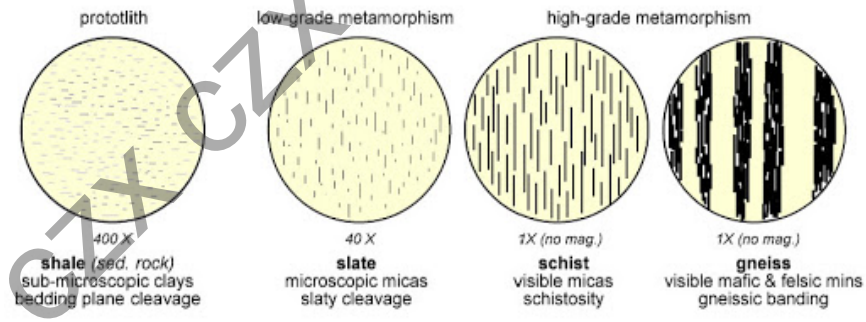


Figure 2. Foliation of metamorphic rocks. Regional metamorphism creates the texture.

The following list is in **increasing metamorphic grade**:

Low Grade

- **Shale**: bedding planes are parallel to minerals
- **Slate**: Sheet silicate minerals **crystallise and grow** in a **preferred orientation** which may be straight or wavy patterns

High Grade

- **Schist**: great length of time to for recrystallisation and new minerals to grow
- **Gneiss**: Sheet silicates may be unstable and dark coloured minerals like *hornblende* and *pyroxene* grow

9b	Weathering

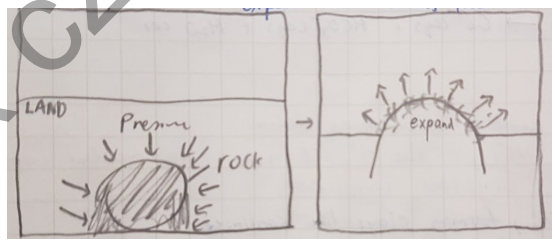
B. Rocks, weathering and soil-forming processes - physical weathering: pressure release, thermal weathering, freeze-thaw and salt weathering - chemical weathering: hydrolysis, carbonation, solution, oxidation and reduction	

There are 2 types of weathering: **Physical and Chemical.**
Weathering refers to the **breakdown and alteration of rock in situ**.

Physical Weathering

Refers to the process where rocks **break up due to a physical force, exposing more surface area**.

1. **Pressure Release** *[not counted as a weathering process for some reason]*



Pressure release **exposes and weakens the rock** to other forms of weathering processes to take place.

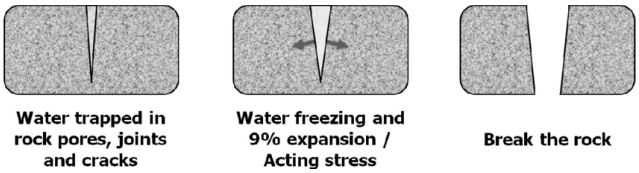
- When a great mass is removed from above a rock that exposes it,
- the pressure acting on the rock reduces.
- Causing the **expansion of the rock**, and
- the **joints to open.**
- **This generates concentric slabs** that peel off through exfoliation.

2. **Thermal Weathering**

Occurs in places with **large diurnal temperature ranges** (i.e. arid tropics) where there are extreme changes in temperature.

- Caused by **heating and cooling cycles** causing **alternate expansion and contraction** of rocks.
- During the day, **high temperatures** result in rocks in **outer layer expanding faster** than inner layers
- while at night, low temperatures cause **outer layers to contract faster than inner layers**
- **Different rates of expansion and contraction** cause **fractures** and **cracks** to form.
- causes rock to undergo **exfoliation** due to stress caused within the rock.
    - This can cause **granular disintegration** in granite
    - dark mica heats up faster than paler feldspar and quartz crystals due to differential weathering of minerals within the rock structure.

3. Freeze-thaw Weathering



Not probable in the tropics due to high MAT, but at high altitudes maybe.

- Water enters a joint
- Freezing of water causes ice to expand by 9%
- Exerts stress on rock, widening cracks and joints, shattering the rock
- When **temperatures oscillate around 0˚C**, this makes freeze thaw weathering occur as the cycle repeats multiple times.
    - **Resulting in large angular blocks to form, or scree slopes.**

4. Salt Weathering

- Water containing quantities of salt like sodium chloride are evaporated.
- Water then becomes **saturated with salt**, forcing the salt to **crystallise within the rock**, and **exert pressure**.
- Causes **granular disintegration** and grains of sand to get dislodged,
    - Common in coastal and arid areas where groundwater can move up to the surface via capillary action from high temperatures
    - May also lead to **honeycomb weathering** aided by wind flow, which causes evaporative salt growth on the surface of rocks and small cavities to form

Chemical Weathering

Water is the most important agent of chemical weathering.

1. Solution and Carbonation

Solution refers to the **dissolving of a soluble mineral in water or acidic water**, bringing along the dissolved rock minerals in **solution**.

- This weakens the rock structure and enlarges rock joints.

Carbonation occurs when carbon dioxide dissolves in water which forms **carbonic acid**.
This can react with calcium carbonate or limestone to form calcium and bicarbonate ions that are soluble in water.

$$CO_2\,(g) + H_2O\,(l) \rightleftharpoons H_2CO_3\,(aq)$$

$$H_2CO_3\,(aq) + CaCO_3\,(s) \rightarrow Ca^{2+}\,(aq) + HCO_3^-\,(aq) + H_2O\,(l)$$

2. Hydrolysis

Water reacts with minerals in the rock, and decomposes them.

- Water contains H+ and OH- ions
- **H^+ ions attack and replace the metal ions** of the crystal lattice in the minerals of the rock
- destroying the orderly arrangement of the rock
- leading to decomposition.
    - **Silicates like feldspars found in granite** are vulnerable to hydrolysis, forming clay minerals like kaolinite.

$$2\,KAlSi_3O_8 + 3\,H_2O \rightarrow Al_2Si_2O_5(OH)_4 + 4\,SiO_2 + 2\,KOH$$

potassium feldspar *kaolinite (clay)* *quartz*

3. Oxidation

Iron, sulfur and manganese react with dissolved oxygen to form metal oxides.

- This causes colour changes to reddish brown colours
- Oxidised minerals **increase in volume**, applying more **stress**, increased in mechanical weathering rates.
- Weathered oxides are **loosened from the main rock** and weakens the structure of the rock.
    - Ferromagnesian(Fe + Mg) is decomposed by oxidation, causing rusty colours on dark igneous rocks like **basalt**.
    - However, this only happens **after the iron cation is freed from the silicate structure via hydrolysis.**

4. Reduction

Refers to the **removal of oxygen** from compounds.

- Can result in changing soil colour to blue, grey or green
    - as Fe^{3+} is converted to Fe^{2+} compounds, mostly occurring in exceess water or waterlogged conditions with a lack of oxygen.

9c	Soil-Forming Processes

C. Rocks, weathering and soil-forming processes - soil forming processes: laterisation, salinisation and calcification	

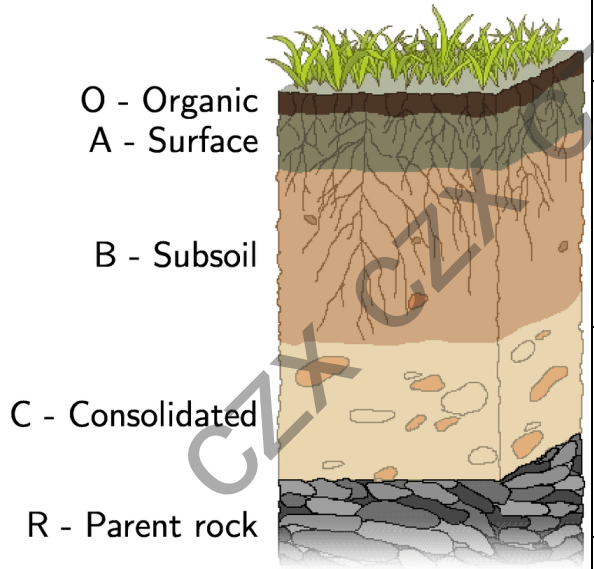
Soils are defined as the **entire profile of weathered and unconsolidated rock material lying above the unaltered bedrock.**

- They can be examined by their water content, colour, texture and structure.

Soil Horizons

A soil horizon is a **visible and distinguishable layer within a mature soil**

- Each horizon has a distinctive physical and chemical characteristic, but they may grade into each other.



O Horizon

- It is the organic horizon comprised of organic material **decomposed from animal and plant litter**.
- Transforms to **humus** which is dark in colour

A Horizon

- Where biological activity and humus content is at their **maximum**
- Affected by leaching of soluble material and outwashing, known as **eluviation**.
- Clay particles, Al_2O_3 and Fe_2O_3 is leached

B Horizon

- Known as the **zone of accumulation** or **illuviation**.
- It is where clays or other material removed from the A horizon are deposited.

C Horizon

- Made of recently weathered parent material (regolith) resting on the bedrock.

Bedrock

Soil Forming Processes

1. Weathering

Soil forming processes start with the weathering of rock in situ to produce regolith in the C horizon.

- May refer to thermal weathering or chemical weathering like carbonation
- Original rock type may affect the soil texture and structure
    - Sandstone produces coarse/free draining soil
    - Clays and shales may produce finer soils

2. Laterisation

Laterisation occurs when precipitation exceeds potential evapotranspiration rates.

- There are movements of large volumes of water through the soil.
- The byproducts of weathering are then eluviated and leached out of the soil
    - Causes the A horizon to be depleted of base cations like Ca^{2+}, Mg^{2+}, K^{+} and enriched in sesquioxides like Fe_2O_3.
    - This forms **laterite**.

Common in humid tropics as high temperatures and heavy rainfall are needed for heavy leaching and oxidation of iron.

3. Calcification

Calcification involves the processes of translocation (vertical movement of soil particles) and leaching. They require potential evaporation to exceeed precipitation rates.

- Calcium and magnesium carbonates may be derived from windblown dust that is deposited over soil surface
    - Dissolution of these minerals produce a carbonate rich solution near the surface environment
- Water is drawn upward by **capillary action**
- Water rises to the B horizon and carries minerals like calcium carbonate
- When the water evaporates, the calcium minerals remain in the soil, accumulating in the B horizon
- Forming calcretes

Common in sub-humid to arid climates where ppt is insufficient to downwash minerals or soil water down to the water table.

4. Salinisation

Salinisation occurs when potential evapotranspiration exceeds precipitation and especially in places where the water table is near the surface.

- As moisture evaporates from the ground surface
- Water, along with the dissolved salts are drawn upward in the soil by capillary action.
- When this water evaporates even more, salts are precipitated at or near the surface.
    - Forming salt crusts on top of the surface.

5. Organic Changes

Plant litter may decompose by action of fungi, algar, small insects or bacteria, forms a dark amorphous mass and releases humic acids which aid in chemical weathering of parent rock.

10	Erosion Processes

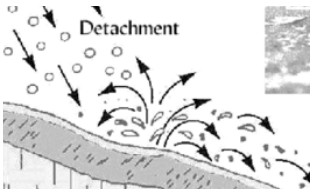
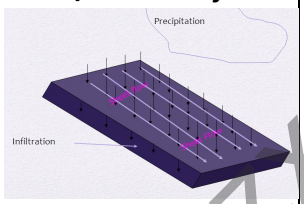
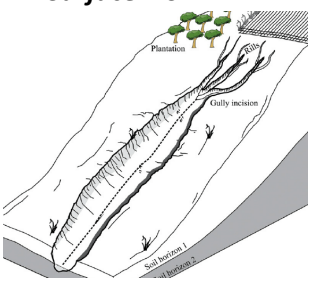
A. Erosion processes - erosion by water: splash erosion, rainwash, rillwash - erosion by wind: deflation and abrasion	

Erosion is the wearing away of land by water, wind or ice. We are focusing on the weathering of *water(fluvial)* and *wind(aeolian).*

Erosion by Water (Fluvial Erosion)

Fluvial activity is essential to create landforms in either fluvial environments or semi arid areas.

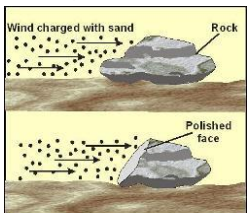
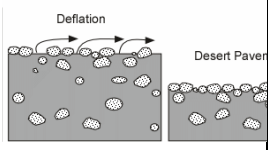
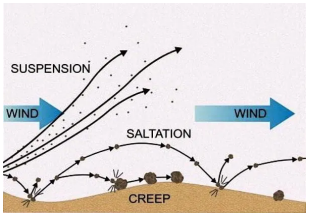
- When water runs over landscapes as unconcentrated and concentrated flows due to the processes of IEF and SOF, rills and gullies or river channels can form
- Dependent on runoff production where precipitation exceeds evaporation rates

Process	Explanation
Splash Erosion / Rainsplash 	Results from raindrops striking rock and soil surfaces. ● **Impact from raindrop compresses and spreads sideways** ● Results in **shear on rock/soil** which **detaches the particles** from the surface ● Releases the particles that **can be entrained and transported** by unconcentrated surface flow/rainwash which may lack power to dislodge and lift particle *(link to Hjulstrom)*
Rainwash / Overland flow 	Refers to **unconsolidated surface flow** **Thin layer of water** moving together with strands of deeper and fast flowing water diverging and converging around surface bulges. ● Involves inter rill flow/**sheetflow** ● **Carries sediment dislodged from splash erosion**
Rillwash / Concentrated Surface Flow 	Rillwash consists of **turbulent flows** that cause **incisions into the hillside**, known as rills. This can grade into streamflow ● **Rills** are **tiny hillside incisions** that are **a few centimeters apart** that grade into: ● **Gullies** which are **larger incisions** into stream beds that are deeper, long and narrow. This grades into: ● Wadis/Arroyos which are ephemeral streams in arid / semiarid regions. This is a bigger gully with steep vertical walls, flat and sandy floors.

Erosion by Wind (Aeolian Erosion)

Wind is a **dominant agent where there are arid conditions, with finer grained soil and little vegetation.**

- Note that only Abrasion and Deflation is explicitly mentioned in syllabus

Process	Explanation
***(Erosion)* Abrasion** 	**Powerful erosive force** as winds **equipped with grains scour the landscape**. ● **Abrasion rates are highest at about 1-2m high**, with stronger winds carrying hard grains. ○ Higher heights tend to have lower particles ● This **functions better when the abrading rock is hard**, and the rock being abraded being soft.
***(Erosion)* Deflation** 	Refers to the **removal of loose particles by wind**. ● Smaller grains are more susceptible to wind erosion than larger ones, especially ones that are 100μm in diameter. ● **Larger grains need faster winds to transport** This **lifts and removes fine sand and sediment by wind**, leaving coarse gravel as lag deposits. This is what provides sediment in landforms like the Loess and Dunes.
(Transport) 	● **Creep**: Coarse sand and particles **roll and slide** ● **Saltation**: Sand grains move in **arc-like trajectories as they bound, land and bound again** ● **Reptation**: Upon hitting the ground, The grains **release a shower like splash of particles from its point of impact**. ● **Suspension:** Clays and silts are **carried in the wind**.
(Deposition) **Sedimentation**	Sediments **fall out of the air** and stop creeping forward, due to a **decrease in wind velocity or rain**. Forms the Loess and the starting of dunes.

11	**Mass Movements**

A. Mass movements - slope stability: factors that influence shear stress and shear strength - classification of mass movement processes: fall, slide, flow and heave	

Introduction

Mass movements are downhill movements of a body of material or regolith primarily under the influence of gravity.

This occurs when the shear stress is greater than shear strength.

- Shear stress refers to the driving force causing a movement of the body of material downhill.
- Shear strength refers to the resistive forces of a body to movement.
    - Example is when gravity overcomes friction, a mass movement may occur.

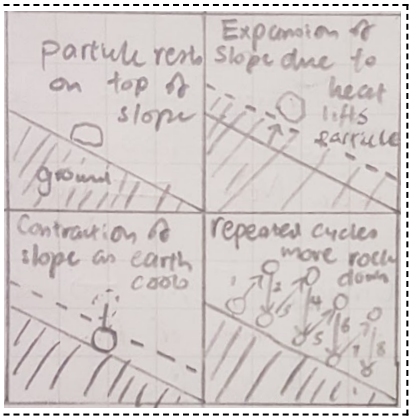
Mass Movement Processes

1. Heaves

Heaves are the slowest type of mass movement

- Smallest scale, highly effective and extensive

1. Expansion of rock fragments in regolith during hot temperatures causes regolith to be lifted perpendicularly from the ground.
2. Contraction of rock fragments in regolith during cooler temperatures causes regolith to move horizontally.
3. Results in a net downward movement of rock fragment due to:
    a. Heating and cooling
    b. Wetting and drying
    c. Freezing and thawing



This form of mass movements can create **terracettes**.

- Affected by slope angle, soil moisture and vegetation.

2. Flows

Flows are the wettest type of mass movement.

- Water can saturate soils, decreasing their cohesiveness
- Water can hold soil together by capillary action, but **too much water would break away the cohesive bonds** between the particles as **pore water pressure in saturated soil increases**

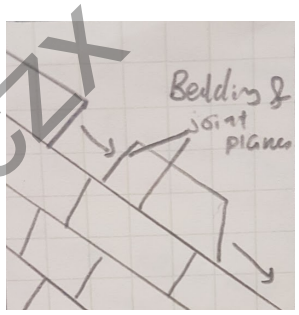
- This decreases the friction between particles → decreases shear strength → causes the mass movement to occur.
- Too much rain can cause the weight of the sediments to increase and cause shear stress to increase → MM
- Lahars are also examples of flows where water is mixed with volcanic material.

(fine material + fast) **Mudflow > Earthflow > Debris Flows** (coarse material + slow)

Example: Earthflows in Uttarakhand, Northern India in 2013
- Slopes were undercut by construction of roads and tunnels for hydropower generation
- Landscapes were triggered by heavy precipitation due to monsoon season
- Killed about 5700(5748) people

3. Slides

Slides can either be a translational slide or a rotational slump
- Favours rocks with joints or have bedding planes
- Translational slides → shear planes is parallel to the slope



1. Involves rocks with bedding planes parallel to the slope, where shear stress can be high.
2. When the shear stress exceeds shear strength, a mass movement can occur

This is especially so as shale when wet can provide a layer for a heavier rock above a slide on.

Example: Volcanic Scoria Cones, Mexico
- Foliation planes of metamorphic rocks with foliation planes dipping down caused a translational slide to occur

Rotational slumps can occur due to a concave curved shear plane.

Example: Rotational Slump Chocolate Hills, Philippines, 2013
- Earthquakes caused a rotational slump along the concave shear plane in the limestone cone karst.

4. Falls

When shear stress exceeds shear strength on a steep slope, soil and rocks free fall as a body of mass through the air.
- May be due to joints in rock or slope angle.

Factors Affecting Shear Strength and Shear Stress (SSSS)

1. Nature of Earth Material

Rocks with shear planes like bedding or foliation planes parallel to the surface of slope, causing slides to occur.

- Moderate moisture levels above said rock → lead to decrease in shear strength → distinctive zone of weakness → separate slide material from more stable underlying material.
- Rocks like shale may be slippery when wet.

Example: Volcanic Scoria Cones, Mexico
- Foliation planes of metamorphic rocks with foliation planes dipping down caused a translational slide to occur

2. Slope Angle

Steeper the slope → greater force driving downhill → more shear stress.

- Milder slopes encourages the process of **soil creep**
- When the slope angle is 31-39˚, **flows** are more predominant
- Sleep slopes are bigger than 40˚ encourage **rock falls** as there is stronger gravitational force → SSSS → MM
- Steepening of slopes may occur due to downcutting of rainwater and exposed rock
    - Angle of slope exceeds angle of repose, leading to increase of shear stress.

Example: Earthflows in Uttarakhand, Northern India in 2013
- Slopes were undercut by construction of roads and tunnels for hydropower generation
- Landscapes were triggered by heavy precipitation due to monsoon season
- Killed about 5700(5748) people

3. External Triggers

External triggers like earthquakes and volcanoes may result in a sudden release of energy, increasing shear stress.

- Liquefaction is a process that involves vibration and soil saturated with water, resulting in earthflows.

Example: Rotational Slump Chocolate Hills, Philippines, 2013
- Earthquakes caused a rotational slump along the concave shear plane in the limestone cone karst

4. Climate

Temperature changes like fluctuations due to a higher diurnal temperature range can encourage soil creep to occur.

- Rain can weaken a slope, decreasing shear stress and increasing shear strength.
    - Water can hold soil together by capillary action, but **too much water would break away the cohesive bonds** between the particles as **pore water pressure in saturated soil increases**
    - This decreases the friction between particles → decreases shear strength → causes the flows to occur.

Example: Hawaii, USA
- Terracettes can be found in the slope of Hawaii, a tropical savanna climate

Example: Sumatra, Indonesia - 2019
- During the monsoon season, the saturated soils triggered a flow which killed 29 people

5. Presence of Vegetation

Roots can hold soil together, increasing shear strength.
However roots can also increase infiltration rates which make the weight of the slopes increase.

Example: Mocoa, Columbia - 2017
- Heavy rain + deforestation caused a landslide which killed 260 people.

1.2.1 Landscapes in the Tropics

13	Karst Landscapes in the Humid Tropics

A. Karst landscapes in the humid tropics - processes underlying the formation of karst landscapes in the humid tropics - factors that affect the formation of karst landscapes in the humid tropics - characteristic landforms: tower karst, cone karst and isolated karst	

Introduction

Karst landscapes are distinctive landscapes **containing caves and extensive underground water systems which are developed on particularly soluble carbonate rock**.

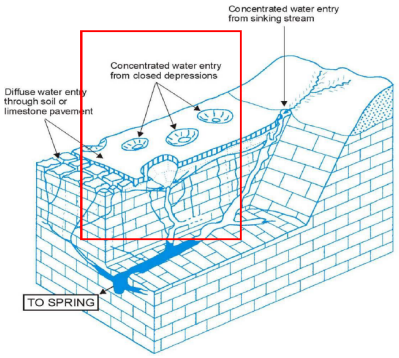
- Most of these carbonate rocks are limestone, $CaCO_3$

Limestone is created from calcium carbonate either precipitating from ocean waters or from the remains of corals/algae that deposit on the sea floor and undergo diagenesis which recrystallises the calcite into an intergranular network of crystals.

- They have have bedding planes and are well jointed
  - As such they have high secondary permeability
- There is high purity that is needed for good extensive development of the landform
  - Impurities like clay can fill up these joints and limit the further development of these landscapes.

Formation of Karst Landscapes

1. The limestone rock is first formed underwater and exposed during an episode of sea level fall.
2. **Rainwater absorbs carbon dioxide** from the air and from soil as **decay of organic matter** generates high levels of carbon dioxide. This forms **carbonic acid**.
3. Due to limestone's low porosity but well-jointed nature, limestone is weathered by carbonation as $CaCO_3$ in limestone reacts with carbonic acid to produce calcium and bicarbonate ions which are carried in solution.
   a. Soil and vegetation on the surface contribute to the chemical weathering process as the humic acids that quicken the rate of dissolution.



4. This percolated water then **concentrates and enlarges at the uppermost joint** which causes even **more water to flow and enlarge that joint**, forming a **positive feedback loop**.
5. The ground then subsides, forming a depression on the surface, known as a **doline**.
6. As there is more rainfall, more gullying occurs which causes the depressions to enlarge laterally, overlapping with other dolines and merging.
7. This forms **polygonal shaped elongated depressions, forming cockpits separated by conical residual hills, known as cone karsts**.

8. Further weathering and fluvial erosion can occur to the cockpits.
9. When the erosion is coupled with tectonic uplift, the cockpits lower the floor vertically until **base level for erosion** is reached.
10. **Lateral weathering and erosion** is more dominant, making the conical hills more steep due to the **undercutting** of rock and resultant mass movements.
11. This forms a dominant feature as a sharp rise from the surrounding alluvial plain, which rises up to 30-200m above the surrounding plains, forming **tower karsts**.

12. When erosion reaches the base level, the cockpits or depressions can form valleys where **rivers may emerge and flow through**.
13. The rivers can cause the valleys to widen, isolating the blocks of limestone.
14. These blocks are then eroded by a combination of undercutting, cave development at the foot of blocks and mass movements, forming single towers that rise out of an alluvial plane, an **isolated karst**.

Characteristic Karst Landforms

In the syllabus we focus on cone, tower and isolated karsts.

1. Cone Karsts

Cone karsts make up landscapes that are marked by **residual relief surrounded by closed polygonal depressions** known as **cockpits**.

- The residual relief can appear as cone shaped hills that rise to **30 - 100m in height** and mark the boundary of cockpits
- The cones are generally ssymmetrical in shape and have angles steep at 45-47˚

Chocolate Hills, Philippines *[Af] [Cone Karst]*

- Tectonic Uplift
  - In an active tectonic convergence boundary with the Eurasian plate converging with the Philippines plate
- Species of grass, flowers and ferns thrive on the hills
- Marine limestone above a layer of clay
  - Clay layer makes the limestone layer less t h i c c → cause the karst to mature to a smaller extent

2. Tower Karsts

Higher and steeper than cones.

- Residual towers can range from towers with narrow bases to almost conical shapes.
- Dominant features include a sharp rise from the surrounding wide and flat alluvial plain.
- **30 - 200m in height**.
- May include steep overhanging slopes or serrated summits

Kinta Valley, Malaysia *[Af] [Tower Karst]*
- Stresses on the geology due to tectonic activity controlled the formation of karst features like caves, dolines and some collapse features.

https://qsm.org.my/products/702001-100639-PDF.pdf

3. Isolated Karsts

Single towers that rise out of an alluvial plain.

- Few hundred meters tall
- Only outcrop in an area
- Cave development may occur at the foot of rock

Gua Charas, Malaysia *[Af] [Isolated Karst]*
- Out in oil palm plantation
- 300 meters tall

Factors Affecting Karst Formation

A. Climate

High temperatures speed up the process of karst formation as higher temperatures can lead to faster chemical reactions and thus weathering.

- **Van Hoff's rule** states that a 10˚C rise in temperature causes the rate of chemical reactions to speed up twice.

A substantial amount of precipitation is also important for karst formation as a large supply of rainwater is essential for the aggressive dissolution of limestone to occur.

B. Presence of Vegetation

Vegetation and soil cover that is thick enough increases the amount of CO_2 to dissolve into percolating or infiltrating rainwater.

- Vegetable and animal droppings decomposing can produce organic acids that halp in the dissolving process of limestone.

Gua Charas, Malaysia *[Af] [Isolated Karst]*
- Out in oil palm plantation
- Presence of the layer of humus and higher levels of organic activity
- 300 meters tall

C. Lithology

Presence of limestone of high purity, at least 80% $CaCO_3$ is needed for effective and extensive development of the karst landscape.

- A thick enough later is needed to have water permeate and flow over, dissolving the limestone.
- Requires a thick aerated zone/vadose zone between the ground surface and the water table.
- Tectonic uplift helps to increase this layer.

Chocolate Hills, Philippines *[Af] [Cone Karst]*
- Tectonic Uplift
  - In an active tectonic convergence boundary with the Eurasian plate converging with the Philippines plate
- Species of grass, flowers and ferns thrive on the hills
- Marine limestone above a layer of clay

14	Fluvial and Aeolian Landscapes in the Arid Tropics

A. Fluvial and aeolian landscapes in the arid tropics - processes underlying the formation of different landforms in the arid tropics - factors that affect the formation of different landforms in the arid tropics - selected landforms: rills and gullies, yardangs, dunes and loess	

Formation of Landforms

1. Rills and Gullies

Rills and gullies are erosional landforms that are common on hilltops, especially with sediment material susceptible to very efficient overland flow generation.

- Rills are a few centimeters wide and deep
- Gullies are deep, long and narrow channels

1. Irregular sporadic rainfall generated in the arid tropics is intense, resulting in the formation of large amounts of **infiltration excess flow**, along with **rainsplash** dislodging particles on the surface.
2. Running water from IEF erodes particles by the processes of rainwash and unconsolidated surface flow.
3. Sheet flow then diverges and converges around bulges in the surface, concentrating the flows.
4. This turbulence generated then forms incisions into the surface.
5. Incisions formed may be few centimeters which form **rills**
6. These rills can grade into **gullies** which have higher erosive power and it can grade into streamflow like wadis.

2. Yardangs

Steep walled long, narrow rock ridges found segragated to each other by each other by passageways found on less resistant rock in deserts.

- Average height is about 8m byt can grow up to 60m in the Lut Desert of Iran
- Mostly formed parallel to prevailing wind direction

1. **Suitable bands of less resistant rock and more resistant rock** form under past humid climatic conditions.

2. After the sediment is dried out, **irregular sporadic rainfall** can cause weaker rocks to be eroded more quickly by **fluvial gullying**, creating **lineations on the rock** that wind can work on to erode further.
3. Weaker rocks are eroded more quickly by **abrasion and deflation** to form **troughs**.
4. **Differential rates of weathering** will cause the resulting landscapes to have **high ridges and mesas, separated by narrow corridors**.
5. **Abrasion** which works best at **1-2 meters** widens the narrow corridors and cause the ridge noses to retreat, undercutting the rock
6. The slopes are then steepened therefore mass movements may occur.
7. This process forms a **yardang**
8. The yardangs relief may be reduced even further to form an aerodynamic whaleback shape.

These yardang fields can be found in Dunhuang, China.

3. Dunes

Dunes are depositional landforms.

1. Sands formed by **dried up riverbeds and ancient river basins** get **entrained by deflation**, by wind.
2. The wind's velocity keeps the sand particles in suspension, until it **meets an obstacle** like a plant or a rough surface.
3. The wind's velocity decreases, resulting in deposition as sedimentation occurs, producing a sand patch.
4. This sand patch then becomes an even bigger obstacle for the wind, causing a positive feedback loop to set up where more wind slows down and more sand is deposited.
5. As the sand patch grows, the wind's flow lines compress and it increases in velocity, allowing sand to transport up the windward side of the dune by saltation and surface creep.
6. Upon reaching the top of the dune, the sand rolls down the leeward slope.
7. The airflow separates, decelerates and deposits even more sand at the leeward side of the dune, forming a slip face with an angle of repose of 33˚.
8. This continuous process of wind erosion and transportation of grains up the windward side, depositing at the leeward side results in a net downward migration of the dune.

4. Loess

Loess are depositional landforms of silt.

1. **Glacial grinding** or rock, **abrasion by wind** and **weathering** processes create **large amounts of silt**
2. Wind transports the silt by **deflation** and carries the silt in **suspension or saltation.**
3. When they reach a rough surface or suitable site, the wind slows down and deposits the silt in the process of **sedimentation**.
4. This can form thick deposits of up to 400m thick.
5. Rills and gullies may form in the loess landforms as well

Factors Affecting Formation of Landforms in Arid Tropics

1. **Wind speed**
    - Wind needs to have high enough velocity to meet the fluid threshold to carry particles in suspension
    - Loess requires a drop in velocity to deposit.
    - China's Loess Plateau next to Mu Us Desert

2. **Wind Direction**
    - Determines the type of dune formed
    - Unidirectional winds form barchan dunes
    - Multidirectional winds form star dunes
    - Badain Jaran Desert forms star dunes that can reach up to 500m tall
    - Taklamakan Desert, China has barchan seas

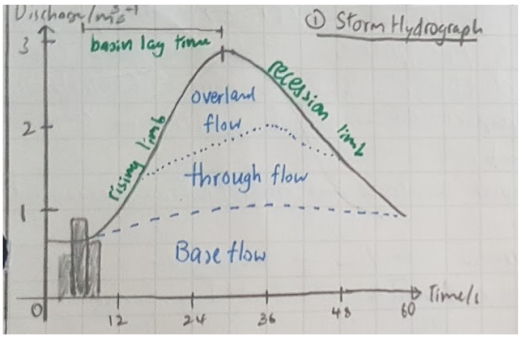
3. **Sediment Supply**
    - From dried up river or lake beds, affects the type of dune formed
    - Loess relies on silt
    - More sediment can cause a barchan to form barchanoids to form transverse dunes.

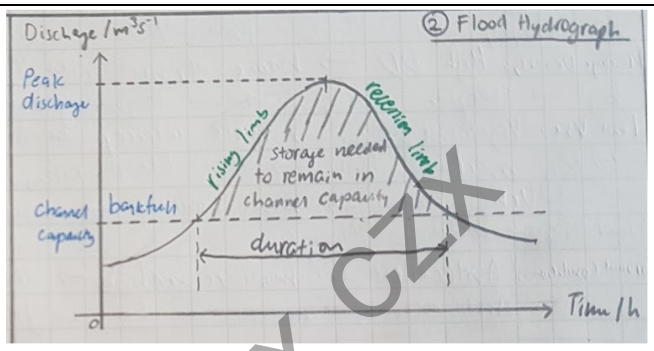
4. **Climate**
    - Low rainfall climates cause soil particles to be dry and are unconsolidated
        - Cohesive bonds are weak
    - Rain generates IEF, forming rills and gullies
    - Longer scale climatic changes involving both wetter and drier climates today profoundly shape the landscape, changing basins from depositional to erosional systems.

1.2.2 Flooding in the Tropics

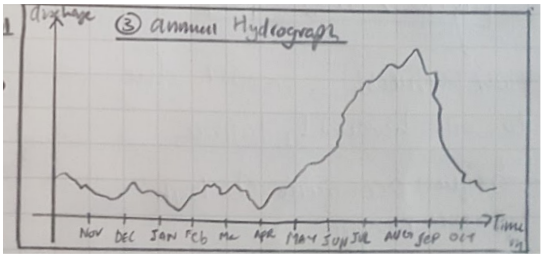
14	Hydrographs

A. Hydrographs - characteristics of flash and fluvial flood hydrographs: peak rainfall, baseflow, storm flow, peak discharge and lag time	





- A **storm hydrograph** is a graph that shows how a drainage basin responds to **one single rainfall event.**
  - ➢ Shows the short term pattern of discharge of rivers
- A **flood hydrograph** is a visual representation of the variation in the stream or river depth over time
- An **annual hydrograph** shoes the **average daily flow** of a river over the **course of 1 year**.
  - ➢ Useful in showing the variations of inputs and outputs for different seasons



The pattern of flow is known as the river regime.
Once bankfull discharge is exceeded, flooding occurs.

Characteristics of Flash and Fluvial Flood Hydrographs

We focus on the peak rainfall, baseflow, storm flow, peak discharge and lag time.

Term	Explanation
1. Peak Rainfall	The highest rainfall of the rainfall event
2. Baseflow	The part of the river flow produced by groundwater seeping into the channel bed. - Slow but continuous - More significant over a longer duration
3. Stormflow	Discharge of both surface and subsurface flows due to a **single** storm. - Overland flow + throughflow + baseflow

4. Peak Discharge	Discharge in river at its highest water level
5. Lag Time	Period between **maximum precipitation** and maximum/peak discharge. - May vary (refer to below) - Rivers with short lag time are more prone to flooding
6. Rising Limb	Refers to the rapid increase in discharge. - Due to initial overland flow, and then later on throughflow - Shape may concave upwards and reflect the infiltration capacity of watershed - Time before the steep limb shows that infiltration capacity is not reached - Steeper rising limb shows a faster response to rainfall *Steep rising limbs are termed as "flashy".*
7. Recession Limb	Outflow of basin storage after inflow/precipitation has ceased. - Determined by the nature of basin - Due to the water draining through the soil by throughflow or baseflow - Or overland flow after the storm dies. Rising limb steeper than falling limb as throughflow is slower than overland flow - Eventually the discharge will reach the same rate as baseflow.
8. Bankfull Discharge	Discharge when the rivers water level reaches the top of the channel, where any more discharge leads to flooding.

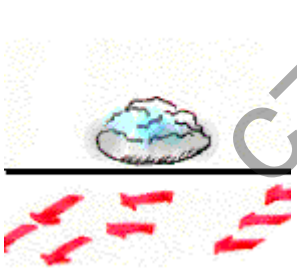
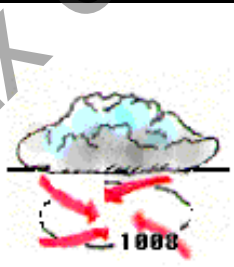
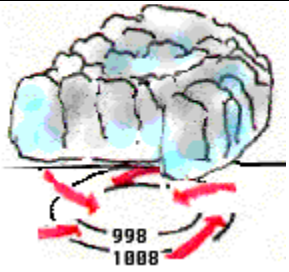
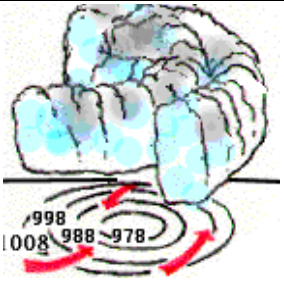
15	Tropical Cyclones

A. Flooding in the humid and arid tropics - patterns of occurrence of tropical cyclones - atmospheric and surface conditions necessary for the development of tropical cyclones	

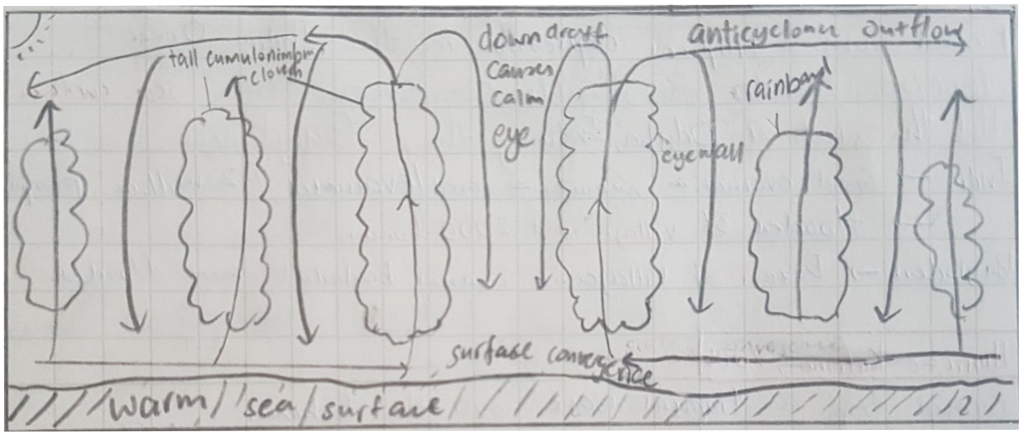
Tropical cyclones are **very large low pressure systems** that **originate over warm tropical seas**.

Conditions for Formation of Cyclones

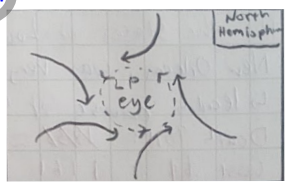
- ❑ **Sea surface temperature should be at least 26.5˚C** in the **upper 60m of the ocean**.
  - Shallow warm waters may cause cold water to be stirred up and halt the cyclone formation process
  - *Some sources say the temperature is 26˚C , some say its 27˚C , either should be fine*
- ❑ There should be enough **atmospheric instability** to produce uplift which can produce more latent heat of condensation
- ❑ **Lack of vertical wind** shear to help the formation of tall cumulonimbus clouds.
  - Weaker upper level winds help the production of anticyclonic circulation in the outflow of the rotating system.
- ❑ **Sufficient coriolis force** to spin the system
  - Therefore cyclones are not formed within 5˚ N/S of the equator

Tropical **Disturbance**	Tropical **Depression**	Tropical **Storm**	Tropical **Cyclone**
			
Clusters of thunderstorms (SST ≥ 26˚C)	Thunderstorms merge, rotating due to coriolis effect	Forms a circular shape, with the wind speeds reaching 117 km h^{-1}	Wind speeds ≥ 119 kmh^{-1} A cloud free eye forms in the middle of system

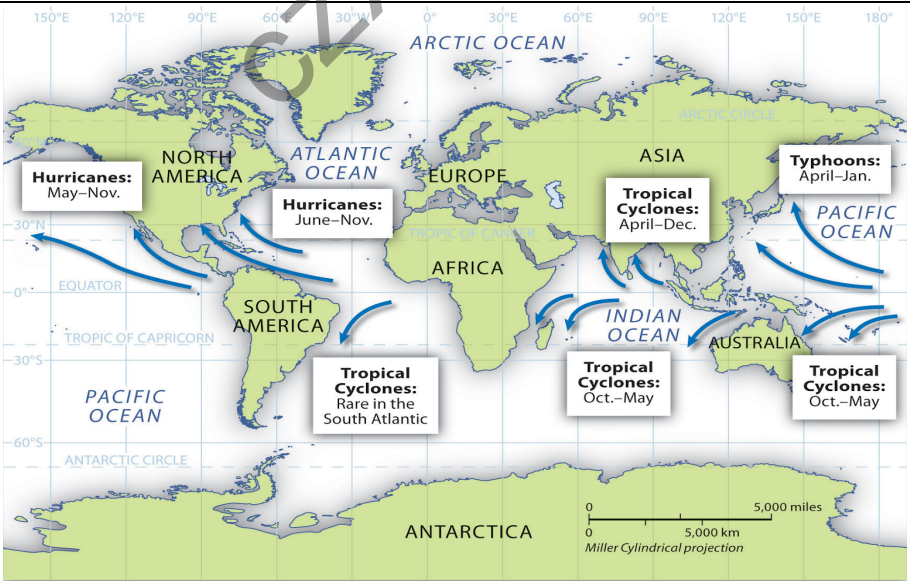
Development of Tropical Cyclones



1. **Intense heating of the ocean during hot seasons** causes **sea surface temperatures to be 26˚C or above** in the **upper 60m of the ocean.**
2. Heated waters form a low pressure cell over the ocean, resulting in **unstable air which rises**
3. Easterly winds converge towards the low pressure cells, causing the upward movement of air.
4. **Coriolis force** causes rising air to **rotate anticlockwise** in the northern hemisphere and clockwise in the southern hemisphere.
5. **Moist warm air rises**, causing **water vapour to condense** and **releases latent heat of condensation**
6. This causes the warming of surrounding air parcels which results in further lowering of pressures in the center of the cyclone,
7. Drawing more wind into the convective activity, causing the **speed of winds converging towards the core to increase**.
8. Therefore forming a **positive feedback loop**, resulting in **increasing wind speeds** and thus the low pressure system grows in strength.
9. When the **wind speeds exceed or are equal to 119 kmh^{-1}**, a cyclone forms.



Distribution of Cyclones



Spatial Distribution
• More westword • Eastern Australia *(El Niño)* • Southeast of China • Shallow seas *5-15 ˚N/S*
Temporal Distribution
• December - May (South Hemisphere) • June - October (North Hemisphere) *Summers in each hemisphere*

Examples of Cyclones

Cyclone Fani, 2019

- Formed from a tropical depression in the Indian Ocean
- Developed under favourable conditions like the sea surface temperatures up to 31˚C
- Hit the state of **Odisha, India** and then **Bangladesh**.
- Cost a total of $8.1 billion USD

India:

- Flooded 36 villages and 2000 homes
- Good evacuation measures saved and evacuated 1.2 million people

Bangladesh:

- Dozens of villages in coastal Bangladesh were flooded.

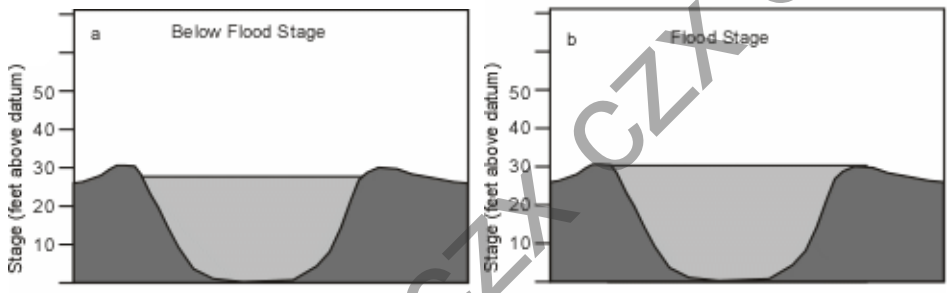
Hurricane Katrina 2005

- Formed from a tropical wave over the Bahamas
- Intensified from the warm waters of the GUlf Stream in the Gulf of Mexico
- Hit the states of Louisiana and Florida, with massive floods
- New Orleans was badly hit and the levees broke, where whole areas flooded, leading to cause of death and destruction
- Cost was $161 billion dollars.

16	River Flooding

B. Flooding in the humid and arid tropics - human and physical factors that influence the occurrence of floods including rainfall amount and intensity, land use and surface cover - socio-economic and environmental effects of floods - hard and soft-engineering strategies to manage floods	

River floods occur when there is a **flow in excess of channel capacity** as the **channel is unable to accommodate the peak discharge.**



- **Flood Stage**: Is the **fixed gauge height** which a **rise in water surface elevation is known as a flood**
- **Flood Crest**: is the highest point that a river has ever reached in a flood event
- **Flood Plain**: is the belt of low flat ground bordering the channel on one or both sides, flooded by stream waters about once a year, rich in *alluvium*.

Factors Influencing the Occurrence of Floods

1. Excessive Rainfall Amount

Unexpected excessive rainfall can be linked to atmospheric circulation processes like the:

El Niño Southern Oscillation (ENSO)

Example: **ENSO over Mississippi Basin, 1993**
- Warm phase over the lower basin of the Mississippi
- Results in high levels of level of rainfall which led to a flood that toppled levees.

Monsoonal Winds

- Monsoons can bring high rainfall during the wet season.
- Not intensive but long and a lot of rain.
- Saturates hydrological stores → causes widespread flooding due to generation of saturated overland flow
- 75% of the rainfall in Bangladesh occurs during June - September

2. Intense Rainfall

Tropical Cyclones are low pressure systems that sweep across systems and brings heavy rain to land.

Cyclone Fani in India, 2019

- Flooded 36 villages and 2000 homes

3. Land Use [Human Factor]

Changes in land use result in the changes in nature and intensity of flooding.

- Decrease vegetation cover through deforestation
  - Rainsplash + erosion by rills and gullies can increase flood risk.
- Urbanisation changes forests to cities
  - More people live in urban areas which results in vegetated surfaces to be replaced with impermeable surfaces like concrete and tarmac.
- Encroachment of embankments of rivers by roads/slums
  - Reduces the width of stream channels and the degree of storage
  - Increases the heights of floods
  - Kibera Slum in Nairobi, Kenya is very susceptible to river flooding as the slum is located next to the Ngong River. (which is very polluted)
- Changes in the microclimate
  - Urban areas are more built up, so it experiences the **urban heat island effect** which results in rural areas being 6˚C cooler than urban areas
  - Urban areas therefore have higher tendencies to have more sudden precipitation events which overwhelm man-made channels
  - Singapore has stormwater canals of up to 800m

4. Surface Cover

Soil type affects runoff rates

- Prolonged rain and permeable soil/porous sandy soil results in lesser runoff and will require the groundwater storage to be fully saturated before SOF occurs.
  - Chichester flash floods in 1994 occurred over chalk landscapes
- Non porous rock like granite or clayey soil results in low infiltration rates and therefore more IEF generated → results in flooding
- High amount of vegetation results in more interception by leaves
  - Roots bind soil together and prevent overland flow from concentrating to form rills and gullies
  - Roots bind soil together and stop loose soil from getting eroded and carried to the river channel which undergoes sedimentation and reduced the channel capacity.
  - Roots can also aid infiltration.

Effects of Floods

- Environmental -

1. **Damage to Ecosystems [Environment -** *Negative***]**

Reduces the supply of oxygen to the soil and roots, resulting in **poor soil aeration**.

- Floods can result in the death and decay of trees

2. **Impacts on Urban Areas [Environment -** *Negative***]**

Sewage floods **overwhelm the sewage system** which can cause raw sewage to spill or destruction of infrastructure which can spill dangerous material to the environment.

Hurricane Barry in Alabama, 2019

- Hurricane Barry caused 80 000 gallons of sewage overflow in Alabama in 2019

3. **Redistribution of Nutrients [Environment -** *Positive***]**

Floods **redistributes water and sediment** which replenishes valuable topsoil, recharges soil moisture and keeps the floodplain above sea level.

- Regions that experience the Am climates depends on seasonal flooding to provide for sufficient nutrients for agriculture.
- Flooding is a natural process that helps to maintain ecosystems in areas like wetlands.
- The Mississippi delta is made by rivers periodically spilling over the banks and depositing sediment.

- Social -

4. **Contamination of Drinking Water [Social -** *Negative***]**

Sewage may burst and contaminate existing water supply.

- Causes the spread of waterborne diseases like **cholera or typhoid fever**.

Hurricane Barry in Alabama, 2019

- Hurricane Barry caused 80 000 gallons of sewage overflow in Alabama in 2019

5. **Loss of Lives [Social -** *Negative***]**

People drowned or were swept away.

Hurricane Katrina, 2005

- Killed 1800

- Economic -

6. **Farmland Crop Loss [Economic -** *Negative***]**

Livestock and crops are drowned & carried away.

7. **Job Loss [Economic -** *Negative***]**

Floods can destroy industrial facilities.

8. **Infrastructure Damage [Economic -** *Negative***]**

Floods may cover urban areas with a thick layer of sediment like silt and clay which may damage power lines, roads and water pipes.

- Buildings may also be covered by the river deposit.
- Cause temporary closure of factories which can lead to the disruption of global production networks of TNCs.

Rojana Industrial Park, Thailand, 2011
- After the floods in 2011
- 8-10% of factories were predicted to close down.
- AGC Electronics (Thailand) Co. displaced 4000 workers.

9. Gain in Construction Industry [Economic - *Positive*]

Gain in new industries.
- River floods can cause an increase in the construction industry.
- Improve the agricultural yield of an area as topsoil is replenished.

Hard Engineering Measures To Manage Floods

1. Levees (artificial)

Levees are defenses that **raise the height of the river's banks, increasing the channel depth**, allowing for **more discharge to be accommodated**.
- Made out of **concrete** as it is resistant to erosion.

Mississippi Delta, 1993
- In 1993, due to heavy rain from April to July, levees collapsed and caused flooding to its adjacent flood.
- Results in damages of over $12 billion in Mississippi's River.

Levees are hard to maintain as **hydraulic action and abrasion** caused the levees to need to be replaced regularly → **expensive**.
- Downstream areas also need to have higher levees to pass floodwaters without a flooding incident.

Mississippi Delta, 1993
- Mississippi delta spends $200 million to be maintained

Levee costs in Bangladesh
- Costs for building and maintaining levees were predicted to cost up to $10 billion in total
- taking up about $500 million every year in maintenance

2. Dams

Build across channels to control flood hazards.

- Water stored in a reservoir upstream is in the dam and released in a controlled manner

Advantages	Disadvantages
- Protects catchment from flooding downstream - Also used as a generator of hydroelectric power - Three Gorges Dam in Hubei, China provides for 10% of China's electrical needs. - Protect the Jing Jiang River from flooding	However the dam may result in the displacement of people upon building and ecosystems being destroyed. - 1 300 000 people were forced to move away because of the building of the Three Gorges Dam. - The Yangtze river dolphin was driven to extinction due to the dam disrupting its natural habitat. - Revered as a symbol of peace and prosperity by locals, but now gone.

3. Dredging

Process where bedload is removed from the channel of the river.

- Through heavy industrialized pumps and diggers → dislodges sediment that encourages the natural flow of the river to transport it.
- Increases river capacity and hydraulic efficiency
- However this may prove to be bad for the ecosystem.
- In the Lower Mekong Delta, sand is dredged with little regulation, causing damage to the local fisheries and destabilising river banks.

Soft Engineering Measures To Manage Floods

1. Flood Abatement

Involves **slowing down the rate where storm water reaches the river** channel through **reforestation upstream**.

Advantages	Disadvantages
- Increases lag time, decreases soil erosion and **prolongs lifespan of hard engineering measures like dams and reservoirs**	- This requires widespread planning over the whole catchment area, causing problems across political boundaries. - They may be susceptible to geopolitical conflict.

Example: Flood Abatement in Thailand, 2011

- Thailand spent a total of ***300 billion*** **baht** on flood management plans that include reforestation, development of warning systems and more.
- A ***10 billion baht*** plan was used for **forest restoration and conservation** in the river basins which include areas which contain the main tributaries to the **Chao Phraya River.**

https://www.reuters.com/article/us-thailand-flood-fb/factbox-thailands-flood-management-plans-and-funding-idUSTRE80I0C320120119

2. Flood Hazard Mapping

Mapping of areas susceptible to floods using historical data on river stages and areas that may be flooded by hypothetical 10-year, 50-year and 100-year floods which arise due to the flood recurrence interval.

Advantages	Disadvantages
- Allows for urban planners to build specially tailored structures to mitigate floods and - plan zoning measures to make sure that costs of flooding is kept to minimum. - Bangladesh has **Flood Forecasting and Warning Systems** which covers all flood prone areas of the country and provides real time information and warning of up to 1 day early.	- The flood recurrence interval involves needing a larger sample size to be more accurate. - Need to be together with warning systems and mitigation measures as people who are affected may not know what to do during a flood. - In Bangladesh, people refuse to leave their fertile farmland during a flood despite early warnings

3. River Restoration

Variety of **ecological, spatial and physical management** in restoring the natural state of the river system to aid biodiversity to regenerate, promote more recreation while acting as a flood management measure.

Advantages	Disadvantages
- Connects streams to other floodplains or natural water storages to increase the channel storage capacity and reduce flood risk.	- Flood mapping and zoning measures are needed to prevent housing damage as floods still can occur.
Kallang River in Bishan-Ang Mo Kio Park, Singapore - Singapore, Bishan-Ang Mo Kio park had its Kallang River turned from a concrete canal to a natural waterway - More natural, prevents soil erosion and connected to drains in the city. - The adjacent park doubles as a convergence channel in the event of rain - Reduces rain torrents speeds by half.	

1.2.3 Tropical Deforestation

17	Causes, Effects and Mitigation Strategies for Deforestation

A. Causes, effects and mitigation strategies for deforestation Causes of tropical deforestation - logging - ranching - agriculture - firewood collection Effects of tropical deforestation - landslides - soil erosion and sedimentation - disruption of ecosystems and loss of biodiversity - disruption of biogeochemical cycles - release of stored carbon Strategies to manage tropical deforestation	

Deforestation is the **clearance of a forest or a strand of trees** from land which is usually to be **converted into non-forest uses like farms, ranches or urban use**.

- (tropical) Rainforests are found in areas that are warm and wet.

Causes of Tropical Deforestation

1. **Logging** (large scale)

Logging refers to the process of cutting and processing trees to produce timber and pulp.

- Aimed to **supply the world's markets** for furniture, construction wood, paper and other products.
- Logging can be **commercial** in nature or done by **individuals** to harvest fuelwood.
    - Important for regional or rural communities

Commercial logging refers to **timber harvested from forests** with the **intention to sell**.

- Much of the world's demand for timber/timber based products comes from industrial logging.
- **Requires logging concessions** which are arrangements with governments or the state's forest department to **grant rights to harvesting/management of a forest for a period of time**.
    - Harvesting of illegal wood is a violation of national regulations
    - Perceived unsustainable as high value timber species are slow growing and occur as low densities.

Example: in 2014, global production of industrial roundwood totalled to 1800 million meters^3, majority of it from Europe, North America and Asia. (Asia - 28%, Pacific - 24%)

2. Ranching

Cattle ranching is the rearing of cattle with large farms, where **large areas of land is needed for cattle to graze on.**

- **Low input cost** + **cheap land** + **ease of transport**(roads built previously) in rural areas make this activity very lucrative.
- Once farmers are done with cattle ranching in an area, the land is then converted to be used for soy production for oil production.

Example: **Deforestation in the Amazon, Brazil**
- In the Amazon Rainforest, more than 450 000km^2 of land is now converted to cattle pasture
- The Amazon is home to 200 million cattle and cattle ranching which supports up to **25% of the global market.**

3. Agriculture

Split into commercial and sustenance agriculture/farming.

Commercial agriculture includes the large scale farming of palm or soy for oil.

- Economically lucrative as palm oil is in high demand → slash and burn techniques are employed for large scale land clearing.
    - Palm oil is used in processed food, cosmetics and biofuels.
    - For palm oil, the tree can produce fruit for more than 30 years.
- Commercial farming also provides employment for rural communities
- Plant yields more oil per hectare than any major oilseed crop.
- Expansion of oil palm plantations can lead to more transportation infrastructure to be built like roads → makes inner forests even more accessible by loggers.

Example: **Deforestation in Malaysia and Indonesia**
- Malaysia and Indonesia account for about 90% of global palm oil production and exports
- Palm oil plantations result in large scale deforestation

Subsistence agriculture refers to farmers growing food crops to feed themselves and their families.

- This relies on **shifting cultivation** which **requires the farmland to fallow** after every round of collection
- **Growing population numbers** and a lack of alternative ways to obtain food result in higher rates of forest clearing for subsistence agriculture.

Example: **Deforestation in the Congo Basin, African Continent**
- Biggest driver of deforestation is subsistence agriculture at 84%

4. Firewood Collection

As compared to large scale logging, this is the **selective removal of trees** to use as **fuel for the locals to cook, heat their homes and income**.

- Especially for rural areas in LDCs

Example: **Cameroon and Ghana**
- Small scale logging is a significant source of income for forest community in Cameroon and Ghana.
- Although illegal, but this is still very extensively done as there is weak enforcement by incompetent/corrupt government.

Effects of Tropical Deforestation

1. Landslides

Mass movements are a downhill movement of regolith or material due to gravity

- Deforestation can remove the trees which bind soil together, decreasing cohesion and thus shear strength of the earth material
- Building of buildings like houses on top of these slopes may increase the weight above the land, increasing shear stress and thus causing mass movements to take place.

Example: **Mocoa, Columbia - 2017**
- Heavy rain + deforestation caused a landslide which killed 260 people.

2. Soil Erosion and Sedimentation

- Deforestation leads to a decrease in vegetation cover, resulting in lesser cushioning of the impact of falling rain
    - Deforestation leads to more splash erosion and less infiltration, which can lead to rainwash and rillwash on bare slopes that have limited vegetation.
- Topsoil rich in nutrients are washed off, so farmers need to user fertilisers and pesticides which can cause pollution to water and land (link to water pollution and scarcity, refer to example about China's nitrogen pollution)
- Increased sediment loading in rivers and streams can cause hydroelectric and irrigation infrastructure to lose productivity as it is affected by siltation.
- Sedimentation can decrease channel capacity and cause the severity of floods to increase.
    - Discharge may also increased due to more load from the sediment

3. Disruption to Ecosystems and Loss of Biodiversity

Tropical rainforests are home to 50% of the world's wildlife species

Deforestation destroys the habitats of the animals and plants

- When forested areas are divided, the reproduction of animals and plants are interfered with.
- Plants in cut-off places cannot be pollinated as seeds may land on unsuitable aries that would lead to no survival of the species.
- Rainforest species are restricted to relatively small areas found nowhere else
- Species are interdependent on one another, especially keystone species which play a large role in the ecosystems

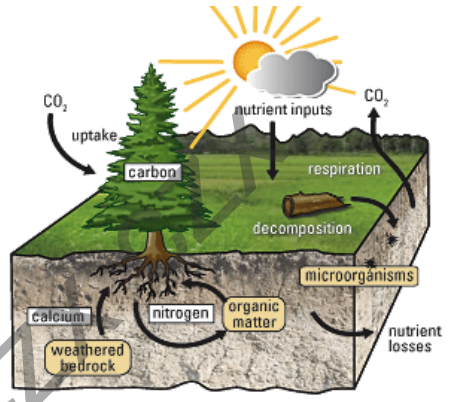
This can lead to the extinction of species of animals and plants which can be potential resources.

- Rainforests contain potential resources like pharmaceuticals and food crops which are threat of becoming extinct even before we discover them
- Extinction is irreversible

Example: **Quinine, Medicine Derived from Rainforests**
- Quinine, a compound used to **treat malaria** is sourced from the **Cinchona Tree in South America.**

4. Disruption of Biogeochemical Cycles

Biogeochemical cycles refer to the natural pathways where essential elements of living matter are circulated in closed systems.



- Nutrient cycles may circulate phosphorus, oxygen, nitrogen, carbon and water (PONC H_2O) through the natural systems.
- Humans have caused significant changes to the cycles by making the cycles very imbalanced.

❖ Dung from the animals restore nutrients into the soil at the same rate as they are withdrawn, allowing for nutrient recycling.
❖ When more crop are harvested, there is less nutrients in the ground and as such the soil is degraded
❖ More fertilisers used to increase the productivity of the land can become runoff which flow to rivers and can lead to eutrophication

There is also a disruption to the **hydrological cycle** as there is lesser **water recycling**.

- Lesser trees result in lesser water that is re-evaporated from vegetation.
  - Causes water recycling to diminish → decreasing the mean annual rainfall on the local scale
  - Rainfall seasonality also increases and becomes more variable.
- Lesser trees also result in more runoff and lesser groundwater recharge.

Example: **Desertification of Central America**
- In 2006, areas that were deforested resulted in drier local climatic conditions

5. Release of Stored Carbon

Forests are a carbon sink by **absorbing more carbon than it releases**.

- Forests remove carbon dioxide out of the atmosphere in large amounts through photosynthesis and locks it in its trunks and branches
- When slash-and burn techniques are used, more carbon is released into the atmosphere by burning
- This disrupts the **carbon cycle** which leads to anthropogenic climate change or global warming (link to carbon cycle chapter)

- The atmosphere is not isolated to one single country, so negative impacts are cumulative on a global scale.

Example: **Data on Carbon Emissions**
- In Amazon, 14-40 kg of carbon is stored per meter^2 of forest.
- According to the Intergovernmental Panel on Climate Change, 25% of greenhouse gas emissions come from deforestation, agriculture and livestock rearing.
- If current rates continue, 169 billion tonnes of CO_2 will be released into the atmosphere by 2050.

Strategies to Manage Tropical Deforestation

1. Reforestation

Forest cover is recovered by encouraging native forest growth or planting new trees.
- This is a very direct solution to deforestation but it has flaws.

Advantages	Disadvantages
- It can be possible to restore biodiversity - Can also be used for flood abatement as well. **Congo Rainforest in Democratic Republic of Congo** - The forest ministry had a $2.5 billion dollar plan to plant 1 million hectares of trees in 10 years.	- Species of trees planted may not native to the region, so the biodiversity would avoid the area. - Defeats the purpose in restoring biodiversity - Expensive and lengthy **Bilar Man-Made Forest. Bohol, Philippines** - Thousands of mahogany trees planted in the 1960-1970s were not native and resulted in the area being biologically dead.

2. Protected Areas

PAs are geographical spaces that are recognised, dedicated for management through legal or other effective means to achieve the conservation of nature with its associated ecosystem services ans cultural values.
- Can be used as a short term measure.
- Very common

Advantages	Disadvantages
- Governments can use it as a way to temporarily stop deforestation to form longer term measures. **Kalimantan, Indonesia** - Kalimantan's third 5-year plan had a goal to protect 10% of its forests as PAs.	- Does not address the root cause of deforestation - PAs remove the resources from locals to have their own activities, leaving locals with no economic alternative - Depends on competence of governments. **Kalimantan, Indonesia** - It was found in 2014, 17% of the forest within the parks were still illegally logged - The PAs of kalimantan had its management committees decentralised from the local

	government, so it was more susceptible to corruption.

3. Reducing Emissions from Deforestation and Forest Degradation(REDD+)

Initiative to reward good forest management practices in Less Developed Countries by DCs by transferring funds to offset emissions in the form of carbon credits to LDCs.

- Encourage investments in low carbon paths to sustainable development

Advantages	Disadvantages
- Makes unregulated logging practices less economically attractive. - Global initiative - allows for a balance between economic and environmental sustainability - May include payment for ecosystem services and protecting of rights of indigenous populations - In 2016, 44 countries all over the world have developed their REDD+ strategy, some have even started their pilot projects. - Brazil has committed to restoring 12 million hectares of forest by 2030 under REDD+	- Monetisation of land would lead to a justification for growing palm oil and deforestation if revenue earned is more than monetary value. - Questions about monitoring and reporting - In Surui, Brazil REDD+ payments average $15 dollars but payment may be used for admin and monitoring costs, so profit is still low. - In the Amazon basin, road access and revenue from crop like soy and palm still have higher potential revenue than these payouts.

4. Certification Schemes

NGOs can help to certify forest products that .

Advantages	Disadvantages
- Pressures TNCs to switch to sustainable methods in their operations	- Certification takes a long time and sources of sustainable products are more expensive. - Consumers may not be willing to pay, TNCs may incur lower profit.
IKEA and Forest Stewardship Council - Furniture company IKEA has pledged to source all its raw material from FSC certified sources by 2020 - LInked to the GPN	

2.1.1 Understanding Development

18 Different Ways of Thinking About Development

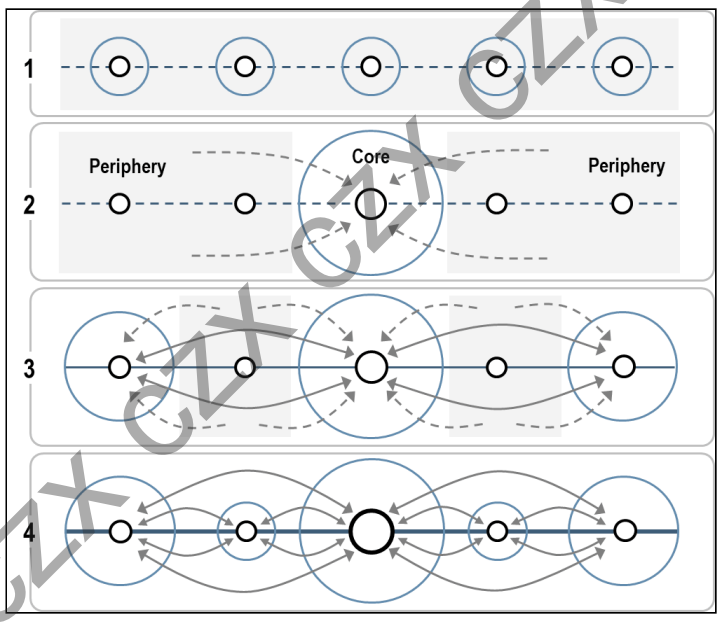
A. Different ways of thinking about development - core-periphery model and dependency theory - bottom-up development	

We will focus on 3 different theories of development.

Core Periphery Model

The core periphery model by John Friedmann theorises that **economic progress is sustained over long periods of time and occurs in 4 stages**.

- Rooted in the belief that unequal and uneven growth is part of development



The stages are as follows:

1. **Stable patterns of settlement and socioeconomic development** with **no surplus production**.
2. There is the **establishment of strong industrial nodes, known as cores,** that become the cornerstone of growth.
    a. Due to strategic advantages in the region like access to trade routes, abundant natural resources or due to exogenic forces like colonialism.
    b. This core then **drains the surrounding periphery by attracting people and flows of wealth.**
3. **Through state/external intervention**, the **flows of wealth and people begin to increase between the core and periphery, known as polarisation reversal.**
    a. This forms a **single national center with strong peripheral subcentres**.

4. The last stage involves the **formation of a functionally interdependent system of cities which allow capital and people to flow between them with organised complexity**.

Pearl River Delta, China [LDC]
- There is a core due to its good locations around financial hubs where 90% of China's trade passes through
- 6 Special Economic Zones
- 14 Open cities
- Provides for 7% of China's GDP

Dependency Theory

This theory developed by Andre Gunder Frank focuses on the notion that underdevelopment is due to the exploitation of satellites(poorer regions) by the metropoles(developed regions).

- Western nations have deliberately under-developed them
- LDC situations are not due to chance but due to the way they are incorporated into the global capitalist system.
    - Development and underdevelopment must occur together for the success of the capitalist system of development

Linked to extractive industries and current day economics

Economic exploitation via the NIDL causes the LDCs to have their resources drained previously for the economic progress of DCs.

- Satellites provide cheap raw materials and labour to boost metropoles economy
- LDCs become the focus of industrial activity due to the lower cost of labour and availability of raw materials with little development of knowledge, skills and technology
- Currently, there is still the dominance of western nations in the International trading system (link to WTO in chapter 25).

LDCs also rely on Western aid (link to World Bank/IMF in chapter 25).

- LDCs are so indebted to the developed nations that they had no chance of escaping that debt and moving forward.
    - These debt have interest in the form of money or resources
- Economies grow too slowly and LT developmental projects can take a long time to generate profit
- Interests can build up and result in the outstripping of the initial loan.
    - Debt redirects funds away from important sectors like healthcare and education.
    - Can also be linked to Neo-Colonialism. (link to TNC/NIDL Chapter 23/22/21)

China-African Ties
- Recently, african countries have rapidly increased their borrowing from China
- African countries owed US $10 billion in 2010 increasing to over $30 billion in 2016.
- China's lending to African countries is part of a large scale overseas investment boom forming its quest to secure access to raw material in its attempt to become an economic superpower.

Bottom-Up Development

Involves the small scale development where the third world countries should increase self-sufficiency and self reliance to reduce their involvement in processes of unequal exchange and to seek solutions themselves.

- first initiated in the 1960s after criticisms of top-down development that did not result in effective change on a local level arose
- Locals plan and control projects that help their local periphery area
- Can consist of varied approaches which may be funded by Non Governmental Organisations
- Immediate and tangible benefiits locals at the local level and is more directly targeted to the needs of the people.
    - This may be through mobilizing the internal natural and human resources to plan for and solve problems in a contextualized basis
    - Uses appropriate technologies and giving priority to basic needs
- Very useful for LDCs as the lack of good governance and financial ability often call for some ingenuity in developing solutions that are effective and sustainable

MicroHydro Scheme, Peru

- Bottom up development scheme
- NGO Practical Action installed 30 miniature hydroelectric dams to mountainous villages of Peru
- Delivered power to 30000 villagers
- Providing for more accessible energy for the poor

Orangi Pilot Project in Orangi Town, Karachi, Pakistan [From Chapter 47 Slums]

- NGO is *Orangi Pilot Project-Research and Training Institute (OPP-RTI)*
- Helped residents to construct sewers to 72000 dwellings
- Intervention is developed through research into household resources and aspirations in Orangi
- Funds in the project is contributed by the households, where residents do not just pay for the pipes installed, but they also maintain it
- Now has better housing, sanitation, health and education
- Current new projects are put in place in other parts of pakistan

19 Measuring Development

A. Measuring development - measuring development using the Human Development Index (HDI) and Multidimensional Poverty Index (MPI) - variations in the levels of development - Millennium Development Goals (MDGs) and post-2015 Development Agenda	

Introduction

There are many ways to measure development. As the notion of development and what it means to people vary over space and time, there can never be one best index to measure it.

Gross National Income (GNI)

Measures development in only the economic domain. GNI is the total income earned by a nation's people and businesses, encompassing income earned by foreigners and residents businesses.

- Measures per capita by the world bank
- Used more in the past where development was considered more economically.

Advantages	Disadvantages
- Easy to measure - Easy to compare across countries.	No indication on distribution of wealth in the country → conceals widespread inequality

- High income countries have more than $9361
- Middle income countries have between $761 and $9360
- Low income countries have $760 or less

Human Development Index (HDI)

- Works as a composite measure of **health, education and standard of living**
- Expressed as a value between 0-1
- Bigger number → good
- **Health**
  - **measured by life expectancy**
- **Education**
  - **measured by mean years of schooling for adults aged 25 years and more**
  - **Expected years of schooling for children of school-entering age**
- **Standard of living**
  - **measured by GNI per capita (measured by purchasing power parity)**
- The scores for the three HDI dimension indices are then aggregated into a composite index using geometric mean.

- created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone

Advantages	Disadvantages

- Recognises that development has more dimensions than purely just economic
- Redirects focus to human-centred development
- Can highlight successes of some countries as comparisons can be made between countries over time
- Data can be collected relatively easily.
	- 3 dimensions are good but not ideal
	  - 5 year old child nutrition would also be better indicator
	- conceals widespread inequality
	  - They pay be between rural/urban areas or between ethnicities
	- HDI is relative, not absolute, so poor countries may not be able to mark progress/get credit for developing more.
	- Leaves out aspects of environmental sustainability, inequalities and empowerment

In 2019, the United Arab Emirates had a GNI of 66,912 PPP$ but had a lower HDI compared to Australia at 44,097 PPP$. UAE was ranked 35th while Australia ranked 6th in the world for the HDI.

- Australia is deemed as a DC with a HDI score of 0.938
- Nigeria is deemed as an LDC with a HDI score of 0.534

Multidimensional Poverty Index (MPI)

The MPI **measures deprivations** in non-monetary factors that contribute to wellbeing.

- Measures progress against SDG 1 which aims to end poverty in all its forms and dimensions.
- Health → measured by **Child Mortality** & **Nutrition**
- Education → measured by **Years of Schooling** & **School Attendance**
- Standards of Living → measured by **Cooking Fuel**, **Sanitation**, **Drinking Water**, **Electricity**, **Housing** and **Assets.**

MPI = incidence of poverty * intensity of poverty

Incidence: the proportion of people who are poor, example 4 out of 10.
- Poor refers to those who are deprived in at least 33.3% of the weighted indicators

Intensity: average number of deprivations people experience at the same time

Advantages	Disadvantages
- Reflects the prevalence/incidence of multidimensional deprivation and its intensity - Individual measures can be unpacked which allows for comparison between countries and within countries by	- Data constraints due to missing dat - The health data are relatively weak and overlook some groups' deprivations - especially for nutritiona - Does not reflect intra household

ethnic groups or urban/rural areas - Allows for policy makers to target resources and design better policy - used as an analytical tool to identify the most prevailing deprivations, and the most vulnerable people.	inequality like between males and females. - estimates presented are based on publicly available data and cover various years between 2000 - 2010, which limits direct cross-country comparability

Millenium Development Goals (MDGs)

There were 8 developmental goals, 18 targets and 48 indicators in the MDGs.

- With the increasing inequality around the world, the United Nations general assembly agreed to the terms of an international set of developmental targets in 2000
- Aims to make globalisation a positive driving force.
- Prime points of reference in the UN and others when talking about the progress of development
- Capture several dimensions of progress separately. Displays the information without any weighting between the parameters

MDGs use indicators to measure and incentivise progress

- Targets typically set desired achievements against such indicators to be met by some date, thus giving them an explicit incentivizing purpose
    - specific deadlines in which certain action must be taken by 2010 or 2015.
- Uses league tables to see countries' standing against other countries.
- The UN has also made specific routes to address issues with it scheme of targets and indicators to recognise development
    - Motivates the countries to act fast

MDGs use developmental indicators as points of reference as the targets are clear and absolute.

- This makes the MDGs easier to follow and incentivise progress

MDG 1: Aims to halve the population of people whose income is less than $1 a day (PPP)
- Proportion of population below $1 a day
- Poverty gap ratio
- Share of poorest quintile(lowest 20%) in national consumption
- Focus on the reduction of poverty, applying not simply an income approach, but one that recognizes some of the other multiple dimensions of poverty

China was the first developing country to realise the UN's MDG to reduce their rates of their poor by 50%.
- They decreased from 94 million in 2000 → 27 million in 2010.

Limitations of MDGs

- Targets give incentives to hit but not to surpass the level indicated.
- Issues about the availability of data
- MDG problems are generalized and not targeted for individual countries
- Unevenness of MDGs as they are more difficult for LDCs to attain as compared to for DCs.
    - Halving poverty rates from 10% to 5% in Latin America is regarded as more progress than cutting poverty from 50% to 35% in the African Continent.
    - More than 75% of people in Madagascar and DR Congo live on less than $1.9 a day

Post-2015 Agenda (Sustainable Development Goals)

They retained the strengths of the MDGs, like the format of goals, targets and indicators as they are a clear and easy way to communicate goals and progress.

- SDGs had more challenges to address that were not previously present like Trafficking and torture of children.
- SDGs involve 17 goals, 169 targets and 244 indicators.
- SDGs were also more specific:

MDG 1.1: Eradicate extreme poverty for all people everywhere, measured by people living on less than $1.25 a day

- 1.1.1 is stated as "Proportion of population below the international poverty line, by sex, by age, emploument status and geographical location (urban/rural)"

2.1.2 Geography of the Global Economy

20	Structure of the Economy

A. Structure of the economy - sectors of the economy: primary, secondary, tertiary and quaternary - economic growth and changes in the structure of the economy as development occurs	

Development refers to the process of change that affects standard of living and usually involves an improvement in the quality of life of people.

The economy is a set of human activities and institutions linked together in the production, distribution, exchange and consumption of goods and services.

- Leads to an uneven distribution of economic activities due to different factors.
- The space economy is affected by the behavior, values and actions of the different actors that govern it(individuals, firms, institutions).
- The structure of the economy refers to the **changing balance of output, trade, incomes and employment** drawn from different economic sectors.
- Within capitalist economies, most of the resources and production are controlled by a small proportion of individuals and firms which seek to improve their economic well-being through competition. (link to harvey chapter 29)
- Market economies also incorporate regulation by national governments and international institutions(WTO)

The relationship between development and the structure of the economy is **reciprocal**.

- Human and economic development can lead to a change in the nature of investments and economic activity.
- Wealth earned can cause standard of living to improve.

Sectors of the Economy

To interpret and measure the processes and interaction that help shape spatial patterns of economic activity, we generalise the structure of economies into 4 economic sectors.

1. **Primary Sector**

Involves the exploitation of natural resources as there is an extraction or harvesting of products from the Earth.

- Agriculture, fishing, mining and oil extraction
- More relevant in LDCs
    - Declining overall globally
    - As an economy develops → increased labour productivity → enable workers to leave the agricultural sector → **move to other sectors** like manufacturing and service sector.

Example: Now, US has 3% of its labour force in primary activity, but in mid 1800s, the primary sector took up ⅔ of the whole labour force.

2. Secondary Sector

Generally involves taking raw material and converting them to finished products (manufacturing, processing, construction).

- Activities include: metal smelting production, chemical and engineering industries.
- Development of **improved technology** enabled growth of larger factories, firms can **reduce cost of production** and **increase labour productivity** due to **economies of scale**.
- This sector **adds value to the raw material** by producing refined goods/services.
    - **Increasing in LDCs.**
    - Decreasing in most DCs.
    - Requires more human capital and better technology for processing.
- Some LDCs move from primary to secondary sectors to boost economic growth
    - Some adopt import-substitution industrialisation and export-oriented industrialisation policies to strengthen their industrial base
        - Example: Asian Tigers In 1960s/1070s [South Korea, Taiwan, Singapore and Hong Kong]
    - LDC suppliers initially provide to bigger firms as OEMs (interfirm relationships chapter 21) → then they start to engage in manufacturing entire products as ODMs
- Successfully **moving up the value chain** requires skills and capabilities which can be **developed through human resource development**(education and training).

3. Tertiary Sector

Generally involves services provided to people/consumer services.

- Wholesale, Retail Trade, Transportation, Entertainment and Personal Services like pest control.
- Focused on people interacting with people
- Biggest component of developed economies
    - Biggest component of developed economies
    - Caused by improvements in transport and telecommunications which transformed the reach of firms and their operations (link to NIDL and GPN).

Example: UK has 80% of its GDP from the service sector, 70% of US's workforce is from the service sector.

- DCs have seen a transition from a manufacturing-based economy to a services based economy, known as tertiarisation.
    - As an economy develops → labour productivity is improved due to better technology → there is a higher output of goods and services with less labour → cause workers to leave the agricultural sector → spare work to **move to other sectors** like manufacturing and service sector which is **more labour intensive.**
    - Worker income increased, so there is more money to spend on services as consumers get to enjoy more leisure based activities.
    - Growing tertiary sector signals increasing SOL.
- Firms in LDCs may move away from being low-cost suppliers or subcontractors to TNCs (refer to chapter 21)

- They can move up the value chain and develop new products/services with their own brands or new market positioning
- Human resources and infrastructure needs to be developed to plug into the service sector.

4. Quaternary Sector

Separate grouping of intellectual services that assemble, transmit and process information, knowledge and expertise.

- Advertising, banking, computing, education, research and development

Focused on the production of **information**.

- Expanding in DCs

Example: Quaternary/Tertiary sector has expanded to become ⅘ of the total jobs in countries in USA, Canada, Britain or Australia.

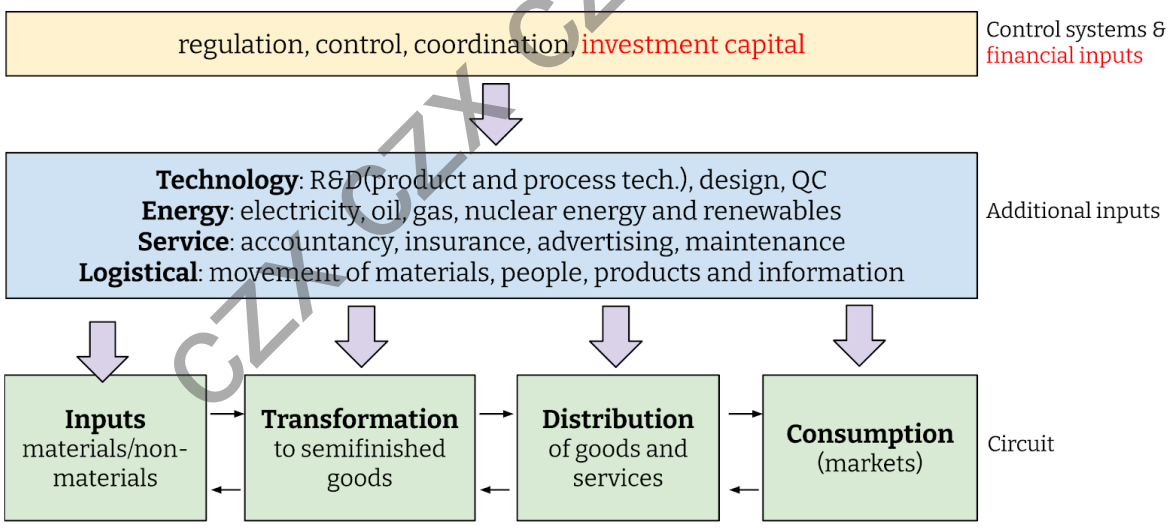
21 Global Production Networks

A. Global production networks (GPNs) - production circuit: inputs, transformation, distribution, consumption, additional inputs, control systems - intra-firm networks: control and coordination of different business functions - inter-firm networks: relationship with suppliers, sub-contractors and strategic partners	

A **global production network** is an **organisational arrangement of interconnected economic and non-economic actors** coordinated by a **global lead firm**, producing **goods and services across multiple geographical locations** for **worldwide markets**.

Production Circuits

The major elements of a GPN include its 4 major operations: inputs, transformation, distribution and consumption. This forms a **circuit of interconnected functions which forms the core of a GPN**.



This causes flows in two ways/directions:

- Flows of materials, semi finished goods and final products in one direction
- Flows of information(demands and feedback of consumers) and money in the other direction.

This forms a circuit/loop but additional inputs (technology, energy, service & logistics) and control systems are added.

Intra-Firm Networks

TNCs can organise their economic functions and divisions of labour internally to control and coordinate different business functions.

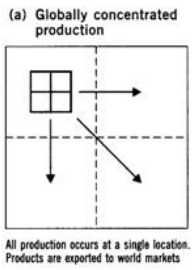
- TNCs are the lead firms that organise these economic/non economic actors based on different corporate strategies.

A TNC consists of:

- **Corporate/regional headquarters** that make decisions like finance/investment decisions/market research/etc.
    - Located in major cities with access to high-quantity external services and skilled labour with good infrastructure.
- **Research and development** that develops products/new processing technology
    - Keeps TNCs competitive in the global market
- **Transnational operating units** that cover manufacturing plants/sales/marketing offices/service centers.

Production units can be arranged as follows:

A. Globally Concentrated Production



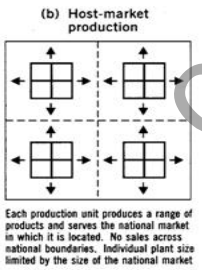
All production occurs at a single location, then **exported**.

- Mainly used by extractive industries as they are location specific in nature (link to EIs)
    - NOT used by the service sectors.
- TNCs can exercise **tight control** over subsidiaries

Most TNCs start with this strategy in the early years before expanding overseas.

Example: Toyota's Lexus series is still entirely manufactured in Japan and then exported.

B. Host-Market Production

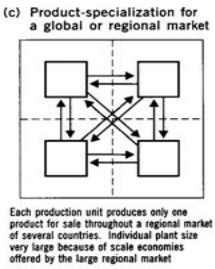


Each production unit produces a range of products and services.

- Serves its host market with no sales across national boundaries.
- Commonly used in service industries **due to demand for local presence**.
- Control is harder over subsidiaries and is very **sensitive to local demand**.
- Preferred when there is barriers on trade exports.

Example: Ben and Jerry's has a factory in Israel to cater to local needs as the ice cream that is manufactured in the United States do not have a sufficiently high enough kosher certification which is needed for the local market. Some flavors are special only to Israel, like Dulce de Leche, while others don't do as well as popular flavors in the States, like the infamous classic, Cherry Garcia. Avi Zinger got the licence to set up the factory in Israel.

C. Product Specialisation for Global/Regional Markets

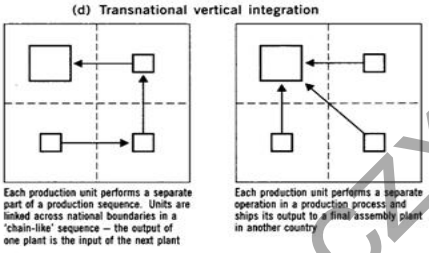


Each production unit produces one product for salt throughout a regional market.

- Commonly used by manufacturing firms.
    - Like Electronics/Petrochemical/Automobile
- Regional production units have more autonomy and can participate in product development.

Example: Hewlett Packard's regional HQ in Singapore opened its first global design center for HP's Imaging and Printing group. However, its high end computer servers are still coordinated by its global HQ in California.

D. Transnational Vertical Integration



Each production unit performs a separate part of the production sequence.
It can then either shop it across national boundaries in a chain OR ship it to a final assembly point in another country.

- Most developed organisational structure.
- Very demanding organisation and coordination of production.
- Exploits spatial variation in production costs.

Zara, a clothing company:

- Cotton grown and fabric spun in India → Dyed in Bangladesh → Sewn into garments in Spain/Portugal

Inter-Firm Networks

Few TNCs can produce everything themselves, they need to also engage in inter-firm networks like subcontracting, strategic alliances and cooperative agreements.

Original Equipment Manufacturers(OEMs) are firms which produce products under a brand that sends the **exact specifications** for parts to manufacturers, making sure that it is as if the buyer had produced them.

Original Design Manufacturers(ODMs) are firms that produce products under a brand, informing other ODMs what parts they are looking out for.

- Buying whichever part suits their needs best without any exact specification.
- The supplier designs and manufactures themselves.

The points labeled by the "star" icon refer to the geographical implications of such relationships.

1. Outsourcing

Contracting an outside provider processes that **could be performed by a company's internal staff**.

- So the company can reserve resources for other tasks, increasing cost effectiveness.
- A company can contract an independent third party to manage its technological needs so staff can focus on sales.

★ May lead to development of highly localised manufacturing clusters.

- International outsourcing/subcontracting forms enclaves of export oriented production in LDCs.
- Extensive outsourcing has led to the rise of Bangalore, India as centers of software production and data processing.

2. Subcontracting

Hiring of an outside provider to perform specific parts of a business contract that **cannot be handled internally**.

- Commercial subcontracting occurs when the principal firm subcontracts production to another firm in another country.
  - Buyer supplies OEM so products are produced as buyers want it, then the suppliers learn and can engage in ODM.
- Industrial subcontracting can involve subcontracting their production and **focusing on just marketing or branding**
  - Used by electronics sectors by engaging **Electronic Manufacturing Services(EMS)**.

★ Forms export enclaves that hosting export driven production in LDCs as the NIDL.

- Results in the development of places like Penang, Malaysia that specializes in manufacturing electronics.
- Rayong, Thailand also specialises in manufacturing electronics and automobiles.

★ This can cause there to be a macro-regional integration of economic processes to occur.

- TNCs organise their interfirm relationships to stitch together different places in a region.
- TNCs like Samsung in southeast asia help to integrate the economies in southeast asia through TNC production networks.

3. Strategic Alliances

Two or more companies **work together to achieve objectives that are mutually beneficial**.

- Companies share risk, resources and capabilities.
- **Common in semiconductor, pharmaceutical industries due to high cost of R&D, intense competition and rapid changes in technology.**

★ Interactions of decision makers occur in cities and science hubs in different countries.

- Therefore some places become more interconnected inthe global economy, becoming more exclusive.
- Silicon Valley in California is such a place
- Star Alliance involves 27 airlines and involves the sharing of codes and customer loads to help the airlines involved to work better.

SEMATECH, United States (1990s)

- 14 leading US semiconductor manufacturers took part in a partnership to share risk with this → with sematech as a Standards Organisation
- Aimed to solve common manufacturing problems and regain competitiveness for the U.S. semiconductor industry.
- This accelerated technological innovation and commercialisation of new material and designs like integrated circuits and computerships.

4. Joint Ventures

2 or more firms decide to **establish a separate corporate entity**.

★ These alliances often have high value added activity

- Making places that host these activity more prosperous, leading to uneven development.
- R&D clusters form in Europe and North America

5. Cooperative Agreement

Encompasses a wide range of inter-firm relationships that range from **licensing agreements to non-equity forms of cooperation**.

- Can be found in manufacturing and service sectors.
  - In Manufacturing, TNCs can issue patents in return for royalties
  - Philips, Sony, LG and Pioneer all own DVD format patents so they get royalties for every DVD player manufactured by their licenses.

22 New International Division of Labour (NIDL)

A. Global production networks (GPNs) - factors that led to the emergence of a new international division of labour (NIDL)	

The New International Division of Labour is a **spatial separation of tasks which was previously done on the same site/country**.

- It involves the relocation of economic activity **from labour scarce** to **labour abundant** countries.

The NIDL is linked to GPNs as the divisions in labour form due to a combination of intra- and inter-firm networks, as **lead firms want to earn more profit** by outsourcing or taking part in joint ventures, crossing national boundaries.

- GPNs require spatial division of labour → certain elements of production are concentrated in particular places through the intra and inter firm networks.

How the Global Division of Labour Changed over Time

Before the current international division of labour, wealthy North countries manufacture and provide services among themselves.

- Involved importing and exporting resources from the less developed south (link to dependency theory)
- Trade relationships tend to be the strongest when they are of close geographical, cultural or political proximity.

Improvements in information communication technology and transport can allow for production to be broken up so they can be carried out in different locations.

- Economic activities have evolved to a more global or regional scale
- Per capita income in LDCs grew 3x as fast as DCs during the age of convergence in the 1990s.
    - May be attributed due to globalisation strengthening trade links and increasing the amount of FDI which can allow for LDC countries to catch up by using modern technology with the help of technology transfer by the TNCs.
    - Demographic transitions in the LDCs enjoyed the golden age ratio of it's population demographic to allow for high efficiency while DCs has an increasingly aging workforce.
    - More investment into the capital and labour in DCs increase the productivity of the economic activity → facilitates the transition from low productivity sectors such as agriculture to high productivity sectors like manufacturing.

Pull Factors Leading to the Emergence of a New International Division of Labour

The underlying reason is the desire for firms to maximize profits by lowering costs or increasing profits.

1. Search for Cheap and Efficient Labour

Some firms have a **comparative advantage** as they can **produce goods/services at a lower opportunity cost than others**.

- Companies can have higher profit margins
- TNCs relocate activity to take advantage of this

Vietnam's Factory Wages

- Vietnam's factory wages are around $50-60 per month, about half of China's worker wages.

2. Search for New Markets

New markets have potential demand, especially in regions that have big population numbers and have growing purchasing power.

- More likely to increase the demand for labour intensive manufactured goods.

China

- Between 2002-2017 the chinese car market grew by 27% on average
- Expected to increase 10 times by 2030

3. Economies of Scale

As volume of output increases, the average cost of production decreases.

4. Fewer Legal and Environmental Concerns

Hazardous industries like textile, petrochemical and chemical production/electronics have migrated to Latin america/Africa/Asia where the laws and policies are less stringent.

Buriganga River in Dhaka, Bangladesh

- Rampant dumping of waste by factories and human waste has cause the waterways near the river to be very polluted and hazardous for human consumption.

5. Little to No Labour Union

When countries have weak labour unions, TNCs can exploit labour with little repercussions.

- This may be through not compensating workers, making them work long hours
- Or having poor working conditions

H&M and GAP in India

- Clothing companies have been found to have factories where violence against workers is common to make them work harder.
- Underpaid so much that workers are unable to afford one piece of clothing they produce :(

6. Role of State *(link to ROS Chapter)*

States may develop national policies or strategies to attract FDI.

- Such as Export Processing Zones in China

Push Factors Leading to the Emergence of a New International Division of Labour

1. High Labour Costs & Unionisation

High labour costs and lobbying powers of unions increase costs of production.

- Makes it harder for companies to realise higher profit margins
- In LDCs, union strikes are less common, workers can work overtime.
- In DCs, Average employers need to pay 20-25% of workers' wage rate for insurance/medical benefits.
- In LDCs, 2-5% at most is required

2. Saturated Markets and Product Life Cycles

When market penetration is maximised, markets are saturated with the product.

- TNCs need to sell somewhere else as products at the declining stage of the life cycle would mean that profits are lower.

3. Exhaustrion of Raw Materials

Exhaustion of raw materials and cheaper raw material in LDCs cause primary industries to be on a decline.

- Linked to David Harvey's idea of a "spatial fix"

23 Transnational Corporations

A. Transnational corporations (TNCs) - characteristics: able to coordinate and control cross-border operations, and able to take advantage of economic and socio-cultural differences by re-deploying resources and reorganising operations - socio-economic and environmental impact on home and host economies	

A transnational corporation (TNC) is a company whose operational activities are carried out in more than one country.

Characteristics of Transnational Corporations

1. Able to Coordinate and Control Cross-Border Operations

TNCs use new technologies in transport and communications to globalise their operations and achieve a spatial division of labour.

- TNCs exploit the principle of comparative advantage in order to cut costs of production.
    - This can result in them operating in multiple markets/plants/raw material sources.

This can be reflected in the structure of the TNC:

1. Corporate Headquarters	**2. Regional Headquarters**
Overall control of the TNC and is responsible for the **strategic decisions** and allocation of budgets	Make up the **intermediate level** in corporate organisational structure with **several countries under them**
❖ Both are found in **well connected places**, developed areas with high quality services and skilled labour ❖ Agglomeration(many TNCs gather together) of the HQs may happen but this mostly happens in home countries. ➢ Especially in countries in New York, Europe or in Japan where economic vibrancy is high (link to chapter 45 liveability)	
3. Research and Development Units	**4. Branch/Production Units**
Helps to **innovate new products and production services**. This helps to make the TNC **stay profitable**, productive and **competitive** in the global market.	Manufacturing plants or where raw material gets changed into finished goods. This usually is found in areas with comparative advantages.
❖ Found in mostly home economies, the global triad(US, EU, Japan), ❖ Near sources of science and marketing	❖ Found in areas all over the world (link to 21 GPN) ❖ The arrangement of the production units

information like in universities ❖ In countries with high amounts of skilled labour ❖ Agglomeration happens often ➢ Science Park is near NUS in Singapore	reflect the strategy of the lead firm ➢ Is affected by the land, labour available and cost of production ➢ Affected by tariff barriers or presence of EPZs (link to 24 role of state)

TNCs have a **command and control relationship with the host country**.

- TNCs help to generate wealth for the country
- However this can lead to a loss in sovereignty and an overreliance on external technology and capital for the state's development
    - TNCs are also controlled by the policies of the government.
    - TNCs need the state to provide infrastructure and amenities
- Therefore the state and TNCs need to negotiate to come to an agreement
    - Usually LDCs may need to have specialisations in low end functions in the GPN.

2. Able to Take Advantage of Economic and Socio-Cultural Differences

TNCs can take advantage of geographical differences in the distribution of resources (natural resources, labour) and the state policies (taxes, subsidies).

- TNCs are **footloose** and therefore **geographically flexible**.
    - Firms can re-deploying resources and reorganise operations between locations quickly.
    - TNCs can engage in strategic alliances, joint ventures and outsource to exploit the sociocultural differences in the host economy.

India

- Northern India is landlocked with no trading sites, little money and low education standards, few sources of decent employment and bad transport systems.
- The Southern and Western India has relatively higher levels of development as they are coastal areas and have access to coastal trade routes
    - They are also affected by the Asian Monsoon to aid in primary sector activity which can contribute to the economy by the multiplier effect.
    - As such this area has a more educated workforce as the state has more money to invest in education
    - This in turn attracts FDI from TNCs and this can become richer.

Impacts of Transnational Corporations on Host and Home Economies

- Economic -

1. Increased Employment, Improved Technology and Efficiency *[Host - Positive]*

See below in social impacts.

2. Economic Vulnerability *[Host - Negative]*

TNCs are footloose in nature and when the competitive advantage of a country is lost, when governments raise the minimum wage of workers or new regulations in place to make operating in a specific country more costly, TNCs may move operations elsewhere.

- TNCs create a new asset base wherever they go, changing the country's reserve of resources, by moving human/physical capital and tech to other parts of the globe.

Uniqlo
- Uniqlo shifted operations from China to Vietnam during the US-China Trade war in 2018
- Vietnam had a comparative advantage as the wages of Vietnamese workers were ½ of wages for Chinese workers.

3. Repression of Domestic Industry *[Host - Negative]*

TNCs increase the competition in the host market so that domestic firms will compete to obtain market share.

- TNCs may be too strong and acquire the total market share of the industry, leading to a monopoly forming.

4. Creation of Monopolistic Markets *[Host - Negative]*

As seen in the privatisation of water supplies (chapter 35).

- 1 company can supply the entire market's demand at lower cost than 2 or more firms can.
  - Results in a lack of competition.
- Can lead to regular price increases to increase profit
- Links to problems with social inequality as there is "accumulation by dispossession", as stated by David Harvey
  - States that the **for-profit nature disadvantages the lower income countries/marginalises poorer communities.**

***Veolia* Water in Nagpur and Delhi, India**
- This city signed a contract with Veolia water.
  - Several dubious financial transactions have been exposed
- Leg to "unforeseen delays" which drove up proves manifold with unfair water distribution.
- Led to a lot of fighting :(

5. Economic Leakage due to Repatriation of Revenue Earned *[Host - Negative]*

Repatriation refers to the conversion of foreign currency into one's local currency. This may be due to business transactions, FDI and travel.

- Usually done by the conversion of offshore capital in host economies to home economies of TNCs.
- Negatively impacts host economies as this can reduce the resources of the host country that could be invested in wealth creation, impeding long term national development or economic growth.

Apple Evading Taxes
- TNCs can choose to evade the home economies' taxes as they store large amounts of their high-value assets overseas in tax havens to avoid taxation by home country to increase their profits.
- Between 2008 and 2015, Apple earned $305 billion before taxes and paid a foreign tax rate of only 5.8%
- Apple shifted its profits into three Irish subsidiaries which allowed for them to exploit a loophole to pay almost no taxes to both home and host states.

6. Development of Quaternary Sector *[Home - Positive]*

TNCs tend to locate their high value operations such as research and headquarter operations within the home economy to manage the rest of the GPN overseas.

- Increases the demand for a strong educated workforce
    - Aids the formation of a knowledge based workforce in home country
- Home economies will have to develop its quaternary sector to enable high value-added jobs to be concentrated within home economies → provide better jobs and employment for people.
    - Can help economic activity move up the value chain.
- Agglomeration of HQs may also occur.

Silicon Valley in California, USA

- US Semiconductor production has shifted overseas to Asia
- Silicon valley retains most R&D facilities and HQs of TNCs like Apple, Facebook, Netflix and more

7. Loss of Jobs due to Outsourcing *[Home - Negative]*

Production plants can be relocated or offshored to other countries with skilled labour and lower operating costs.

- Can lead to job losses and unemployment especially for low-skilled workers.
- Can lead to more inequality in the country.

- Social -

1. Provision of Employment and Income *[Host - Positive]*

An inflow of FDI and the creation of new jobs can result in the economy that is boosted due to the multiplier effect.

- Can result in further technological transfer to locals
    - May be limited depending on the will of TNCs some may liscence the practice for money
- New practices by local firms to increase efficiency

Shell in Nigeria

- Shell produces ⅓ of Nigeria's oil output
- Accounts for 10% of the country's overall GDP
- Employs over 40 000 locals
- Also "invests in education and healthcare"

2. Exploitation of Workers *[Host - Negative]*

TNCs may be attracted to the weak regulations and the lack of a strong labour union.

- TNCs are profit driven and end to neglect the welfare of locals

Adidas' Human Rights Violations

- Has been exposed to have weak human rights regulation
- With about 775 000 workers in the factories in Vietnam, India and Indonesia being

3. Increased Capital Flow Back to Home Economy *[Home - Positive]*

TNCs can reach new markets to earn more profit as they capture value through GPN activity.

- TNCs can collect fees and profit from host countries to be transferred back to home country
- Multiplier effect boost home economic activity as people will have more disposable income blahblah...
- Country has more revenue to invest in healthcare and infrastructure to aid in development.

- Environment -

1. New Imports of Foreign Green Technology *[Host - Positive]*

Foreign technology can lead to improvements in the environmental standards of the host economy.

- Companies that brand themselves to be sustainable can change consumer habits in host economies.
    - Encouraging more sustainable lifestyles

Apple and Clean Energy Facilities

- Apple uses facilities that uses clean energy with a
- Apple also invests in wind, solar, and other clean energy facilities around the globe, builds its own energy sources, and ensures that any new offices and plants it constructs do actually run on 100 percent clean energy
- Over 485 megawatts of wind and solar projects have been developed across six provinces of China to address upstream manufacturing emissions.
- In Singapore, where land is scarce, Apple adapted and built its renewable energy on 800 rooftops.

2. Pollution *[Host - Negative]*

Weak environmental laws can attract TNCs as they tend to not want to deal with the aftermath of the production activity. (can be linked to extractice industries 31)

- Linked to David Harvey's idea of a spatial fix (contradiction 11) (chapter 29)
    - TNCs may use up the the natural resources of an area and move elsewhere

Shell in Nigeria

- Shell in 1976-1991 had spills of about 2.1 million barrels of oil which spread to the Niger delta
- Due to people who illegally tried to tap on the pipelines going across Nigeria
- Destroyed farmland and killed the sealife and fish which locals depended on for food/livelihoods.

Newmont in Buyat Bay, Indonesia

- US gold mining TNC Newmont dumped 2000 tonnes of daily mine waste into Buyat Bay.
- Resulted in poisoned fish and health problems due to the Hg in the wastes (Hg + As) poisoning the locals.

2.1.3 Governing the Global Economy

24	Role of State

A. Role of the state - regulator of economic activities - provider of public services and goods - business owner and investor	

The state is a politically bounded space where the resident population is governed by an authority.

- The state primarily aims to serve the needs of people and develop the country
- Governance refers to the conduction of policy, action, and affairs of the state, organisations or people with authority
    - As such they have influence over activities and outcomes of these activities
- Different countries and their states have varying degrees of power

<u>Regulator of Economic Activities</u>

The state can regulate and control all activities of the state to ensure systemic development of the country and the welfare of its citizens.

- Controls what happens within and across borders
- States can regulate a range of activities, with economic and social goals
- Make policies to advance its national competitive advantage

1. Market Regulation

States can uphold the fairness of the market mechanism by regulating economic flows.

- In the time of rapid globalisation, states need to manage high cross-border flows of capital, commodity, people or knowledge
- States may be restrictive in **not allowing financial capital to enter/leave the country without complying with regulatory procedures or paying taxes**.
- **Capital outflow** can result in a depreciation of of domestic currency (linked to the resource curse in chapter 32)
    - States can control and limit large capital inflows which can potentially cause local currency to appreciate which can lead to the export performance being impaired.

Export Strategies in China

- China controls the outflows and inflows of FDI to maintain an undervalued exchange rate to support export growth to have lower costs and thus a comparative advantage.

Labour flows relate to people and migration.

- Globalisation has allowed for more opportunity for individuals to migrate overseas in search of better job opportunities in TNCs.

Singapore

- There are foreign worker levies in place as a pricing mechanism to regulate the number of foerign labour in SG

2. Foreign Direct Investment Strategies (SEZ)

Rising levels of cross border investments by TNCs can allow for more skills transfer to locals and aid the development of countries.

- States may aim to increase the levels of inward FDI
- States may combine tax incentives, availability of prime land, supporting industry and workforce characteristics to attract foreign investors

These strategies may come in the form of **Export Processing Zones**.

- EPZs are industrial zones that have special incentives to attract foreign investors. These import materials undergo some degree of processing before being exported.
- This may include elimination of custom duties on imports, provision of infrastructure and reduction of corporate tax.

This is popular for states that wish to increase economic growth through TNCs but **wish to control the effect of the TNC FDI on the local economy.**

- Increased over the years due to the new international division of labour.

Pearl River Delta, China

- World leader in production of electronic goods, electrical components, toys and textiles.
- Was used to internationalise the Chinese economy and worked very well.

3. Industry Strategies

Stimulate certain areas of economic activity to prevent decline or stimulate growth in certain industries/geographical areas like depressed inner city areas. *(link to chapter 18 core periphery model and chapter 49 urban reimaging)*

- State can promote growth through manufacturing services by subsidising their labour costs and providing tax holidays in industries that they wish to promote.

Singapore

- Provides powerful economic incentive to discourage deforestation by countries/companies/communities/individuals through DC → LDC fund transfer
- Addresses the economic aspect but does not address other underlying drivers like reducing demand for timber or how they can help locals shift to a low carbon economy.

London Docklands, East London

- Current day Canary Wharf
- Long sought after retail and office space
- Lea Valley's waters were cleaned to build the olympic park site, causing new wildlife habitats to form and lesser pollution flowing to residents living downstream
- Formation of an enterprise zone where firms were given corporate tax relief, government grants as well as lenient planning and capital allowances, attracted many new businesses.
- Canary Wharf was at the centre of this transformation and financial institutions such as KPMG, HSBC and Barclays all moved into the area.
    - 120,000 new jobs were created and 25 million square feet of new office space was created. This was coupled with an injection of £6.5bn of private investment and £1.8bn of public investment

Provider of Public Services and Goods

The state is also a direct provider of a range of goods and services. These are provided by states as they are often too risky and unprofitable for individual firms and are fundamental to the population's well being.

1. Transport

The state is involved in the provision of transport on a variety of scales. This ranges from local to international connection.

Most developed economies own and manage their national airlines - Singapore Airlines.

Example: **Curitiba, Brazil**

- Curitiba's forward-thinking and cost-conscious planners integrated public transportation into all the other elements of the urban planning system.
- They created a system that focused on meeting the transportation needs of all people rather than those using private automobiles
- one of the most heavily used, yet low-cost, transit systems in the world
- about 70% of Curitiba's commuters use the Bus Rapid Transport to travel to work, resulting in congestion-free streets and pollution-free air

2. Health and Education

The state can provide health services by public sector provision.

- For education, at tertiary levels, the state funds universities, as well as funding research infrastructure and grants.
- Influences the economic growth through social policy, which would improve the quality of the workforce.
- Educating the population to increase skilled labour, like in Singapore, Hong Kong and Taiwan.
- Universities in Taiwan cost ½ of private ones as states fund them and are of higher quality.

3. Infrastructure

Infrastructure refers to the physical systems of the nation which are fundamental to the country's development.

- High cost to build and maintain and so needs to be public funded
- Communications, sewage, water and electrical systems

Therefore states need to provide basic facilities and amenities.

In DCs, there is a capacity for states to provide good infrastructure to attract FDI.

- Development of the port of Singapore can allow for the good growth for manufacturing and service sectors

Business Owner and Investor

1. Business Owner

The state can own economic activities by engaging in **State Owned Enterprises (SOE)** and **Government Linked Corporations(GLC)**.

- State owned National Oil Companies (NOCs) have also taken part in the competition for reserves (link to Extractive Industries)

- States have immediate developmental goals which they can achieve through state ownership and management of enterprises.
- GLCs are business enterprises where states have a direct or indirect stake in, but the management is being done by the profession.
- The size and resources of such companies help them to manage and finance projects more easily.
    - They are able to face the risk that these projects entail
- NOCs are also used by the home states to try to secure energy resources for domestic industries (link to energy use and carbon cycle)

Chinese National Offshore Oil Corporation (CNOOC), China
- China's largest oil company
- 66000 employees and has an annual turnover of $32 billion

2. Investor

States can be global investors through their own national funds accumulated by:

A. Huge resource endowment in home countries like Saudi Arabia in Oil Fields
B. Trade imbalances through exports, which can be done through foreign exchange receive which are accumulated in national funds → China and Singapore

Form a sovereign wealth fund that is a state owned investment fund which pools money from the countries' reserves. (Linked to resource curse chapter 32)

- Funds reserves for investment that benefit the country's economy
- Some countries use their SWF to diversify the economy.

Chile SWFs
- Relies on copper for its main resource.
- Led to good results as it resulted in lower levels of economic volatility.
- Higher shares of gross fixed capital investment
- Increased developmental spending

Singapore
- Government of Singapore Investment .Corporation has about $440 billion in assets
- Owned and funded by the government
- Deals with assets and real estate.

Norway's oil fund
- Norway's oil fund, (Government Pension Fund Global) was created after they discovered oil in the North Sea.
- After the discovery, the country's economy grew dramatically.
- Then it was decided early that revenue from oil and gas should be used cautiously to shield the economy from ups and downs in oil revenue.
- Also serves as a financial reserve and as a long-term savings plan so that both current and future generations get to benefit from their oil wealth

25	Influence of Regional and International Organisations

A. Influence of regional and international organisations - promoting intra-regional trade in the ASEAN Free Trade Area (AFTA) - global financial institutions (GFIs): the International Monetary Fund's (IMF) control of the global financial system and development assistance provided by the World Bank - the World Trade Organization's (WTO) regulation of global trade	

International Trade

International trade has been attributed to be a key factor in socio-economic development of nations.

- Trade liberalization requires countries to open up their markets
- This may involve trade reforms in cases of multilateral negotiations
    - Trade reforms help to give opportunity to make industry more efficient.
    - This is seen in the SAPs by the IMF (below)
- LDCs have a heavy reliance on tariffs for government revenue and low technology specification.
- LDCs develop comparative advantages by cutting high tariffs on imports which in theory can boost growth and living standards.
- Therefore, trade reforms and closely coordinated policy packages should be used to maximise benefits.
    - This usually aims to improve trade capacity of a region/state.
- Protectionism by restricting imports were found to be ineffective for sustained development.

Global Financial Institutions: International Monetary Fund & World Bank

These international organisations can help to aid in multilateral trade liberalization to help in trade reform.

1. International Monetary Fund (IMF)

The IMF **controls the global financial system** and is closely linked to the world bank.

- IMF provides financial assistance and advice to member countries by **loaning funds to states in need**.
    - Usually countries helped are dealing with economic crisis or they are in debt
- However, if the country wants to obtain funds, the recipients need to conform to their advice and carry out what is known as the **Structural Adjustment Policies** (SAPs).

Structural Adjustment Policies (SAPs)

The SAPs are a set of economic reforms the country must adhere to to secure a loan from the IMF.

- Includes reducing government spending, trade liberalisation which aims to make the nation more competitive and encourage economic growth

- These policies had mixed reviews: Mexico had no improvement, Egypt achieved great results.
- Caused increased poverty, social polarisation and overexploitation of natural resources (link to chapter 32 resource curse)

Therefore, they made a successor, the Poverty Reduction Strategy Papers.

Poverty Reduction Strategy Papers (PRSPs)

- Created in 1999
- Written by national governments and ***SHOULD*** be formulated by civil participation.
- Aimed to relief debt and to meet the Millenium Development Goals to recognise the multidimensional nature of poverty
- Should consist of coherent macroeconomic, structural and social sector reforms to reduce poverty

However, this:

➔ Led to misallocation of funds

➔ Civic participation is not enforced (link to sustainable development)

2. World Bank (WB)

The world bank consists of 5 closely associated institutions and provides **developmental assistance**.

- Formed at the Bretton Woods Conference which is a framework for economic stability after world war II.
- Aimed to lower poverty rates as it lends money for development by financing and advising countries.

Institution 1: International Development Association (IDA)

- Provides no-interest loans to the poorest countries
- Engaged in investment projects, finance service sectors and extended to agricultural sectors.

Institution 2: International Finance Corporation (IFC)

- Offers investment, advisory and asset management
- Encourage private sector development in less developed countries
- Promote accessible and competitive markets to promote the development of the economy

IFC funds water privatisation projects by providing loans and financing to private investors like Aegea in Brazil to improve the infrastructure of water there. (link to chapter 35 privatisation)

- Improve infrastructure of economies to improve and increase the possibility of economic activity.

Regulators of Global Trade (World Trade Organisation)

The World Trade Organisation(WTO) is the only global international organisation that deals with the rates of trade between nations.

- Ensures that trade flows smoothly and predictably

Liberalisation + Privatisation + Deregulation leads to **competition** which forces changes in the state and market.

- In theory is able to increase economic activity and help to overcome poverty

They facilitate trade by **making the global trade rules and regulations**

- The WTO provides assurance and stability
- Producers and exporters know that they will remain open to each other for trade

They also can **settle global disputes**.

- They developed a trading system that deals with tariff reduction and conflicts.

WTO creates out a non-discriminatory trading system that gives each country rights and obligations.

- WTO agreements contain special provisions for developing countries
    - This measures aim to increase the LDC's trading opportunities and build better infrastructure to attract more FDI blahblahblahblah…
- However, WTO can be argued to be biased towards DCs.
    - This is seen in the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement

Trade Related Aspects of Intellectual Property Rights (TRIPS)

- Provides patents by individuals and companies
    - The patents protect these people from theft and piracy
    - Covers agricultural products, medicines etc
- TNCs which manufacture genetically engineered agricultural seeds can have patent rights to the seeds.
    - However, the cost of using such seeds is high due to the legal fees involved
    - LDCs cannot freely copy or innovate on these seeds
    - Results in a loss in comparative advantage of the LDC farmers and therefore a loss in trade activity from these LDCs.
- For LDCs, an expanding export of primary activity product or raw material may cause an increase in resource dependence and therefore lead to the resource curse.

World Trade Organisation

- Since 2004, WTO promised to take action to reduce the rich countries' subsidies to cotton producers in US who sell exports below market prices
    - The US spends about $20 billion dollars per year to produce to other countries
    - However they never did
- LDCs face limited opportunity to export produce which leads to livelihood insecurity

Regional Trade Organisations - ASEAN Free Trade Agreement

These are collaborative agreements which **aim to create large markets** to **protect them from outside competition**.

- Can be in the form of regional trading blocs to promote intra-regional trade.

The **ASEAN Free Trade Agreement (AFTA)** is a trade bloc agreement by the Association of Southeast Asian Nations to **support local manufacturing in ASEAN nations**.

- Increase ASEAN's competitive edge on a production base
    - Eliminates tariffs/non-tariff barriers → attracts more Foreign Direct Investment.
- However they do cause trade between non-member states to decrease.
- This is done by the Common Effective Preferential Tariff Scheme (CEPT)

Common Effective Preferential Tariff Scheme (CEPT)

- ASEAN members apply tariff as outside imports
- ASEAN members apply a tariff rate of 0-5% for goods within ASEAN.
- Economic growth rate of 5.9% (compared to a global 3.8%) *[Positive]*
- Inconsistent GDP and inequality in region *[Negative]*
- Inconsistency of laws within countries so trade is hindered *[Negative]*

[SUMMARY]

1. International Monetary Fund → **SAPs and PRSPs**
    a. **Structural Adjustment Policies** which evolved to become the **Poverty Reduction Strategy Papers**
2. World Bank → International Development Association, International Finance Corporation and more to aid development.
3. World Trade Organisation → **TRIPS**
    a. **Trade - Related Aspects of Intellectual Property Rights Agreement**
4. Asean Free Trade Agreement → **CEPT**
    a. **Common Effective Preferential Tariff Scheme**

26	Involvement of Non-State Actors

A. Involvement of non-state actors - watchdogs, media agencies and standards organisations	

Non-state actors are entities that participate/act in international affairs such as the global economy.

- May involve NGOs, Media Agencies, Standard Organisations, Intermediaries
- TNCs and IGOs may also be considered under non-state actors.

They have **sufficient power to influence or cause a change** even though they do not belong to any established institution or state.

- They play a critical role in creation, enhancement and retention of economic value
    - Aids developmental processes in localities/regions/national economies
- They are nimble and have looser organisation structures
    - Allow for more efficient courses of action than states

Thus they can monitor TNCs activity well.

There are many forms of NSA, the ones we focus on in the syllabus are watchdog, media agencies and standard organisation.

Watchdogs

A watchdog is a person/community whose job is to make sure that companies do not act illegally/irresponsibly.

- Tend to be a non-profit organisation
- Publishes information on alleged abuse

1. Auditors

Auditors aim to **independently examine a companies' financial information** to **assess its validity and accuracy.**

- Certification by an auditor signals to investors that companies' fiscal statements conform to general accounting principles.
- Required by law in countries like Singapore

Audits in Singapore are all carried out under the guidelines of the Singapore Standards of Auditing (SSA), inspected by the Accounting and Corporate Regulatory Authority(ACRA).

There are **potential conflicts of interest**:

- Auditing firms are charged with protecting investor's interest
    - Audits are paid by the companies that choose to audit, so the auditors may not want to lose their client
- Auditors may also offer consultation practices
    - Accountants may not want to perform tough audits on clients if they fear losing revenue from them via consultations.

2. Private Watchdogs

They can also be known as monitors.

- They check on business proceeds where firms are suspected of infringing regulation
- Monitors have broad mandates(permission to do many things)
    - Financial institutions need to follow the reccomendations that make
- They can watch financial institutions like HSBC.

The Hongkong and Shanghai Banking Corporation (HSBC)

- Bank was under strong scrutiny from involvement in drug trafficking and money laundering.
- Fined up to $1.92 billion dollars
    - Spawned and Established new firm Exiger to oversee the bank's compliance efforts
    - Forced HSBC to turn over more than 2 million pages in documents

Media Agencies

1. Watchdog Journalism

Watchdog journalism informs the public about incidents in institutions and society.

- Especially in circumstances where a significant portion of the public would demand changes in response
- Involves fact checking statements with public officials, interviewing public figures and challenging them with problems, gathering information from meetings that members of the public might not otherwise attend.
- Alert others when a problem is detected
- Located in a variety of media like in radio, television, print or on the internet

2. Influence on Public

The media is able to influence dominant social groups to benefit the public. This may lead to a conflict of interest:

- Most of the media is regarded as for-profit enterprises so they may dumb down the news and increase the dominance of news that have more entertainment value.
    - Competition between media agencies may cause greater pressure to pander commercially to businesses.
- New big news organisations support investigator reporting due to the prestige it brings which may become the news outlet's selling point
    - Example: Washington Post diverted more resources to watchdog journalism in 2019.

Buzzfeed and FinCEN Documents

- Buzzfeed news exposed the FinCEN documents in 2020 which showed that large banks all over the world like Standard Chartered bank have been guilty of a global money laundering scandal.
- Many banks that also laundered the money included the German bank Deutsche as one of the top banks that laundered the most money
- All the money laundered globally totals up to US$2 trillion dollars

very sus

Standards Organisations

Standards organisations are intermediaries that are involved in the **establishment, enforcement and harmonisation** of **protocols, codified knowledge and specification** in the **global production of goods and services.**

SOs help to **foster technological innovation** and new services like in current fields like biotechnology.

- Help companies to **specialise different economic functions** and business segments in GPNs.
- Without common technical interfaces and modularity standards (refer to page 8 of this link) in constituent components and subsystems, electronics and automobile production would not be this globalised today.

Following is a table that shows its benefits to different stakeholders:

Manufacturing	Customers	Traders	Technologists
1. Rationalise the manufacturing process 2. Eliminate waste in material and labour 3. Reduce production cost	1. Ensure quality of good purchased 2. Provide better value for money 3. Easier to settle disputes with suppliers	1. Provides a way to reject or accept goods 2. Minimise delays arising from inaccurate or incomplete specification of products	1. Provide starting points for R&D for the further improvement of goods and services.

Limitations of SOs include that international standards can be a significant barrier for entry for local firms to GPNs due to the high economic, social and institutional costs of needing to adhere to the standards.

SEMATECH, US in the 1990s

- 14 leading US semiconductor manufacturers had a partnership to share the risk in venturing out
- This accelerated technological innovation and commercialisation of new materials and designs in integrated circuits and computer chips

Intermediaries are diverse actors in GPNs.

- If a lead firms and its key partners or suppliers become the industry standard, they capture high levels of value
    - Examples include Android for telecommunications.

2.2.1 Valuing the Environment and Natural Resources

27	Human-Environmental Relationships

A. Human-environmental relationships - nature-centred: non-human life has intrinsic value that is equal to that of humans - human-centred: non-human life has instrumental value in the creation of material goods to improve the quality of life for humans	

Introduction

There are different ways in which the environment is valued:

1. **Instrumental Value**

We view a resource to have a specific end.

- A forest has only a use as a source of fuel

2. **Inherent Value**

We value it beyond using it as a resource but also relates it to how it makes us feel.

- We value a woodland as we enjoy walking through it and its role for atmospheric stability.

3. **Intrinsic Value**

We value it as important in and of itself, with no reference to how it can be used.

- Just like how we value human life

Humans will always be the **distributors of value**, but they not necessarily are the only bearers of value.

Nature-Centred Thinking

Suggests that non-human entities have **intrinsic value**, also known as **ecocentrism**.

- Leads to the sentiment of "deep ecology"
- As such this can lead to more radical beliefs and ways to manage the environment.
- Results in **radical approaches** which advocates for **major societal and political changes to how we act as environmental protection cannot be accommodated by the current systems**.

Deep Ecology

- Type of ecocentrism where everything has intrinsic value.
- Believes that all humans and non-human entities are interconnected and interdependent
- Humans are not only part of nature, but are equal value to other non-human entities

"Upset one, impact all other elements"

Human-Centred Thinking

Suggests that only human entities have **intrinsic value** while the **environment has instrumental value**.

- Known as anthropocentrism
- Environment only exists as a resource to improve the standard of living of humans
- Gives rise to shallow ecology
- GIves rise to more **reformist approaches** where **people work within current political and economic systems** which **modify our actions** to reduce environmental impacts.

Shallow Ecology

- More pragmatic
- Less "spiritual"
- Seeks technological solutions to major environmental problems

International Organisations like the **Organisation of Petroleum Exporting Countries (OPEC)** can govern the **tool of demand and supply** to **influence the prices** and therefore **profitability** of resources. [Linked to the next chapter 28]

- The OPEC constitutes 13 countries like Angola, United Arab Emirates, Venezuela and more.
- Aims to use the tools of supply and demand to shift power from the west
- They have a control over the majority of proved crude oil reserves and are responsible for 60.3% of the world's exports
- Decision about levels of production (local, regional or export globally) affect global oil markets as they are **highly interrelated.**
- The OPEC regards oil **to have instrumental value as they are just for profit.**
- The OPEc thus affects the viability of resource extraction.

In reality, there is a continuum between anthropocentric and ecocentric beliefs in managing the environment.

- Radical and reformist beliefs are also two extreme ways in which people manage the environment

28	Factors Affecting Resource Appraisal

A. Factors influencing resource appraisal - cultural: value systems and traditions - socio-economic: income levels, education and profitability - technological: knowledge and technical capability - political: national resource policies and influence of international organisations including the Organization of Petroleum Exporting Countries (OPEC)	

Introduction

Natural resources are things that have utility and that are derived from Earth's biosphere, hydrosphere, atmosphere and lithosphere.

- Things become resources when humans find utility in them as resources are a socio-cultural and political construct
- Things acquire utility or value only within the contexts of politics, culture and economics
- The consideration of what constitutes being a resource is varied across time and space.

Factors Influencing Resource Appraisal

1. Cultural Background

Different cultures assign value differently to different resources.

- different resources may have different meanings to different cultures, which have different value systems and traditions.

Gold In India
- Gold is ingrained in Indian culture
- There is even a special holiday where the goddess Lakshmi blesses anyone who buys gold on that day
- Locals buy gold as they see it as an investment instead of a luxury

2. Socio-Economic (PIE)

Influences the value and use of the resource.

- **Income** is a factor which causes the value of a resource to change.
  - As someone's income increases, more "wants"/or luxuries become a need
  - Singaporeans that have higher income tend to use and regard the air conditioner as a necessity
  - Higher income households use more energy than lower income households
- **Education** allows for individuals to learn more about resources which lead to a change in perception and thus a change in the usage of these resources.
- **Profitability** affects resource appraisal.
  - In a capitalist economy, a commodity would not be exploited unless it can be done for profit.

- As prices change, things become resources.

Oil Sands, Canada
- When the production costs increase as oil prices fell below $65, the extraction was not economically feasible
- When the prices fell, the desire to exploit the oil sands also fell
- However when technological improvements allowed for the costs of extracting oil to fall, extraction resumed as it was now profitable.

3. **Technological** *(Knowledge + Technological Capacity)*

More knowledge and research can turn minerals or previously undiscovered material into resources.

Uranium in Niger
- Demand for electricity seeked to rise in the LDC
- Uranium seemed to be a potential resource to generate electricity in Niger
- However, Niger itself lacks the infrastructure and technology to extract the uranium
- They also **lack the ability to translate their uranium into practical use**
- Furthermore, uranium mining is exploited by France TNC, Areva, that previously historically held colonial powers over natural resources in the African continent (political)

4. **Political Factors**

Can be due to **National Resource Policies** or **International Organisations**.

- **National resource policies** involve governments laying out policies in relation to resource use and management.

British Columbia, Canada
- They stated that natural resources are perceived as an integral part of life and are protected by law
- There is law enforcement by officers to protect British Columbia's ecosystems and natural resources, so they can prosecute violators
- The government owns 94% of the land and forest resources, allowing them to allocate the resources themselves
- They also conduct research into new techniques and studies like tree breeding which can improve the management of forests in the area (link to protective areas for deforestation)

- **International Organisations** like the **Organisation of Petroleum Exporting Countries (OPEC)** can govern the **tool of demand and supply** to **influence the prices** and therefore **profitability** of resources.
  - The OPEC constitutes 13 countries like Angola, United Arab Emirates, Venezuela and more.
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  - The OPEC regards oil **to have instrumental value as they are just for profit.**
  - The OPEC thus affects the viability of resource extraction.

29	Perspectives on the Relationships Between Population and Resources

A. Perspectives on the relationship between population and resources - different views including those of Thomas Malthus, Ester Boserup and David Harvey	

Introduction

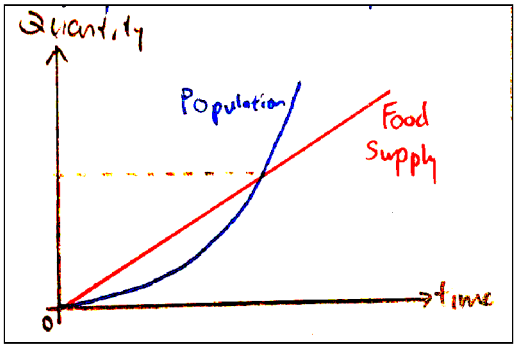
The relationship between populations and resources are **complex**.

- Population growth requires resources and this sustains the world economy.

There are 3 main views on the relationships between resources and population, Malthusian theory, Ester Boserup's views and David Harvey's Views.

Thomas Malthus (1798)

- Also called Malthusian Theory
- Published in the 1800s



This theory states that the human population if left unchecked would grow at a geometric/exponential rate while food supply at best only increases at arithmatic rate.

- Eventually, the population would exceed the food supply
- The population would exceed the carrying capacity of the environment
- Once the ceiling is met, further growth in population would be curved by negative/preventive or positive checks.

Preventive Checks: Methods to limit population growth

- Abstinence, postponement of marriage → leads to lower fertility rates
- Moral restraining → give rise to lesser or smaller families

Positive Checks: Ways population would reduce in size

- By events such as famine, disease, war and natural disaster.
- Increase mortality rates → reduce life expectancy → rate of population growth decreases
- Death of many women of child bearing age → immediate effect on the number of children born → reduce the number of parents.

Limitations

1. **Intensification of Food Production**

There was a great increase in availability of land in North and South America

- Revolutionised food production
- New innovations like refrigerated ships, faster transportation → Green Revolution in 1970s
- Agriculture is intensified → mechanization, fertilisers, green revolution through high yielding varieties

2. **Poverty was a result of Population Growth**

Malthus believed that laws that deal with relieving poverty contributed to the misery of the poor as these laws now make them prudent and still allow them to reproduce.

- Historical evidence between the 1800s of those English parishes(territories with churches) that administered these laws did not have higher birth/marriage/ total population growth as compared to those without poor laws.

3. **Moral Restraint was the only Preventive Check**

There have been changes in societal and cultural norms and societies have moved away from high to low fertility rates due to growing awareness and acceptance of **contraception, sterilisation and abortion.**

4. **Assumption that every country acts by its own, there is no trade**

Supporting Example: Sahel Region, Africa

- After 2002, a successful vaccination programme was established
- Resulting in low death rates, which is the absence of a preventive check
- Resulted in famine
- Now there is a food deficit in the Sahel region.

Counter Example: India

- High population growth due to a fast-growing economy
- Lack of a large enough preventive check like famine that occurs as a result

Ester Boserup (1965)

- Drawn up in the 1960s
- The threat of starvation and the challenge of feeding more mouths motivated people to improve their farming methods → invent new technologies to produce more food.

"Food production can and will increase to match the population's needs."

- Population densities increase → human populations are forced to change the methods of food production and supply (irrigation/HYVs) → **increase the carrying capacity** of the land.
- However, the population pressure need to be keenly felt before land use intensification can take place even with access to intensive technology.
    - Investments in labour are often large → intensive methods of cultivation only produced marginally more food → people tend to reject it

Limitations

1. **Only Temporary**

Boserup's idea cannot work indefinitely as at some point, the population may get so huge that they cannot be fed no matter how inventive people are.

- Furthermore, this may lead to the long term environmental degradation as many forms of intensification may involve more use of water and fertiliser.
- Results in large scale destruction of the environment
- Need to consider the impacts of climate change

2. **Not Proven in Reality**

If Boserups theory was true, more advancements in agricultural technology should be found in places facing the largest Malthusian crisis.

- However, highly populated places with issues of food shortage tend to have low-tech agriculture while rich countries tend to have high-tech
- Patented inventions like seeds may also be too expensive for poor farmers to use.
- Link to Trade-Related Aspects of Intellectual Property Rights (TRIPS) by the World Trade Organisation where LDC farmers cannot afford and access such inventions.

Supporting Example: Green Revolution, India

- Green Revolution led to improved wheat, rice and other cereals
- Wheat production tripled from 1965 - 1980, outpacing population growth

Counter Example: Sub-saharan Africa

- Overpopulated, with 13% of the global population
- Most food-insecure region due to more drought from climate change and conflict from
- Adoption of modern agricultural technology is sparse

David Harvey's 17 Contradictions and The End of Capitalism

- Created by David Harvey in 2014
- Instead of focusing on the direct relationship between man and food, he discusses other types of resource-population relationships
- He discusses the ills and potentials of capitalism

Capitalism is any **social formation where capital circulation and accumulation is dominant in providing & shaping the material, social and intellectual bases for social life**.

- An economic system based on the private ownership of the means of production & operation for profit
- This form of system is unjust and exploitative

A. Contradiction 5

Contradiction 5 states that there is an exploitative social relation between capital and labour → the underpaying of labour is essential for the creation of surplus-value.

B. Contradiction 4

Contradiction 4 states that the accumulation of capital by a small number of individuals by the dispossession and accumulation of wealth brings about the formation of a small but powerful capitalist class.

- Money can be accumulated without limit, and to the degree that this big amount of money can be translated into social power.

C. Contradiction 7

When capital becomes concentrated in the manner in the hands of few → overproduction results in the workers earning insufficient wages to purchase the goods they produce. :(

- Leads to a collapse in the system.
- This leads to the internal contradiction of capital circulation & accumulation lead to a crisis
- As such his theory posits that resource scarcity is not absolute
- Scarcity exists as workers havea limited capacity to purchase the goods they need/produce.
- Capitalists tend to continue generating profit, extending production into new areas/regions, known as a spatial fix.

D. Contradiction 16

There is a relationship between capital and ecological crisis.

- Nature is internalised within the circulation and accumulation of capital
- Capital has turned environmental issues into profit-making opportunities, especially during an environmental catastrophe.
- This may also lead to **Greenwashing of TNCs.**
- From the point of view of the market, nature is only of instrumental value and is viewed as capital. (Link to the limitation of how society is organised which impedes SD)

Nestle, 2019

- Allegedly said that they had used "sustainably sourced cocoa" but they have been found to drive deforestation in West Africa
- ALSO some claims of child and slave labour >:(

In conclusion, Harvey believes that **social accessibility**, the **level of access by different segments of the population**, is the main cause of **poverty and scarcity**.

2.2.2 Managing Resource Base

30	Nature Of Resources

A. Nature of resources - classification of resources: perpetual, renewable, non-renewable and potential resources - resource availability: proven, conditional, hypothetical and speculative reserves	

Introduction

Resources are defined as things that have **utility**.

- They are socially constructed and are dependent on context.
- As such they are constantly changing, as usefulness to potential users may **change over time**
- New technology processes, demands and concerns vary over time and space
- As such new resources may be found, like
    - Rare earth metals used in "green technology" like **Lithium for Batteries.**
- The **nature of a resource** should be considered when talking about human-resource relationships.

Resource Classification

Refer to the classification of resources based on whether they are renewable or not and how they actually exist as a **continuum**.

These resources are classified as Non Renewable, Renewable, Perpetual and Potential resources.

1. Non-Renewable Resources

These forms of resources are also known to be stock resources → Finite in nature

- Mainly mineral, takes millions of years to form
- Considered non-renewable as there is **no possibility to replenish the resource on a timescale relevant to human society.**

Consumed by use (coal/oil/gas), theoretically recoverable (all elemental minerals) & recyclable (metals)

- Highly **localised**
- Only found in areas of relative abundance like oil fields and coal mines
- Some of these minerals are **absolutely scarce**
    - Affects the price of them.

2. Renewable Resources

These forms of resources are **naturally renewed.**

- Within a **sufficiently short enough time to be of relevance** and use to human society.

Can be categorised into 2 types:

Critical Zone	Non-Critical Zone (perpetual)
- Depends on the **management** to determine the continued availability of the resource Fish, Forests, Animals, Water in Aquifers	- Resources will still be available **independent of action** of society Solar energy, Wind.

3. Perpetual Resources

They refer to resources that **cannot be exhausted** regardless of rate of use.

- Challenging to convert these forms of energy into useful energy
- Requires **technology** which requires **investment**
- New scientific and technological advancements → decrease amount of energy loss during energy conversion
    - Can also lower environmental impact and decrease the reliance on stock resources
    - Lower CO_2 emissions

4. Potential Resources

They are resources that are **found in a region but have not been utilised**.

- Due to the lack of capital or other reasons

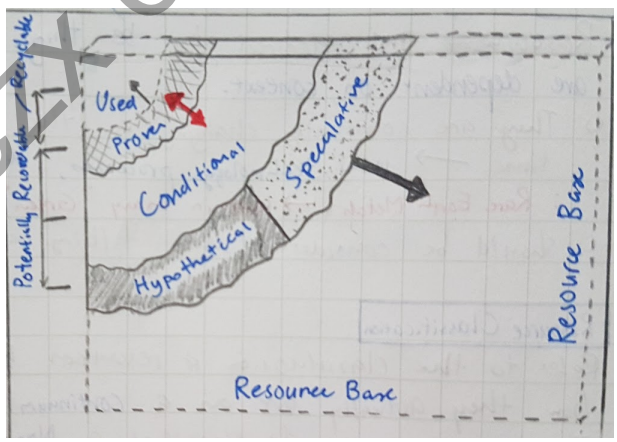
Resource Continuum

A resource continuum may form as resources that are renewable and are in the critical zone may move up to become stock resources.

- Water may have been thought to be relatively abundant as a resource, but due to population growth and industrialisation, more stress on the finite supply of freshwater
- Freshwater may shift and become a stock resource.
- Important as this concerns long term sustainability of resource usage.

Resource Availability

Natural resources can also be classified based on their availability of the resource.



1. Proven Reserve

Refers to the deposits that are already:

- **discovered** and are
- **economically extractable** under current demand/price/technological considerations
- Such as oil

Extent of proven reserve is **dynamic** & **varies over time and space.**

- Due to price/demand/cost/availability of substitutes
- Environmental or social cost involved
- May be susceptible to regional regulation

2. Conditional Reserve

Refers to deposits that have been:

- **Discovered** but are
- **NOT economically extractable** under current demand/price/technological considerations

The boundary between proven and conditional resources are **dynamic and bidirectional**.

Oil Sands in Canada

Oil Sands (oil sources) in Canada have been at this boundary before. An increase in production costs require the oil prices to be above $65 to be economically viable.

- When prices fell, investment into extraction fell
- When technological improvements & cost decreased, the oil extraction then could resume again.

3. Hypothetical Reserve

Are resources that may be found in:

- **partially surveyed** / developed areas
- Undiscovered resources are similar to known mineral bodies with **similar geological conditions**
- Not readily available

4. Speculative Reserve

They are found in:

- **Unexplored areas**
- Have **favourable geological conditions**

There remains a large part of the earth which we have no information about its resource base.

- If exploration continues, they can become Hypothetical → Conditional and then Proven reserves.

Arctic Oil

- The arctic possibly holds 13% of the world's undiscovered oil & 30% of undiscovered natural gas.

Do note that now we face the problem of waste produced from resource consumption which threatens the stabillity of ecosystems.

31	Extractive Industries

A. Extractive industries - commodification of resources and the global development of extractive industries - characteristics: location specific, capital and technology intensive, mixture of large private and state-owned firms - impact on the environment including the effect on the regenerative capacity of nature especially at environmentally sensitive areas	

Introduction

Extractive industries(EIs) are **primary activities** involved in the **extraction of non-renewable resources.**

- Resources that can provide energy services have been sought most after
- Due to mankind's fossil fuel dependency
- EIs not include industries like agriculture, forestry and fisheries.

Examples (mostly energy, metallic or non-metallic minerals):

- Oil / Al / Cu / Natural Gas / Diamonds
  - Traded globally due to high value per unit
- Coal / Limestone / Steel
  - Traded regionally
- Sand / Gravel / Stone
  - Traded locally (not very high value)

Characteristics of Extractive Industries

EIs are the initial stages of the production circuit as they engage in primary activities. Their extracted resources are **non-renewable.**

1. Location Specific

The environment has to be exploited where the minerals occur.

- Refining can be done elsewhere
- Extraction is done in situ, where the resources are found
- The combination of the finite quantities of the minerals, fixed locations & territorial embeddedness of the activities in countries, this creates a specific shape and path for EI development.

Territorial embeddedness refers to the economic life of a market bound by location specific social and cultural relations, infrastructure & operating environments.

- Resources closely bound to the ideas of sovereign territoriality and national identity.

EIs are sensitive economically, politically, environmentally and culturally. → may lead to conflict and bargaining between firms and states.

2. Capital & Technology Intensive

These extractive industries use high tech equipment and skilled labour in the exploration and construction phases of major extractive projects & for production and maintenance.

- Highly expensive & sophisticated technology have to be employed at all stages of production circuit
    - Sensors, wireless communications, computers for seismic testing
    - Stuff for well drilling
- Previously, mine workers had to go physically to hard-to-reach places and dangerous corners of a mine to check for gasses and pressure values.
- Now, sensors and computers can perform these tasks safer and faster
- Also allows for more accurate drilling & speed.

Pioneer Natural Resources, West Texas

- New technological developments in using new oil drills can allow for drilling to be twice as fast now, without additional human labour.

3. Mixture of Large Private and State-Owned Firms

EIs consist of a mix of private firms (TNCs) and state owned enterprises (SOEs).

This industry is dominated by giant firms known as International Oil Companies (IOCs)

- which operate at all stages of the production cycle (exploration, production, transportation, refining and marketing)
- These companies have expanded beyond their home base, indeasing competition with other IOCs for access to new/existing petroleum reserves.

Examples are like Shell and British Petroleum.

- State owned National Oil Companies (NOCs) have also taken part in the competition for these reserves
- The size and resources of such companies help them to manage and finance projects more easily.
    - They are able to face the risk that these projects entail
- NOCs are also used by the home states to try to secure energy resources for domestic industries (link to energy use and carbon cycle)

Examples are like Chinese National Offshore Oil Corporation (CNOOC), China and Petrobras, Brazil.

Commodification of Resources

Commodification is a process where different things are made **equivalent and exchangeable through the medium of money.**

- They take on the general quality of having an exchange rate
- Becoming **measurable** by the same standard / commensurable
- This monetization allows for the resources to be **exchanged**
    - Allowing for separation of production, circulation & consumption over time and space. (can link to NIDL)

Global Development of Extractive Industries

We will look at two resources, Oil and Copper.

- EIs are the starting point of GPNs (link to production circuit in chapter 21)

1. Oil

Oil is used as a source of heat and fuel for electricity.

- Able to be transported over long distances by using pipelines, oil tankers and rail
- Generated the petrochemical industry → producing plastic and textiles
- Created resources where there are no known substitutes
    - Jet Engine Fuel
- Advanced societies are dependent upon the continued supply of oil at a reasonable price for energy security.

Production grew by 46% from 1975-2007. Until 2007, Middle east stull accounts for 31% of oil production

- World map of production today is more complex and spread out due to the desire for diversified sources of oil to allow for supply security
- New producers have emerged like former soviet states Kazakhstan and Angola.
- China went from being the biggest exportert of oil in asia to becoming the largest importer of oil due to rapid development
- Half of total imports of the world are by US and Europe.

Oil has also became an important sector of income for some countries.

- Saudi Arabia's Oil and gas sector accounts for 70 % of export earnings.

Impact of Extractive Industries on The Environment

EIs have contributed to the improvement of the capacity of many economies by creating jobs, exports, revenue and reinvestments.
However, EIs have devastating environmental impacts.

These impacts **include the long term effect on the regenerative capacity of nature, especially at environmentally sensitive areas**.

1. Land and Water Pollution

For water pollution, gold mining is notorious for the negative impacts due to techniques of using mercury and cyanide to extract gold which is one of the cheapest techniques.

- Some of these mining companies dump the toxic waste directly into water bodies like rivers and oceans.
- Leads to toxic chemicals and heavy metal ions by leaching and polluting groundwater
- This kills marine life and biodiversity of the affected areas.
- Can affect entire ecosystems as the metals are cycled over long time spans, may lead to bioaccumulation as well.

Newmont in Buyat Bay, Indonesia

- US gold mining TNC Newmont dumped 2000 tonnes of daily mine waste into Buyat Bay.
- Resulted in poisoned fish and health problems due to the Hg in the wastes (Hg + As) poisoning the locals.

(theres a second part in the next section about this)

- Newmont's EIA claimed that there would be a protective thermocline layer that would prevent the tailings from spreading to the biologically productive layers of Buyat Bay but

there was no such effect.

Furthermore, oil spills can have effects on land pollution.

- May be due to pipeline theft

Shell, Nigeria

- Shell's pipelines from 1976 - 1991 had spills of oil which polluted the Niger Delta, killing fish and farmland.

In the long term, even when the mines are closed, the waste rock in the mine site may contain sulfides which may react with air and water in a process known as **Acid Rock Drainage**.
This can cause the groundwater to be polluted with sulfuric acid.

$$\mathrm{FeS_2\,(s) + 14\,Fe^{3+}\,(aq) + 8\,H_2O\,(l) \longrightarrow 15\,Fe^{2+}\,(aq) + 2\,SO_4^{2-}\,(aq) + 16\,H^+\,(aq)}$$

This is commonly found in the Philippines where abandoned mines are found to have outflow of acidic water.

2. Deforestation

Mining is a cause of deforestation as forests are cleared for mineral extraction, processing and infrastructure development.

- This coupled with the associated pollution can cause forests to die off
- Mining accounts for 10% of the Amazon's deforestation
- Developing countries have less stringent environmental regulation.

3. Carbon Emissions and Air Pollution

The use of gas flares by the EIs during the processing phase releases CO_2, CO, SO_2 into the atmosphere which may result in air pollution and acid rain (SO_2).

- Processing of materials also requires large inputs of energy that leads to high greenhouse gas emissions.
    - Contributes to global warming
- Mining also releases gasses normally formed underground like methane which is a greenhouse gas more potent than CO_2.
- Climate change affects abilities of LDCs to deal with poverty, access to healthcare & education
- Impedes sustainable development.

As of 2019, EIs account for ½ of the world's emissions.

4. Loss of Biodiversity

There are long term impacts of pollution and the development of the infrastructure.

- Especially in environmentally sensitive areas
- Unable to regenerate

Ok Tedi Mine, Papua New Guinea

- When the tailing dams collapsed in the Ok Tedi mine in Papua New Guinea in 1984, it resulted in Cu heavy waste polluting the surrounding forests.
- Forest die off for the next 30 years.

Strategies to Mitigate Impacts

The main strategy to help minimise the effects of EIs on the environment is to use Environmental Impact Assessments (EIA).

1. Environmental Impact Assessments (EIA)

EIAs analyse the potential social, economic and environmental impacts of each project. Then, there must be a set of solutions to prevent, mitigate & control these damages.

- There must be an establishment of air, water and soil emission limits, protections and contingency plans.
- This is important to make sure that sustainable development.
    - helps to minimise the trade offs in economic development.

Advantages	Disadvantages
Bolivia-Brazil Gas Pipeline Project (GASBOL) is a large pipeline project that crossed Bolivia & Brazil. This crossed ecologically and socially sensitive areas but was successful due to: - Continuous monitoring & follow-up - Strategies considered both upstream impact of oil & gas extraction in Bolivia and downstream in brazil - Civil participation, with indigenous communities which have allowed for good feedback & negotiations.	There must be political will and transparency to allow for strategies to work. - Plans may only be executed later and the affreements need to be carried out with another government due to the transboundary nature of impacts. EIAs need to also be scrutinised as sometimes they are not done well: - Newmont's EIA claimed that there would be a protective thermocline layer that would prevent the tailings from spreading to the biologically productive layers of Buyat Bay but there was no such effect.

32	The Resource Curse Thesis

A. The 'resource curse' thesis: reasons for underperforming resource-rich countries - reliance on expat specialist labour to operate imported technologies - limited job creation due to highly mechanised production techniques - limited local production linkages - economic leakage due to the repatriation of revenue earned - exceptions to the 'resource curse': strategies to develop resource-rich countries	

Introduction

The resource curse thesis refers to the **academic observation** that countries which tend to have **greater resources or reserves** tend to **develop economically more slowly than countries with fewer resources.**

In other words, it serves to explain why resource-rich countries fail to benefit from a favourable endowment.

- Poor countries can be thought of as countries with lower than average GDP.
- The presence of diverse mineral supplies should be a source of **comparative advantage** in economic development → **attract FDI** → allowing for the **alleviation of poverty** by the generation of wealth

As such it can be thought that mineral wealth **does not necessarily translate** into productive and social human capital.

- **Economic, social and political/institutional forces** guide mineral-rich countries away from developmental progress & poverty reduction.

Characteristics of cursed countries include: being **high in debt**, having **high export earning instability**, having a **distorted sectoral composition of the economy**, vulnerable to economic shock and investing little in education.

Explanation For the Resource Curse

There is **no one simple explanation as it varies across countries**.

- However, for most of them the wealth that is being created by natural resource exploitation is nor well retained.

1. Limital Local Production Linkages/Enclave Tendencies

There is **limited scope** for the establishment of backwards and forward production linkages between the extractive sector and the local economy, especially for the oil and gas industry.

Backward linkages refer to the inputs into the extractive activity from the domestic economy in terms of the employment, capital and material inputs into the value chain.

- For extractive sectors, the production process is largely continuous, capital intensive with inputs from foreign sources.

- The sector employs a relatively small number of highly skilled workers, most of which are foreign.
    - While mining does employ low skilled workers, they are usually temporary.
- Little diffusion of technical & managerial knowledge to locals due to low labour mobility

**Labour mobility refers to the ease with which laborers are able to move around within an economy and between different economies*

Forward linkages refer to the supply of the extractive sector output to the rest of the economy.

- Mineral companies often locate processing plants outside of the country where the resources are extracted.
- Low transport costs today make it no longer critical for processing industries to be close proximity to the resource reserves.
    - Unprocessed oil & minerals are largely free from tariffs that the Organisation for Economic Co-operation and Development place on processed goods.
- As such, when firms export the resources, they do not contribute significantly to domestic economies.

2. Reliance on Expat Specialist Labour to Operate Imported Technology

There is a distinct reliance on expatriate labour in extractive industries.

- Affects the rate of local employment → implications on the local economy and standard of living.
- Even if jobs are available, the skills of the local people are mismatched with the skulls required by investors or subcontractors.

Malaysians, Indonesians and Chinese Nationals in South Sudan

- In South Sudan, the oil-producing sector depends on expatriate labour which mostly comes from Malaysia, Indonesia and China.
- It is hard for the local population to get the skills to manage operations as students in South Sudan need to study for 6 years to get the qualification.
- This further impeded the local supply of skilled labour.

3. Limited Job Creation due to Highly Mechanised Production Techniques

The reliance on the expatriate labour & highly mechanised production techniques are due to the highly technologically intensive characteristics of EIs.

- The mismatch of skills from locals + trends of increased mechanisation means that less manual labour is needed.
- The industry cannot continue relying on manual labour as they need to be competitive.

4. Economic Leakage due to Repatriation of Revenue Earned

Repatriation refers to the conversion of foreign currency into one's local currency. This may be due to business transactions, FDI and travel.

- Usually done by the conversion of offshore capital in host economies to home economies of TNCs.
- Negatively impacts host economies as this can reduce the resources of the host country that could be invested in wealth creation, impeding long term national development or economic growth.

Extorre Gold Mines in Argentina

- Argentina used to lose up to $3 billion per month to repatriation by companies, like Extorre Gold Mines.

- the country has less revenue to invest into improving infrastructure and increasing accessibility to healthcare for social development.
- In response, the country may impose laws such as mandating that TNCs keep 30% of the profits in the case of argentina.
- May result in a situation whereby footloose TNCs scale down on operations or move operations elsewhere as seen in a 18% decrease in profits of the Extorre Gold mines after the regulations were imposed.

Limitations to the Resource Curse Thesis

1. Inapplicable to some countries

Examples: Norway, Chile and Botswana

2. Observations of countries may still be in too short a time frame

Studies were only focused between 1970 and 1990

- There is very little long term data
- Resources have culturally played an important role in the success of many successful industrialised economies, but only due to long term development.

For many countries. What is presented as evidence for the existence of a resource curse weakens if the time frame is longer.

Strategies for Developing Resource-Rich Countries

Not all mineral-rich countries have fallen to the curse.

- Managing a mineral economy requires developed state capabilities
- Voice & accountability, control of corruption
- Political stability, absence of violence

1. Sovereign Wealth Funds (SWFs)

Stabilisation funds may be accumulated during upswings in the economy where the excess income is channelled into SWFs. During downswings, SWFs can partially finance budget deficits.

- Encompasses a saving fund from mineral revenue that can be saved' for future generations.
- Can be used to diversify revenue schemes (link to role of state)
- Effective only when countries have prudent macroeconomic management.

Norway [Positive]

- Low levels of corruption
- High SOL and HDI
- Managed to diversify its economy while accumulating huge financial reserves
- Norway's oil fund, (Government Pension Fund Global) was created after they discovered oil in the North Sea.
    - After the discovery, the country's economy grew dramatically.
    - Then it was decided early that revenue from oil and gas should be used cautiously to shield the economy from ups and downs in oil revenue.
    - Also serves as a financial reserve and as a long-term savings plan so that both current and future generations get to benefit from their oil wealth

2. Diversify the Economy

Investment into manufacturing & industrial sectors help to build human capital through technology transfer and institutional capital (SWFs).

- Limits boom-bust cycles
- Can also allow for drawing of linkages between extractive sectors & other parts of the economy
- Allows for economies to create income that continues to operate even when EIs are gone or resources are exhausted.

Chile [Positive]

- Relies on copper for its main resource.
- Led to good results as it resulted in lower levels of economic volatility.
- Higher shares of gross fixed capital investment
- Increased developmental spending
- Diversified economy to include fishery and agriculture as its main activity as well

3. Development of National Oil Companies

NOCs can effectively compete with other foerign TNCs.

- They can reinvest earnings back into the host country to reduce the leakage of profits.

Examples: Petronas, Malaysia and Petrobras, Brazil

4. Environmental Impact Assessment

EIA to manage the impacts of extractive industries → refer to chapter 31

2.2.3 Water Resource Management

33	Water Scarcity

A. Water scarcity - variability of freshwater supply from lakes, rivers and groundwater - global patterns of freshwater usage and sources of water pollution - causes of water scarcity - strategies to manage water scarcity including conservation and desalination	

Introduction

Sustainable Development Goal 6: "Ensure availability and Sustainable management of water and sanitation for all.

Water scarcity is defined as the **lack of supply of available freshwater to meet the demands of water usage within a region.**

- Normally, there is a variability of freshwater supply from lakes, rivers and groundwater.

Water scarcity is driven by growing freshwater use and the depletion of freshwater resources.

- Worsened by climate change due to droughts and polluted water systems
- Freshwater may also be unevenly distributed dueto climatic factors and rainfall patterns globally (refer to theme 1.1.1)

Definitions of Water Scarcity

1. Physical/Absolute/Hydrological Scarcity (of freshwater supply):

This can arise due to an inadequate natural water supply to mean a region's demand.

- Caused by climate type (Bwh/Bsh)/rainshadow effect/cool ocean currents like the Humboldt current or continentality

2. Relative/Socio-economic Scarcity (of freshwater supply):

This is relative and can arise due to poor management of the sufficiently available water resources.

- There is a lack of infrastructure, competition with other uses like from industry
- Many countries often have enough to meet household/industry needs but they lack the means to provide it in an accessible and affordable manner.
- Especially in Sub-Saharan Africa where some countries may be physically near a water source but lack the technological or infrastructural capacity to produce potable water.

Causes of Water Scarcity

1. Agriculture - 70%

Due to demand for food with a high ecological footprint like quality meat from farms → there is a requirement for agricultural intensification → high levels of freshwater withdrawal is needed as this activity is highly water intensive.

- Leads to pollution as crop production normally involves the use of pesticides or chemical fertilisers
    - When it rains, the chemicals + animal waste from farms and the associated pathogens would be washed into waterways in the process of overland flow, infiltration and percolation.

Nitrogen Water Pollution, China

- In China, agriculture is responsible for a large scale of surface-water pollution and is responsible for a large part of groundwater pollution by nitrogen in nitrate fertilisers.

2. Dam Construction

Dams serve as a means to deliver water to agriculture and power to rural/urban households. They also can be used to mitigate floods.

- They are also concerns for downstream countries as dams or diversion canals can **reduce the quantity of water reaching them**, affecting ecosystems along the way as well.
- More elaboration in chapter 34

Example: Mekong & Nile Basin

3. Industry - 19%

The industrial waste generated from manufacturing and industrial processes can also pollute and have negative impacts on the environment.

- In developing countries, these industries do not have proper waste management systems
- Discharge wastewater locally without treatment.

Industry Pollution, India

- 70% of surface water resources and a growing percentage of groundwater were contaminated by biological, toxic, organic and inorganic pollutants.

4. Population Growth and Urbanisation

Population growth leads to an increase in demands for water, especially in slum areas.

- This results in economic scarcity as people have no money to pay for water, there is a neglect for urban development of water infrastructure.

Urbanisation also increases the area of impermeable surfaces → decreases infiltration capacity → increase infiltration excess flow

- runoff carries more sediment into river, decreasing water quality
- Lesser water storage in the zone of aeration or soil water storage → decreases water table height

Kibera Slum*, Nairobi, Kenya*

- Slums in the city have to result in using the heavily polluted streams nearby if they cannot afford water provided by the Nairobi City Commission.
- Kibera Slum is next to the Ngong River

Strategies to Manage Water Scarcity

1. Desalination

Desalination allows for the generation of quality freshwater from saltwater by removing salt from seawater, in processes like **reverse osmosis using membranes.**

Advantages	Disadvantages
Desalination for seawater and brackish water is increasingly becoming affordable due to technology. - Provides drinking water / industrial supply for countries that are water-stressed - New tech aims to decrease energy use and increase efficiency **Example: Singapore** - Uses desalination to meet up to 30% of water demand - USes new electro-deionisation technology which uses a magnetic field to remove salt from water, halving the energy needed.	Brine dumping may have issues which affect ecosystems around as salt is left as a waste product of this process - Brine can settle to the bottom of oceans and lower O_2 levels. - Suffocates organisms **Example: Mediterranean Sea / Arabian Gulf** - Red and Mediterranean Seas are becoming saltier due to consistent desalination activity around it. - Arabian gulf lacks strong current to disperse the brine and is now 25% saltier than sea water

2. Conservation

Involves the care and protection of water resources to minimise loss or waste of water, making sure that the use of it is efficient and effective.

- Involves the principle of equity, efficiency and sustainability
    - Lends itself to be one of the strategies that embody the spirit of integrated water resource management.
- Encourages the employment of **behavioral changes** and the employment of **more efficient systems.**

Efficient Systems

- Like agricultural sectors → irrigation systems are extremely ineffective especially in LDCs → they can adopt **drip irrigation systems that have an efficiency of 95%** where water is dripped into root zones, minimising water loss.
- Farmers can also use techniques like contour ploughing to control erosion, allowing for more infiltration and adding to soil moisture.

Encourage Behavioral Changes

- Campaigns by governments for locals
- Public Utilities Board (PUB) in singapore → “make every drop count” campaign in 2019, having roadshows...

Advantages	Disadvantages
- Potentially effective for countries at low levels of development as the sector of economy is largest in its agriculture - Each country can customise practices to suit their own contexts. **Example: India, "Per Drop More Crop"** - Farmland can now adopt irrigation systems that are more efficient like drip irrigation - Loans available to curb initial costs for farmers.	- Requires governmental competence - Some countries may not have the people with enough skill or expertise to operate and use these practices. **Example: Drip System, United States** - Expensive at $1000 per acre of land - Furthermore water in US is subsidised by countries like US - Making it less appealing for users to want to use a more efficient system.

Smart Water Metering in Cape Town, South Africa
- Cape Town, South Africa, used smart metering technology to combat the ongoing water crisis plaguing the city.
- Smart meters track water usage for customers and relay that data to their accounts.
- Cape Town citizens then get a daily bill that shows their water consumption.
- Reduces the time lag between the water bill and the time where water is excessively used.
- After the smart metering pilot project launched, residential homes realized a 40 to 60 percent drop in water consumption.

3. Wastewater Recycling

In areas with *limited water supplies* → by operating facilities that **break down waste in wastewater**, the reclaimed wastewater can be used for applications like using as a coolant in industrial processes, firefighting etc.

- Sometimes using ultraviolet disinfection techniques can produce water that is drinkable → NEWater in Singapore

Advantages	Disadvantages
- Can be a good alternative for water scarce countries like places with a Bsh or Bwh climate - Good as wastewater increases with higher populations **Example: Windhoek, Namibia [BSh]** - No freshwater resources - City introduced a domestic wastewater reclamation scheme in 1968 which succeeded in providing for industry and people	- Some countries may not have the proper sewerage systems to put this in place - Expansive to do **Example: Windhoek, Namibia** - People have bad perceptions about the water for drinking as the water is from the sewers - Social context need to be considered.

34 Managing Transboundary Sources of Water Supply

A. Managing transboundary sources of water supply - understanding sources of water supply as common property - factors contributing to conflict as a result of competition over water supply - international water agreements and other strategies to manage transboundary sources of water supply and associated conflicts	

Introduction

Water catchments can span across territories, so it is crucial to consider the various rights of individual political bodies.

The transboundary nature of resources requires the management committees to **consider the long term needs & pressures faced by different political bodies** & **balance them** with the rights of both upstream and downstream states.

Water as a Common Property

One main view of water is that it is a common property resource.

- As such it is managed by a community/society rather than individuals
- Water is a good that is **non excludable** and also **subtractable,** so resources may be depleted.
- Water resources are open access available for everyone → as such it is unlikely to elicit investment for maintenance or protection.

This has led to the phenomena of the "Tragedy of the Commons"

- Non excludable resources unowned by any single person can be exploited with no one to hold responsible for its depletion.
- As such, it is important to balance the long term protection and conservation with resource utilisation.

Factors Contributing to Conflict Over Water Supply

There are 3 main issues that may cause conflict, however do note that they are also **indirectly exacerbated by pressure on supply due to population growth, economic development and pollution**.

- Access to water and its allocation and use are becoming increasingly contested which can have **effects on conflict and social stability.**

1. **Quantity**

The quality of water flows is crucial as potential for tensions over allocation increases when the resource is scarce.

- still highly contested over users like in agriculture and industry.

This quantity of water issue is also made more extreme due to climate change as monsoons like the South Asia Monsoon is increasingly getting **unreliable in terms of when it occurs and the distribution of rainfall** due to the enhanced greenhouse effect leading to global warming.

- Increased frequency of & intensity of droughts (desertification) which may set the stage for more water stressed countries to have potential conflict with issues of physical & economic water scarcity.

Cauvery River, India

- There was a lack of allocation of water between the downstream Tamil Nadu & upstream Karnataka where the upstream state wanted to increase irrigation, so the quantity of water downstream would be lesser.
- Both parties are heavily dependent on water quantities for agriculture, so there was fighting and violence
- This scarcity was extremified by increased drought in the area

2. **Quality**

Water of low quality may be caused by pollution from wastewater, pesticides or excessive levels of salt, nutrients or suspended solids.

- Makes water inappropriate for drinking, industry or even agriculture
- Pose threats to human health and ecosystems

As such, unclean water can be a source of dispute between those who cause it and those affected,

- Leads to social instability and environmental degradation
- Decreasing quantity of water concentrates the pollution, linked to point #1
- Increasing quantity leads to flooding which gets even more contaminated from the overflowing stage

3. **(Timing of) Flows**

Timing for water flow is important as the operational patterns of dams are often contested. There may be **competing needs or interests between the different users of water**.

- May range from domestic users/farmers/hydropower generators
- Affected by the timeliness of the arrival of water
- Some cases, upstream users may only release water from reservoirs in winter for hydropower generation while downstream users need water for irrigation in the summer.

Mekong River, Asia

- In recent years, China's Mekong river dams have been holding back even more water, causing massive droughts downstream in Thailand and Vietnam
- Use to have regulat flows, but now the flows in downstream states are little to non-existent
- Caused a drought between 2019-2020 which limited water for rice cultivation

Strategies to Manage Transboundary Water Supply

International conflict over water has historically been resolved even between enemies.

- As the various stakeholders like NGOs, states and International Organizations view the access to this resource as a **basic human right.**
- However, **some states undergo unilateral projects** to avoid political issues that may arise.

Usually, the time lag between the start of disputes and the final agreements between stakeholders makes problems worse.

1. Institutions

Institutional agreements, treaties and conventions can form the basis of international agreements which allow for *regional cooperation*, *information sharing* & exchange of experience and technical assistance.

- More formal in nature

Advantages	Disadvantages
- These institutions can involve a neutral third party to allow for mediation, facilitation or arbitration(some court thing idk) to occur. - Allow for balancing of competing interests - Institutions centralise the decision making process, allowing for a more holistic view about the issues - Able to set and achieve social and economic goals	- If the agreements in the institution are **too legally binding**, it is hard for states to get on board. - If the agreements are **too informal** and **non-legally binding**, states can choose to exercise discretion and progress in decisions for self interest.

Despite that, the institutions need to be more concrete with measures → enforce treaties to be effective.

Mekong River Commission [Cambodia, Laos, Vietnam, Thailand]

- This is a river sharing agreement between the above 4 countries to allow for equitable & reasonable use of water.

(Negative)

- Despite that, upstream China and Myanmar are just dialogue partners, and they choose to not join as it might decrease their freedom of developing hydropower dams along the Mekong :(
- China has caused low levels of discharge and interruptions to fish migration due to dams.

(Positive)

- Looks at sectors like fishery sustainability, hydropower and the conservation of ecosystems.
- There are rules to coordinate technological cooperation among members.

2. Cooperative Water Management

These strategies involve the working together of different stakeholders to anticipate conflict and resolve disputes → these work on **different scales**.

- Can be international by a **river basin commission** (above)

- Can be national by allowing for public participation to occur
    - Educate and allow for **people and NGOs to be involved in standard setting**
- Can be on a local level, cooperation can be done between institutions and locals
    - Allows for **marginalised groups to articulate and negotiate interests**

Advantages	Disadvantages
- Help make decisions that are more likely to be accepted by all or most stakeholders, even if a consensus cannot be reached. - Helps prevent conflict - Allows for confidence and consensus building measures like joint research and training.	- Relies greatly on third parties for funding and support, like the **World Bank**. - High costs and time constraints make consulting all stakeholders hard.

Nile Basin Initiative [DR Congo, Egypt, Burundi, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania & Uganda]

- Aims to achieve sustainable socio-economic development through equitable utilisation of and benefit from the Nile river
- Multi Stakeholder dialogues are held with people from policy making/academics/private sector/media
- Allows for knowledge exchange and cross sectoral understanding.

(Positive)

- Allows for professionals to work together and increase knowledge about the Nile River
    - Making projects that can benefit all like the mutualagreement to hydroelectric and power generation projects.
    - Power generated can be traded between countries to improve the reliability of power supply

(Negative)

- Egypt and Sudan still have historic rights to Nile waters and is unwilling to give it up

3. Integrated Water Resource Management (IWRM)

Has associated ideas of **"Economic Efficiency", "Equity" and "Environmental Sustainability".**

The IWRM promotes the coordinated development and management of water/land/related resources in a way that maximises economic and social welfare without compromising the sustainability of vital ecosystems.

- Embraces the complex interlinked nature of water with economics and the environment.
- Allows for more diverse governance structures on a local, regional and global level
- Flexible and allows for countries to design policy to fit their socio-cultural contexts

Advantages	Disadvantages
- Long term management strategy - Removes dichotomy between economic development and ecological sustainability	- Requires good knowledge about the natural resources present in the basin - Money, comprehensive monitoring and evaluation is needed to ensure good implementation - Need for skilled labour

Mekong IWRM Project

IWRM principles were applied under the Mekong River Commision

- Essential to ensure that the development of water resources
- Used to maintain environmentally sensitive ecosystems like fisheries where LDC communities would tend to rely on
- Used in the management of the Mekong Delta what is shared by Vietnam and Cambodia
- However such management is time consuming

35	Privatisation of Water Resources

A. Privatisation of water resources - considerations when assigning ownership of water resources to private or public sector - impact of privatising water resources on society and the environment	❑

Introduction

Water resources are viewed as a basic human right that should be universal
- SDG 6 aims to have access to clean water and sanitation.

Current pressures of **urban growth, agriculture, manufacturing industry and power generation** puts pressure on water resources.

Water privatisation is a process where **publicly owned/operated** water companies are **sold to private investors** or operate as **Public-Private Partnerships** (**PPP**)
- PPPs occur when the state retains the ownership of assets of water companies but the day to day management is delegated to private companies.

Water can be regarded as a commons or commodity.

Regarded as a commons	Regarded as a commodity
- Common asset for all people - All citizens can access it, maintain and conserve the resource.	- Water becomes an economic good through privatisation. - Aimed to hopefully make the water system more efficient in operation - Hopefully having lower costs and higher quality.

The World Bank's International Financial Corporation has been funding water privatisation projects by giving loans & financing to private investors like Aegea, in Brazil, to improve the infrastructure there.

The water privatisation debate is thus a miniature representation **of the contemporary debate of the role of states vs markets** and **over the acceptability and efficacy of markets/private ownership** as **solutions to the world's environmental crises.**

Arguments FOR Water Privatisation

1. **Some governments may be inefficient** *(why government bad)*

Some governments have little ability to maintain/develop the infrastructure of the country as water reservoirs, treatment facilities, pipelines and sewage is **expensive to maintain**.

- Governments are non-corporate entities and tend to **lack expertise**
- Water sector tends to be **underinvested** due to a **lack of fiscal spending**, resulting in **declining service provision standards**.
- This state failure is seen in **rapidly urbanising LDCs** like Mexico City, Mexico and Manila, Philippines.

The involvement of the private sector can also facilitate broader reforms in the allocation of resources → helps in **alleviating economic scarcity of water**.

2. **Private companies are more economical and efficient** *(why corporation good)*

Some corporations can provide water more efficiently as they have the **capital and expertise to fix and improve on the issues** when they crop up. → these may be TNCs that **engage in R&D.**
Some supporters argue for the concept of **Free Market Environmentalism**.

- **markets are employed as allocation mechanisms for water,** which can be a solution for these environmental problems as:
    - By using tools like **incorporating environmental externalities** through **pricing**, goods like water can be more **efficiently allocated**
    - Prevents **inefficient use of resources** and waste
    - **Lessens degradation** of environment
- Argued as a **long term** move to **sustainability** as customers pay the full price of water.

HOWEVER: Some argue that this is just for **profits** sake → involvement of TNC may not guarantee a better environmental quality as TNCs may engage in **cost-cutting measures** that may be detrimental for the environment.

Manila Water [East Manila, Philippines]

- Manila had issues with its infrastructure which caused pipe leakages, causing 60% of water to be lost, and a lack of access to water for households.
- Manila water increased the accessibility of water from 49% in 1997 to 94% in 2013 in East Manilla

Arguments AGAINST Water Privatisation

As a public good/ "commons", water cannot be just valued economically and be defined as a commodity as there are moral and technical considerations too.
Water is essential for life and human dignity → it is unethical to profit from water.

1. **Loss of Control** / Lack of Equitable Allocation

Water is a basic human need that is essential for **socio-economic development**.
Equity refers to fairness in outcomes where special attention is paid to people who previously did not have access to it.

- TNCs are **only accountable to their shareholders**, not the populations they serve as they are **profit driven and footloose**.
- TNCs unlike governments **cannot be "voted out of office"** unlike democratic governments if they fail in their services.

These TNCs also tend to cherry pick areas:

- Rural/outlying areas are' ignored as they are small scale, have low population densities and may not pay their fees on time → leads to low profit
- These TNCs focus their operations on large urban centres/ wealthier areas with affluent people where profits are higher.
- As such, the **needs of the urban poor cannot be met** as water privatisation cannot solve water scarcity.

2. **Affordability Issues**

The company providing water can act as a **natural monopoly**:

- 1 company can supply the entire market's demand at lower cost than 2 or more firms can.
- Results in a lack of competition.
- Can lead to regular price increases to increase profit
- Links to problems with social inequality as there is "accumulation by dispossession", as stated by David Harvey
    - States that the **for-profit nature disadvantages the lower income countries/marginalises poorer communities.**

***Veolia* Water in Nagpur and Delhi, India**

- This city signed a contract with Veolia water.
    - Several dubious financial transactions have been exposed
- Leg to "unforeseen delays" which drove up proves manifold with unfair water distribution.
- Led to a lot of fighting :(

3. **Government can be effective in water conservation**

Water conservation can help to **prevent pollution & excessive groundwater extraction** which threatens water supplies to allow for **long term water sustainability**.

- Government has the power to enact measures like build reservoirs, employ a water conservation tax. (singapore)
- Furthermore, as compared to TNCs, the **governments tend to have more protection and better policy design** for the environmental implications.
- Certain TNCs sell **bottled water** which have had implications on the environment.

Nestle [Nigeria, Brazil, America]

- Nestle dried up local underground springs to bottle its water.
- Caused local water table to shrink and locals unable to buy the bottled water stolen from the spring
- As such they go drink the nasty contaminated water
- Done in Nigeria where 1 bottle water costs more than the average daily income of a citizen >:(
- Furthermore the plastic bottle has environmental impacts too (blah blah blah smoke...)
- Called out by watchdog Corporate Watch which exposed some unethical and illegal practices that nestle been doing all over the world.

3.1.1 Sustainable Development: Our Common Future?

These two chapters are SUPER fluffy and honestly, this is one of the hardest ones to write for aka im bad at this.

36	Sustainable Development & Its Key Tenets

A. Definition of sustainable development according to 'Our Common Future' and its key tenets:

- the concept of 'needs', in particular the essential needs of the world's poor
- the idea of 'limitations' imposed by the current level of technology and how society is organised on the environment's ability to meet present and future needs
- sustainable development involves maximising the goals across three interdependent dimensions (economic, social and environmental), and yet may involve trade-offs

❑

Definition of SD and Introduction

Sustainable Development is defined **as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.**

- Definition established by UN in 1984 to identify long term environmental strategies for the international community.
- Published in 1987 under "Our Common Future" by the World Commission on Environment and Development.

There were observations that there are still issues of uneven development, poverty and population growth that put pressure on earth's resources. This is especially in LDCs which lead to a waste of opportunity and resources.

- Inequality is the planets main "environmental" and developmental problem.
    - There is a resource gap between DCs and LDCs which is widening.
    - DCs also dominate rulemaking of some key international bodies like the IMF and WB *(link to World Bank & IMF chapter)*
    - Furthermore, DCs also have used up a lot of the planet's ecological capital. This degradation leads to conflict and unrest on various scales. *(link to transboundary conflict on water)*

As such, attempts to sustainability cannot be viewed as solely at an environmental standpoint.

Concept of Needs

Development must be sustainable to meet the essential needs of the present and future generations. These needs, **especially of the world's poor** include:

1. **Jobs [SDG 8: Decent Work and Economic Growth]**

Jobs offer employment.

- The pace and pattern of economic development must **generate sustainable work** opportunities which have a level of productivity to **enable poor households to meet the minimum consumption standards.**

2. **Food [SDG 2: Zero Hunger]**

Food to feed people and **tackle undernourishment**.

3. **Energy [SDG 7: Affordable & Clean Energy]**

Energy consumption patterns must change.

- There is a need to change, especially in LDCs, the use of certain fuels like **wood/coal** which is not as energy efficient and very environmentally damaging.
- Corrective action must occur to **preserve ecological base.**

4. **Housing, Water Supply, Sanitation, Healthcare [SDG 6 & 3: Clean Water & Sanitation / Good Health & Wellbeing]**

Deficiencies in these areas normally show signs of environmental stress.

- Especially in LDCs, where diseases like malaria, cholera and typhoid are widespread.
- **Population growth + high rates of rural-urban migration makes problems worse**
- Urban planners need to rely on supporting community initiatives and self-help efforts by locals by using **low-cost technology.**

Key Tenets of SD + Dimensions

Sustainable development aims to **maximise the goals across the 3 interdependent dimensions which sometimes may include trade-offs.** These 3 dimensions include the social, economic and environmental goals of SD.

The key tenets include:

1. **Safeguarding long-term ecological sustainability**

If human needs are to be met on a sustainable basis, the Earth's natural base must be conserved.

- Human development tends to damage ecosystems, leading to loss of plant and animal species
- This limits the options of future generations

Furthermore, conservation should not be due to developmental goals but it is also a moral obligation to other living beings and future generations. *(link to ecocentric views)*

Links can be made to EIAs and requires some form of governance by either the state (protected areas) or by TNCs (Extractives) or by NGOs (WWF forest certification)

2. **Satisfying basic human needs**

This is usually the core of development but it does not only refer to only basic necessities as people are entitled to aspire for more like for a better life.

- Living standards that provide for more than basic needs can be sustainable but only if such living standards assure long term ecological sustainability.

3. **Promoting inter- and intra-generational equity**

Policies for development must pay attention to considerations like changes in **access to resources** and in the **distribution of costs and burdens**.

- Policies in place must have ideas of social equity which in turn allow for the future generations to meet their own needs by conserving stock/non-renewable resources.

- Within each generation, there is a disparity in the level of resources available to the world's rich and the world's poor to meet their needs due to the disparity in their financial resources as technology allows for more modes of resource exploitation.

Limitations

Imposed by the current level of technology

- There are no limits in terms of growth in population or resource use → results in ecological disaster.
    - However, there are limits in the amount of resources, the land and materials that we have.
    - In the long run, this results in **rising costs and diminishing returns** rather than a sudden depletion of the resource base.
- Carryingcapacity of the environment is only so limited and cannot be improved infinitely → link to the limitation of Boserup's theory
    - Technological advancements are the mainspring of economic growth but they also cause pollution.
    - New tech can potentially slow the rapid consumption of finite resources.
- Development of knowledge and technology can improve carrying capacity of land, but there must be equitable access to resources (link to Harvey).
    - direction of technological developments may solve some immediate problems but lead to even greater ones
    - Possibilities of economic reform towards a 'green economy', with investment in innovation into alternative energy, application of principles of circular metabolism and proper valuation of goods and services to factor in environmental and social costs.
- The world is increasingly economically and ecologically interdependent.

Industries that are most heavily reliant on environmental resources and most heavily polluting are growing most rapidly in **LDCs which have the most urgency for growth and less capacity to minimize damaging side effects.**

This can be linked to Alternative Energy in trying to attain SD: **Hydropower**

- Hydropower may be good in its low emissions
- But the building of Dams can deplete the sediment load of the river, as it did in the Mekong River which changed the sediment regime of the river and flows of the river.
    - Led to an improved hydraulic radius, increased channel velocity and more stream energy.
    - Higher rates of erosion of downstream agricultural lands.

Imposed by how society is organised

- Current capitalistic definitions of economic valuation is based on financial output and **does not necessarily factor in environmental costs and services.**
- The present model of development is also based on a **linear metabolism of resource extraction and consumption**.
- An increase in population can increase the pressure on resources and slow down development in areas where deprivation and poverty is widespread.

- More importantly, the **equitable distribution of resources** is key as sustainable development can only be pursued as some parts of society can be more marginalised by ill considered development.

37	Challenges Attaining Sustainable Development

A. The political and economic challenges in attaining sustainable development over space and time as exemplified through the following two international conferences: - Rio de Janeiro 1992 – UN Conference on Environment and Development (a.k.a. Rio Earth Summit) - Rio de Janeiro 2012 – UN Conference on Sustainable Development (a.k.a. Rio+20)	

Introduction

The quest for attaining SD over space and time can be exemplified by the **UN 1992 Rio de Janerio (Rio Earth Summit)** and the **2012 Rio+20 summit**.

This also exemplified the fact that difference in perspectives in the dominant economic worldview vs views of deep ecology can greatly influence the understanding and implementation of SD.

Importance of International Cooperation

There are **multiple stakeholders** involved in attaining SD, where international financial institutions, private business investors/TNCs, NGOs and civilian groups may be involved.

- Due to various environmental problems caused by their **decisions** and **behaviors** at local, redional, national and global scales.
- Impacts are due to the **different values and interests surrounding environmental resources and functions.**

This gives concepts of environmental governance → captures the multiscalar nature of environmental problems.

This gave rise to **Multilateral Environmental Agreements (MEAs)**

- MEAs are treaties that bind international behavior towards collective objectives that cannot be achieved by nations acting alone.
    - Countries confirm cooperation through signing MEas
    - Important for transboundary problems (link to transboundary water resource management)
    - Effectiveness depends on state being willing to devolve some soverign power to the created institution.
    - Refer to example about Kyoto Protocol under UNFCCC/

Despite that, MEAs can facilitate new partnerships between governments and businesses.

- Helps to use the role of private sector organisations and market mechanisms 'to deliver environmental improvements.
- By using "**hybrid governance strategies**" → recognise **strengths and weaknesses of particular organisations**.
- Combine strengths to achieve SD through legislation (state), market incentives (TNCs) and self regulation.

Example: Reducing Emissions from Deforestation and Environmental Degradation(REDD$^+$)

- Provides powerful economic incentive to discourage deforestation by countries/companies/communities/individuals through DC → LDC fund transfer
- Addresses the economic aspect but does not address other underlying drivers like reducing demand for timber or how they can help locals shift to a low carbon economy.

Differing Priorities of Developed and Developing Countries

The idea of SD was first identified in 1980 to overcome **2 fundamental conflicts.**

1. There seems to be an **incompatibility between a healthy environment and economic growth** needed for development.
2. There is **continual inequality** between the rich north and the impoverished south.

DC was increasingly **concerned about the state of the environment**.
LDCs were focused to **achieve continual economic growth**.

- Led to LDCs finding DCs hypocritical as there was already damage done to the environment that was an unintended consequence of the DCs development.
- This environmental agenda may be a tool to stifle LDC growth.

Rio Earth Summit / 1992 UN Conference on Environment and Development

Held in Rio de Janeiro where for the first time, the heads of states gathered to consider the environment.

Aim: Identify key principles of an **agenda for action towards SD** in the future.

Principles of the summit

Principle 2: "Countries have the right to exploit their own natural resources"

- Defends notions of sovereignty, important for LDCs to lift them out of poverty.

Principle 3: "The right to development must be fulfilled so as to **equitably meet the development and environmental needs of present and future generations**."

Outcomes: Agenda 21, a comprehensive programme of action for SD.

AGENDA 21

- Deals with problems like overconsumption, health, poverty and education.
- Promotes roles for all, governments, TNCs, scientists, indigenous people and citizens have **roles in SD and should participate in the decision making process.**
- Encourages **reduction of environmentally & socially detrimental processes** but within a framework that allows for economic success.
- Encourages **NGO involvement.**
    - For SD to work, issues must be tackled on all scales → respect interests of all.

Political Challenges	Economic Challenges
Political motives obstruct the inclusion of SD principles - OPEC opposed mentions of fuel efficiency and alternative energy. - TNCs were portrayed favourably - Diplomatic compromise to maintain **friendly relationships between states were prioritised over feasible policy**	For LDC: - Suggested strategies require **large amounts of funding to support infrastructure development.** - EIA may add even more **red tape** to the process of project management. - There is a conflict of goals between poverty eradication and environmental conservation. DC: DCs may face structural unemployment for areas focused on fossil fuels if there is a switch to alternative energy.

UN Framework Convention on Climate Change (UNFCCC)

Objective to **stabilise greenhouse gasses** at a level that would prevent dangerous interference with the climate system.

- Led to the Kyoto Protocol which set forth **binding commitments towards emission reductions.**

Political Challenges	Economic Challenges
- UNFCCC is largely an **inefficient system as it is governed by consensus** by > 190 countries. - Each country promoted their own agenda - **Kyoto Protocol used carbon emission trading to allow countries with excess carbon credit to put it on the market to trade** - **US did not sign** - 2017 paris accord was better with 90% sign up rate	- Reluctance by governments to sacrifice economic development for environmental outcomes. - Canada withdrew from Kyoto Protocol to not force its citizens to pay penalties which cause wealth transfers out of Canada. - Richer countries with more technology and financial capabilities found it **easier to meet the targets** that were similar to LDCs. - But LDCs have no money, no skilled labour and no tech.

Rio+20 / 2012 UN Conference on Sustainable Development

Aim:

- secure renewed political commitment for SD
- Access progress on outcomes of previous summits
- Address new and emerging challenges for the global community

The Rio+20 focused on the challenges of moving to a "green economy"

Outcomes: Created a document called "The Future We Want"

- Negotiation by 193 UN member states with engagement of civil society
- Gave descriptions of a **green economy** in context of SD and poverty eradication.

GREEN ECONOMY

A green economy is referred to as a system that can **improve human well being** and **social equity** while significantly **reducing environmental risk and ecological scarcities**.

- Can be through activities like decoupling of natural resources with economic growth
- Decarbonising energy and transport
- Phasing out environmentally harmful subsidies/greening of tax systems

However there were differing concerns for LDCs and DCs

LDC Concerns:

- LDCs have a **different structure of economy**, so it is more economically challenging for LDCs to **transit** from labour & material intensive economy → less materially intensive one without much aid of technology
- The green economy should not result in trade barriers
- LDCs did not want to accept proposals as they **impose an external timeline that limits economic growth.**

Political Challenges	Economic Challenges

- India and China opposed socio economic cost integration and financialisation of resources in fears that it would cause the concentration of financial resources in developed countries
- LDCs feel that this is an agenda for a **new wave of green protection by DCs**
  - DCs can **block foreign trade imports on ecological grounds**
- LDC leaders often are corrupt
- Traditional standards and regulatory bodies recognise DCs as standard setters and LDCs as standard takers.
	- Financially difficult as it **requires additional public expenditure** for transition to a green economy to fund all sectors like **forestry, agriculture and more.**
	  - DCs are unable to provide such funding
	- Integration of social and economic costs are undesirable as they increase the cost of goods relative to other countries.
	  - Decrease competitiveness
	  - Decrease domestic consumption for these goods.

DC Concerns:

- Relatively more **supportive of the shift to a green economy**

Political Challenges	Economic Challenges

- Requires **high political will & commitment.**
- There are questions on the definition of green economy.
  - Should it be up for each country to interpret or should they subscribe to a top-down definition
	- **Binding climate targets** may result in **economic growth being sacrificed**.
	  - Includes needing to deal with problems with waste management and air quality.
	- Issues with **intellectual property rights.**
	  - Struggle to make tech cost competitive or prevent cheap imitations from being invented.

3.1.2 Climate Change and Sustainable Development

38	The Science of Climate Change

A. The science of climate change - evidence of climate change since the last ice age - atmospheric processes that result in the enhanced greenhouse effect - relative significance of anthropogenic activities in climate change	❑

Introduction

Climate change is the change in state of the climate **that can be identified and persists for an extended period**, typically decades or longer.

Changes in climate in Earth's history can be outlined in the 2 epoches in the Quarternary.

- The **Pleistocene** and **Holocene** epochs showed that the earth's climate shifted from a period of general stability to a period of instability.
- Natural climate change due to **Milankovitch orbital forcings + feedback mechanisms**
- This may also be due to human activities that have many uncertainties regarding the complexities of climate change as human activity is unprecedented

Linked to the **Anthropocene** → current geological age viewed as the period during where human activity has been the dominant influence on climate and environment.

Evidence of Climate Change since the Last Ice Age

Many natural systems are affected by climate. As such, they provide evidence on the conditions in past climates.

Scientists can take records left by many natural data and combine them to get an overall picture of the global climate.

- CC during the quarternary allows us to place present-day CC in a longer-term context.
- Historically, CC takes thousands of years to take place, so current CC cannot be understood in the same light.

1. Pollen/Palynology

Pollen grains contain the male reproductive cells of seed plants.

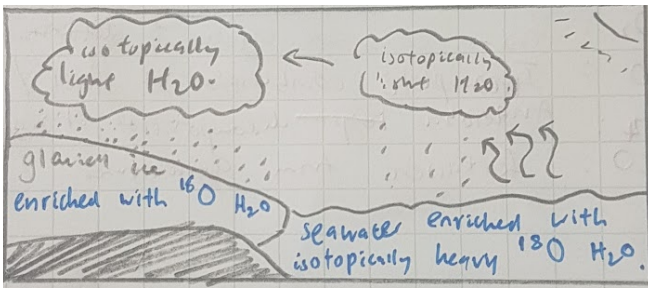
- They have own unique shape depending on parent plant
- Walls of the pollen grain is lined with ***sporopollenin*** which is chemically inert and acts as strong walls.
- When pollen grains are washed or blown into bodies of water → **tough outer walls** allow them to be **preserved in sediment layers** ;n the **bottom of ponds, lakes or oceans.**

Scientists can then take a core sample of the sediment layers and determine the kind of plants growing at the time → tells us the climate by using knowledge about modern & historical distribution of plants in relation to climate.

- Scientists can also compare the changes in vegetation and its trends to investigate how we are impacting the environment.

2. Ice Cores

a. Isotopic Records (^{16}O / ^{18}O)



Snow at higher elevations that accumulate from snowfall is compressed as ice. This forms ice sheets where an ice core, a cylindrical tube can be extracted out of using a drill.

- Chemical composition of ^{16}O and ^{18}O in the water can be used to **infer the temperature of an area.**
- **Lower concentration** of ^{18}O tells us that an area has a **colder** climate
- The gas trapped in bubbles shows the **atmospheric composition** at the time.

b. Texture of Ice

During summer → 24 hours of sunlight results in a **different texture** of ice built up in winter, where there was 24 hours of night time.

- This forms **distinctive layers**

Therefore, the isotopic records and the texture of ice tells us info about the climate in each year.

3. Tree Rings

Climate influences the tree growth and patterns in the **ring widths, cell densities and isotopic compositions**.

- Trees grow average 1 ring a year → some trees grow for hundreds and thousands of years, so they can provide some data.
- Scientists can core the tree.

If a tree is dependent on **temperature**:

- **Narrow** rings are produced during **cold** periods
- **Wider** rings are produced during **warmer** periods

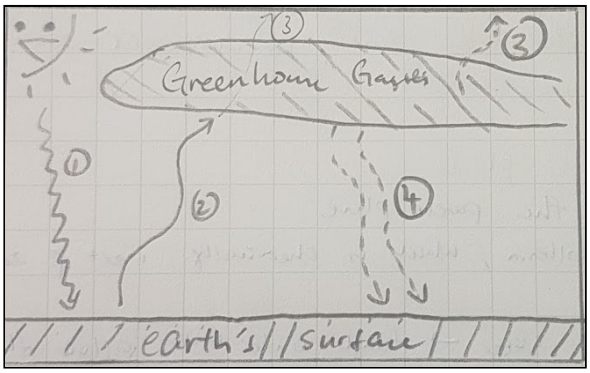
Iff a tree is dependent on **precipitation:**

- **Narrow** during the **dry** season
- **Wider** during the **wet** season.

By examining the trees from all over the globe → can see the global picture of past climates.

Atmospheric Processes that Results in the Greenhouse Effect

The **Greenhouse Effect**



1. CO_2, H_2O and other gasses allow for the shortwave radiation(SWR) from the sun to reach the earth unimpeded.
2. SWR from the sun is absorbed by the earth's surface and is emitted back up as longwave radiation(LWR).
3. Greenhouse gasses like CO_2, H_2O, CH_4, N_2O absorb this LWR and only 9% gets lost to space.
4. Some greenhouse gasses reradiate the LWR to space and some back to earth's surface, causing the surface atmospheric temperatures.

Enhanced Greenhouse Effect

Human activity has increased the concentration of CO_2 in the air, by 280 ppm → 400 ppm after the industrial era.

- Small increases in concentration of CO_2 has a large effect on the atmospheric system, while the natural processes that remove it taking place more slowly than the increase.
- Anthropogenic action intensifies the greenhouse effect by increasing the concentration of atmospheric greenhouse gasses which trap even more heat, causing the earth's surface temperatures to increase even more.

Rapid CC has been observed in recent decades that may also be due to land cover change and change in land use.

Examples of Greenhouse Gasses

CO_2 → from the carbon cycle, **deforestation/ burning of fossil fuels**
CO → **incomplete combustion of fuel/deforestation**
CH_4 → **anaerobic decomposition of organic matter/cattle ranching/solid waste/fuel**
N_2O → fertilisers from agriculture

39	Possible Effects of Climate Change on Sustainable Development

A. Possible effects of climate change on sustainable development	.

Introduction

Changes in climate affect human and natural systems on all continents and oceans.

- Indicates the sensitivity of the natural and human systems to a changing climate
- Scientists have used climate models to predict and gain insight on the nature of climate conditions in the future
- These models use the first principles of thermodynamics and fluid mechanics to predict, like the Atmosphere-Ocean General Circulation Models (AOGCMs) which run on supercomputers

*Note that there are arguments over how these impacts may only be predictions and so it may not be entirely true.

Impacts of Climate Change

The impacts of Climate Change tend to be uneven geographically and socially.

1. **Increased Frequency of Extreme Weather Events**

With climate change, the frequency & intensity of extreme weather events and hazards like heat waves, cyclones, droughts and floods would be altered.

- The El Niño is predicted to increase in frequency and be more extreme as this may lead to intensifying droughts in Australia and worsening floods in the eastern Pacific.
    - + shifting hurricane patterns

Impacts include alteration of ecosystems, disruption of food supply, drought intensity, water scarcity for arid climates, damage to infrastructure and death.

- Uneven impacts as certain coastal regions are more susceptible.
- Increase in mortality and economic losses → **affect development rates especially in poorer regions which cannot cope financially.**
- These events can set countries back by years
- Rehabilitation can further worsen the situation for **debt ridden governments**
- Challenge for SD as poor countries will struggle to survive natural disasters & will not be in position to resolve other pressing issues like poverty and hunger.

Cyclone Fani, Bangladesh and India, 2019

- Developed over sea temperatures of 31˚C
- In india, it flooded 36 villages and 2000 homes
- Cost US$8.1 billion in damage

2. Sea Level Rise

Due to the thermal expansion of the oceans as a result of rising atmospheric temperatures and an additional input of melting ice → sea level rise

- Puts a large proportion of people at risk', especially in countries that are low lying like Jakarta
- Especially dangerous for Small Island Developing States (SIDS) like Maldives and Fiji.

This melting of sea ice can also disrupt ocean circulations as an **addition of freshwater from ice sheets can slow down the regulation of temperature**.

- Affects the thermohaline circulation(chapter 5)

This also causes **saline intrusion of seawater into groundwater**, which has implications for water scarcity.

Jakarta, Indonesia

- Sea level rise is one of the factors causing them to relocate the country's capital to Kalimanta
- Island is also sinking due to excessive aquifer drainage
- Low lying land
- 40% of Jakarta is below sea level

3. Crop Yield

As climate belts shift, the patterns of agricultural land use is also affected.

- Climate shifts affect the suitability of certain crop growth in certain regions.
- Also affects hazards like pests and diseases
- Increased heat stress and droughts lead to consequences on food production
- **Poorest and most vulnerable may have reduced access to food.**
- **Adaptive measures like high yielding varieties may not be accessible by LDCs**

Positive Impacts	Negative Impacts
- Crop yield increases due to **fewer frosts** and so less damage to harvests - The average crop yield in certain regions like Australia has increased by 50000 kg/km^2 since 1952	Larger swarms of hungrier insects - Temperature increase → **Insect metabolism rises** → more reproduction → eat more crop Models state that for every 1˚C rise in temperature, insects consume 2.5% more rice/wheat/cereal.

4. Shifts in Ecosystems and Species Extinctions

As temperature increases → atmospheric capacity for air to hold water increases → there is strengthening of precipitation patterns → "wet gets wetter, dry gets drier" phenomena occurs as heavy precipitation in wet regions are balanced by evaporation in arid regions.

- Increasing temperatures cause climate zones to shift
- Different species of plants and animals are to adapt and migrate differently to climate change.

Climate Change's Effects on Migration

- Numerous bird species migrate earlier → cause timing of blooming vegetation and emergence of insects to be out of sync with the passage of migratory birds
- Negative consequences for the health of these birds
- Could cause sensitive ecosystems to collapse.

A warmer climate facilitates the growth of Dothistroma, a needle blight that causes defoliation and death of trees in forests

Unevenness of Impacts

- LDCs have **economic dependence on climate sensitive primary sectors like Fishery and Agriculture**
    - Small farmers → livelihoods and main source of income are threatened
- These LDCs may have more limited **institutional & financial capacity** to **anticipate and respond to the impacts of climate change**

40	Responses to Mitigate and Adapt to Climate Change

A. Responses to mitigate and adapt to climate change	.

Adaptation Measures

Adaptation measures are aimed to **adjust to actual or expected climate and its effects, moderating its harm or exploit its beneficial opportunities.**

- Saves money and lives in the long term
- Increases resilience to recover from hazards
- Can occur by government initiatives for implementing new technology
- **Especially crucial for small island developing states like the Maldives**

Maldives [SIDS]
- Maldives is about 1.5 meters above sea level.

1. New Crop Varieties/High Yielding Varieties

Climate change brings more extreme weather like more droughts or heat waves.
- Damages crop and food supply
- Currently there is already the use of more stress tolerant crop varieties

New Rice for Africa, African Region [LDC]
- The cultivar/plant variety of specific hybrid rice developed by the African Rice Center is aimed to help in decreasing poverty levels by:
  - Increasing production of crop → increase income of farmers
- The new cultivar has increased **yield** (x2.5), more **protein** (2% more) and can resist insects and pests more.
- Started in Uganda

2. Coastal Protection

To adapt to rising sea levels, sea walls can be constructed to prevent the flooding of the coast.
- There also should be government acquisition of coastal lands to prevent development and conserve natural embankments.

Flood Control, Netherlands [DC]
- ⅓ of netherlands is below sea level
- They use a complex system of drainage ditches, sea walls and pumping stations to keep their low lying areas from coastal flooding.
- These resulting dry areas are also known as Polders.
- Very expensive and complicated.

However, note that when these measures fail, GGWP.

Mississippi River, 1993 [DC]
- Due to heavy rain from the El Niño from April to July, this caused the levees adjacent to

the river to collapse, resulting in devastation of the buildings on surrounding floodplains.
- Very expensive to maintain as the delta spends $200 million in maintaining it.

Mitigation Measures

Mitigation is the human intervention to **reduce the sources**, or **enhance the sinks** of greenhouse gasses with the **aims of decreasing the rate of climate change**.

- May involve the drivers of climate change like the issues of changing land use or fossil fuel combustion

1. **Switching to Alternative Energy Sources**

Vomit everything in chapter 41 and 42

Hydropower, United States [DC]
- Hydropower generates 12% of the US's electricity.

Nuclear Power in India [LDC]
- India in 2018 has 22 nuclear reactors
- All owned by the state
- Powers 3% of the nations electricity

2. **Afforestation/Reforestation**

This enhances the carbon sinks as trees that help to aid in the process of carbon sequestration.

- This has positive impacts on indigenous people and biodiversity as well.

Congo Rainforest in Democratic Republic of Congo
- The forest ministry had a $2.5 billion dollar plan to plant 1 million hectares of trees in 10 years.

However, note that this requires good planning, money and political will.

Bilar Man-made Forest, Bohol, Philippines [LDC]
- Thousands of mahogany trees got planted in the 1960s-1970s
- Those trees were not local to the area
- As a result the area is biologically dead, RIP

3.1.3 Use of Alternative Energy Sources to Mitigate Climate Change

41	Energy Use and the Global Carbon Cycle

A. Energy use and the global carbon cycle - different methods of energy production - variations of energy mix and energy consumption over time and space - the effects of the use of fossil fuels on the global carbon cycle - alternative energy sources and their potential to mitigate climate change	

Introduction

The production of energy puts the most stress on our world's natural resource base.
The balance between various sources of energy is known as the **energy mix.** *(refer to variations over space)*

Different Methods of Energy Production

There are many ways to generate electricity, the primary one is by generators.

1. Generators

Electric generators generate electricity from kinetic energy based on Faraday's law of electromagnetic induction.

- Involves the driving of an engine/turbine → driving a magnetic field past coils of wire → turns mechanical energy into electricity
- Requires some form of driver to turn the turbine like heat, water or wind.

Turbine Types	Explanation
Steam	- Water boiled by coal combustion **(41%)** - Nuclear fission heat in reactors create steam **(15%)** - Renewable sources like biomass or solar parabolic troughs boil water by concentrating sunlight. Boil water → turns to steam → turn turbine
Natural Gas (20%)	Gasses combust → cause product gasses to turn the turbine. - Residual heat also generates steam which turns the turbine
Water (16%)	Movement of water → fallling water/rise and fall of tides/ocean thermal currents → turns turbines
Wind (2%)	Wind turns the blades of the windmill → turns rotor and shaft → Turns the generator

2. Electrochemistry

This involves the direct transfer of chemical energy into electrical energy → in batteries

- Useful for portable and mobile applications → primary cells, like the Zinc-Carbon battery
- Fuel cells can also be rechargeable

3. Photovoltaic Effect

The photovoltaic effect involves the transformation of light into electrical energy/

- Uses sunlight as source
- Solar power is expensive as there is a high cost of producing the panels
- Commonly used in remote sites where there is no access to commercial power grid
- Example from North Africa later.

Dominance of Fossil Fuels

Coal, oil and natural gas are referred to as fossil fuels

- They are non-renewable as they replenish on a timescale that is not relevant to humans
- Fossil fuels are readily accessible, highly concentrated sources of energy
- Easy to convert it into useful forms using current technology
- BUT results in high greenhouse gas emissions

A. Coal

- is relatively bulky
- Recently unable to compete with oil and natural gas

B. Oil

- Very versatile fuel
- Used in many industrial processes
- Transportable over long distances using pipelines/oil tankers/small rail
- Allowed for a petrochemical industry to develop which developed plastics and textiles
- Substituted products of other non-renewable resources like wood from timber

Advanced industrial societies are totally dependent on a continued supply of oil at a reasonable price → relates to the idea of energy security

C. Natural Gas

Natural gas has recently been an increasingly important source of energy or feedstock.

- Replaced coal and even oil
- Favoured as it is cleaner than other fossil fuels & is more reliable than AE
- But the natural gas is harder to transport as it requires substantial amounts of investment in plants and consumes large quantities of energy to convert to **liquefied natural gas (LNG)**
- CH_4 is super duper wooper strong as a greenhouse gas so pipelines need to be maintained regularly.

Variations of Energy Mix and Energy Consumption Over Time and Space

Energy mix refers to the combination of different energy courses the country uses to meet its energy consumption needs.

Over Time

1. Wood ↓ Coal ↑ [18th Century]

Before the industrial revolution, people used sources like wood, charcoal, dung peat and animal fat.

- Then, people started steel making which drove up coal consumpiton rates
- Developed coal-powered steam engines

2. Coal ↓ Oil ↑ [19th Century]

Then, the intense combustion engine caused the demand for oil to increase due to developments in jet engines and cars.

- Automobile demand increase, more tech into **refineries, pipelines and distribution facilities**
- More research into tech improvements to discovering oil
- Caused oil to be more **competitive** as a fuel

3. Oil ↓ Gas ↑ [20th Century]

Late 20th century, there was an expansion of the world industrial economy post world war II.

- Urbanisation and industry growth caused increase demand for fuels
- Increasing desire to reduce dependence on Middle East *(aka the hard mode PVP zone)* for oil
- Electricity generation with natural gas has fewer carbon emissions compared to the previous ones.

Over Space

Developed Countries:

The energy mix of industrialised countries has undergone 2 major transitions.

- **Coal to oil:** rapid increase in oil consumption due to advancements in transportation technology like the Jet Engine and a boom in the petrochemical industry.
- **Oil to gas:** reduce dependence on oil from the middle east + natural gas generates lesser greenhouse gasses
    - Currently natural gas and oil dominate

Developing Countries:

Generally a greater reliance on oil for commercial use and coal for some regions.

- Energy mix is not as diversified as DCs
- LDCs are **vulnerable to sudden periodic increases** in oil prices.
- DCs increasingly depend on LDCs for oil supplies or coal
- National Oil companies now control the most attractive oil fields to supply their own domestic oil demand.

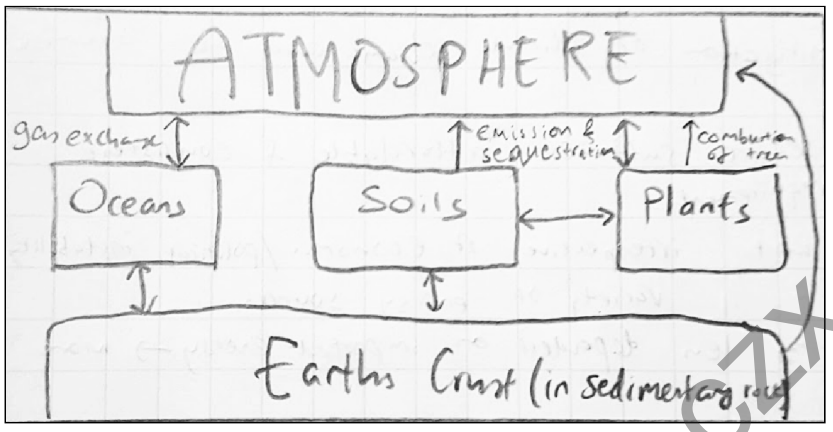
Energy Mix may be affected by:

1. Level of availability/type of resources available
2. Security of supplies
3. Level of development which relates to skilled labour availability
4. Legislation

5. Cultural preferences

Fossil Fuels and the Global Carbon Cycle

[CO_2] has risen 280 ppm to 400 ppm since the industrial revolution.[CO_2] has risen 280 ppm to 400 ppm since the industrial revolution.



The carbon cycle is a system where carbon circulates through the atmosphere, biosphere, hydrosphere and lithosphere.

1. Plants photosynthesise by plants on earth combining CO_2 and water to form plant tissues and oxygen, aiding in the process of **carbon sequestration**.
2. Decomposition of plants and animals put carbon back into the soil
3. Some carbon drops into ocean floors, **forming sedimentary rocks through processes of diagenesis**.
4. These fossil fuels would leak slowly into the atmosphere through **volcanic activity.**
5. Left undisturbed, the fast and slow carbon cycles maintain a steady concentration of CO_2 in the atmosphere, oceans and land.
6. When humans burn fossil fuels and clear land, it removes plants and releases more CO_2 into the atmosphere while decreasing the number of carbon stores.
7. These activities **pushing the carbon from a slow cycle to a fast one**
8. Causes a higher concentration of CO_2 in the atmosphere, ocean and land.

Alternative Energy

Hydroelectricity and nuclear energy has been moved to chapter 42.

1. Biomass

Biomass energy involves the burning of plants and animal residue.

- Can be carbon neutral if biomass waste is burnt
- But is expensive, some use a lot of energy to produce
- There are problems with agriculture (smoke)
- Some are not carbon neutral

Jatropha

- Jatropha is a biofuel, where the oil can be extracted from the seeds of the fruit pods.
- Can be grown on mountainous areas and rough terrain
- but when the soil quality is bad there's little seeds produced.

2. Solar Energy

Conversion of solar energy from sunlight into electricity by using photovoltaic cells.

- Sun's rays can also produce thermal energy to warm buildings
- More of a small scale solution
- **Weather dependent**

Desertec, North Africa
Company Desertec aimed to build large scale projects in north Africa in the desert regions to supply to demand in Europe

3. Geothermal Energy

Heat from the earth's crust helps to heat up water which turns to steam to turn turbines.

- Location specific
- Only viable in areas that are volcanically active

Iceland
- 25% of the nation's electricity is generated from geothermal sources
- Iceland is over a rift between 2 oceanic plates.

Indonesia also uses geothermal energy as they are in the Pacific Ring of Fire

Evaluating Potential of Alternative Energy Sources

Sustainable Development

- Economic development is strongly correlated with increasing energy use and growth of GHG, but AE can decouple that correlation
- contribute to social and economic development
- Accelerate access to energy → provides benefits to community or households, especially in rural areas
- Reduce vulnerability of places to supply disruption/market volatility when energy sources are diversified → energy security.

MicroHydro Scheme, Peru
- Bottom up development scheme
- NGO Practical Action installed 30 miniature hydroelectric dams to mountainous villages of Peru
- Delivered power to 30000 villagers
- Providing for more accessible energy for the poor

42	The Debate on Alternative Energy Sources

A. The Debate on alternative energy sources - the promises of hydropower and either nuclear energy or biofuels, including that of energy security - the environmental, social and economic issues associated with hydropower, and either nuclear energy or biofuels	❑

Introduction

Alternative energy has the potential for the mitigation of climate change and the **promise of energy security.**

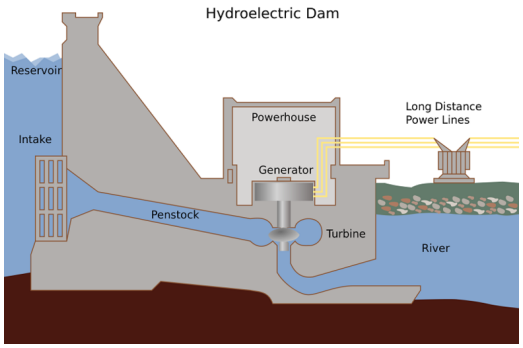
Energy security is the ability of a nation to secure sufficient, affordable & consistent energy supplies for domestic/industrial requirements.

- Allows for current and future energy needs to be **met**, irrespective of economic/political instability
- An energy secure state means having access to a variety of energy sources
- Also linked to **energy dependency**, where a country less dependent on import energy is more **secure**.
    - Done by importing from reliable and consistent suppliers(ehem not middle east)
    - diversifying imports or
    - decreasing domestic demands for energy by insulating homes and conserving electricity.

Hydropower

Dams are built and reservoirs are filled behind it.

- Directs water into the turbines when needed
- Falling water flows through the turbines, rotating them
- Converts the GPE → KE → Electricity



Hydropower Trends and Distribution

Given current economic and environmental considerations, hydroelectric power is one of the best sources of energy available.

- Hydropower is favoured in areas with large volumes of available water, wet climate or places with deep and narrow valleys

Hydropower has increased slowly but steadily all over the world.

- China and Brazil are one of the highest producers of hydroelectricity
    - China has built over 23000 dams. Dam thats alot
- Greatest potential in LDCs where **many large rivers are still unmanaged**
- In DCs, some river valleys are already committed to other uses like agriculture of nature reserves → cannot generate hydropower

Hydropower, United States [DC]
- Hydropower generates 12% of the US's electricity.

Advantages of Hydropower

1. Renewable Resource + Ecofriendly [Environmental]

With hydropower production, water is not used up.
- Compared to fossil fuels, this resource is better as a long term resource
- But climate change may alter it :(
- Hydropower is relatively clean as a source of energy that contributes small amounts of greenhouse gas emissions to the atmosphere.

2. Cheap Source of Energy [Economic]
- Upfront costs of **construction and installation of hydropower plants may be high**
- Once in action, the **maintenance costs are low.**
- Water used does not need to be transformed or purified, which would technically add to extra cost
- Not vulnerable to market shifts
- Long lifespan of 50 - 100 years.

3. Socio-Economic Advantages

This may bring secondary benefits to communities that have access to such power.
- When hydropower is introduced to remote areas that previously lacked the resource
- Promotes commerce, industry, improved infrastructure
- Allows for improved access to education and health
- Can be used as flood mitigation as well to protect downstream communities (link to river flooding)

MicroHydro Scheme, Peru
- Bottom up development scheme
- NGO Practical Action installed 30 miniature hydroelectric dams to mountainous villages of Peru
- Delivered power to 30000 villagers
- Providing for more accessible energy for the poor

Disadvantages of Hydropower

1. Upstream Implications [Environmental]
- Transformation of a free flowing river to an artificial reservoir habitat has problems
    - reservoirs can change the whole habitat and ecosystem
    - These habitats can host non native and invasive species like snails

- Sedimentation in the reservoir may occur as velocity is low → stream energy is low → Deposition
    - Deforestation makes this effect worse as land needs to be cleared for construction

2. Sediment Load Changes [Environmental]

- Sediment deposited behind dam
    - Changes regime of river
    - ↓ sediment load → better hydraulic radius → higher efficiency and channel velocity
    - More erosive flow

Erosion of the Mekong
- Dam building has caused the lower agricultural reaches of the mekong to be eroded away.

3. Ecosystem Destruction [Environmental]

- Dams can restrict flows of water which can change the quality of water flowing

Incomati River, Southern Africa
- Dam building has caused a decrease in freshwater flows
- ↑ salt levels in the river mouth at the estuary in Mozambique
- Killed salt intolerant crops and animals that the people relied on

4. DIsplacement of Communities [Social]

Large dams forced people to leave for the projects to be built.

Three Gorges Dam, China
- Displaced 1.2 million people

5. Economic Impacts [Economic]

- Dams consistently cost more and take longer to build than projected
    - Average cost overrun of dams is 56%
- Burden of uneconomic dams is shouldered by a nation's citizens
- Large dams are often the largest energy development in many poor countries, which can
    - lead to an **unbalanced and climate-risky energy supply**
    - Of the world's 40 poorest, 15 are more than 90% are hydro-dependent.
    - Numerous of these countries have suffered drought-induced blackouts and energy rationing in recentyears

Nuclear Energy

Nuclear energy is harvested by the fission process of ^{235}U or ^{239}Pu atoms which releases energy in a chain reaction. This reaction heats up water → produces steam → turns turbines → generates electricity. *(take note, the writer of this does think that nuclear is a great AE source, so my arguments tend to favour it)*

Some Oopsies with Nuclear Energy

1. **Chernobyl Nuclear Plant, Ukraine, 1986**

- Result of flawed reactor design that was operated with inadequately trained personnel.
- Resulting steam explosion and fires released at least 5% of the radioactive reactor core into the atmosphere and downwind.
- Killed 2 at first, then another 28 from radiation poisoning.
- Children who were in the immediate area were ill with leukaemia, **thyroid cancer** and other radiation-induced diseases
- 15 years after the accident, a **vast region is virtually uninhabitable**
    - 30km radius of the plant is officially closed to the public
    - Now a tourist attraction lmao

2. **Fukushima Daiichi Nuclear Plant, Japan, 2011**

- Following a major earthquake, a tsunami disable the power supply and cooling of reactors
- Radiation continues to contaminate underground water
- High levels of caesium contamination in commercially important freshwater fish
- Radiological contamination of the coastal estuaries
- Reactors were based on the old designs.

These events **caused the public to have fears over the use of nuclear power**, and these accidents caused the **decommissioning of nuclear power plants for commercial use**.

- Then, new and safer technology made the public more confident again

Nuclear Power in India

- India in 2018 has 22 nuclear reactors
- All owned by the state
- Powers 3% of the nations electricity

Advantages of Nuclear Energy

1. **Low GHG Pollution [Environmental]**
    - Nuclear power produces fewer GHG emissions than fossil fuels
    - has minimal impacts on the atmosphere due to the lack of waste gasses
        - However, Uranium is non renewable.

2. **Low Cost + Efficient [Environmental]**
    - Nuclear power produces inexpensive electricity as the cost of uranium is low
    - Start up cost is high
    - Cost of running such a plant is low
    - Nuclear energy has a higher energy density than fossil fuels
    - Creates jobs too + stimulates economic activity

3. **Reliable [Economic]**
    - Normal lifespan of a nuclear reactor is **40-60 years**

- Source of energy is not disrupted by climate conditions so countries like arid climates can also use these as a form of AE.

Disadvantages of Nuclear Energy

1. **Heat Rejection [Environmental]**
    - These thermal power plants require some means to expel heat
    - Nearby water bodies have heated water dumped into them
    - Affects aquatic life
        - Thermal changes cause different wildlife to react differently

Thermal Changes in Aquatic Systems, US Fish and Wildlife Service
- The US Fish and Wildlife Service found that heat rejection causes fish not to swim in the water which disrupts spawning activities.

2. **Pollution [Environmental]**
    - The nuclear waste from manufacturing, processing, dismantling of uranium rods are hard to dispose of as they are radioactive
    - Mining of uranium can also pollute rivers (link to Extractives)
        - Pit lakes may form from uranium mining that have high levels of selenium which impairs the reproductive ability of aquatic birds

3. **Social Stigma [Social]**
    - People fear the risk of being exposed to high levels of radiation which can lead to health issues

Chernobyl Nuclear Accident, Ukraine
- This was especially so after the Chernobyl Nuclear Plant incident which led to
- Radiation poisoning
- Increased thyroid cancer
- 30 deaths!

4. **Less Employment [Economic]**
    - Not a significant employer as compared to conventional coal or other alternative energy industries
        - 4% of France's industrial sector is in nuclear power
    - However, as prices of electricity decrease → nuclear power becomes more competitive → stimulates growth → boosts GDP → compensates for any employment effects.

3.2.1 Sustainable Urban Development and Liveability

43 Urbanisation and Cities

A. Urbanisation and cities - defining 'urban' as an entity and a quality - urbanisation at the global scale and reasons for variations - global trends and projections of urban population change	

Introduction

Urbanisation refers to the continuous process of transformation where an increasing proportion of the rural population of a country live in urban built up areas.

This results in a shift from a more agrarian economy to a more metropolitan, market based economy.

- Occurs when rural-urban migration is greater than urban-rural migration
- Increased life expectancy and natural population increases in urban areas
- Also may involve a change in migrant attitudes, beliefs, values and behavioral patterns.

Defining 'Urban' as an Entity (Quantitative)

1. **Population Size and Density**

Since urban places are generally larger than rural areas, population size and density can be used to decide if a settlement is denoted "urban".

- Minimum threshold of population and density vary over time and space
- Reflects the diversity in social contexts of different countries.
- Most countries use minimum population size
- Differences must be made explicit, if not it may complicate international comparisons.

Example: Sweden vs Japan
Any settlement with more than 200 inhabitants in Sweden are classified urban, but in Japan the minimum is 30 000

2. **Economic Base**

Some countries combine population size with other diagnostic criteria to define an urban area.

- These include the nature of employment and the range and provision of services.

In **India**, a settlement must have more than 75% of adult male population engaged in non-agricultural work to be classified urban.

Defining 'Urban' as a Quality (Qualitative)

There are many ways to define urban qualitatively.
These definitions regard an urban area by the characteristics of life or the effect of the urban environment in people's lifestyles and attitudes.

Lewis Wirth defined urban as a "relatively large, dense and permanent settlement of socially heterogenous individuals."

1. Size

A large population size will affect the relationships between individuals.

- Wirth claims that interpersonal relationships are **generally interpersonal, superficial and transitory**.
- Individuals would only come together in groups to achieve particular ends or to defend interests

2. Density

An increased density of population diversifies men as competition for space is great → results in increasing complex social structures and segregation or dissociation of work from residence.

- People in urban areas live close to one another and work together but have no sentimental or emotional ties.
- This fosters spirit of competition and mutual exploitation

3. Permanence

Permanence refers to the state or quality of lasting or remaining unchanged indefinitely.
Urbanism represents a stage in development of human society and the dominant form of social organization in the modern era.

- Cities can create spaces for many social processes to work.

4. Heterogeneity

Cities are historically made of a melting pot of races, people and cultures.

- Diversity is rewarded
- People are different and thus useful to each other for mutual exploitation.

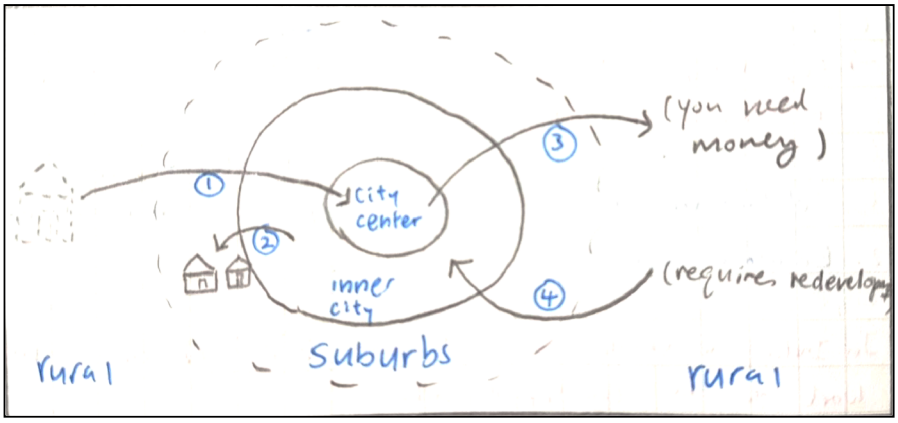
Criticisms of Wirth

- He failed to capture some key features of urban life and exaggerates others like the spirit of mutual exploitation
- Urban and non urban characteristics may be both present in a city
- New towns like slums or shanty towns may have the quantitative criteria for being considered urban, but it does not have the quality of permanence.

We need to acknowledge the **dynamic and plural definition** and **experience** of the 'urban' landscape.

- As such the definition varies over time and space.

Urbanisation in Developed Countries



Stage 1: Industrialization/Urbanisation

This occurred during the industrial revolution as the IR changed society from one that depended on agriculture, which depended on industries.

- Rural urban migration occurred as towns had industry and better employment due to steam and electrical power
    - Led to higher standard of living
- Created a state of cumulative growth where other services like banks and shops stared growing as well due to worker influx.
- This activity brought more workers and factories into the inner cities.

Stage 2: Suburbanisation

Came after the largescale process of industrialization and rural-urban migration, developing suburbs.

- Involved the outward growth of towns and cities to engulf surrounding villages and countrysides
- Push factors were present like how urban centres became older and polluted, with little plans to redevelop it
    - Cities became packed with factories and became plagued by disease and high rates of crime.
- Pull factors included that edge of towns had more modern housing or facilities, make safer neighbourhoods and cheaper land for businesses
- This was catalysed by more access to cars and public transport.

Stage 3: Counterurbanisation

People migrate from major urban areas to rural settlements.

- Not as major as stage 1 or 2 as it was mainly the rich that wanted to develop their own way of life in rural areas.
- Catalysed by the higher mobility of people as a result of rising car ownership, construction of motorways and roads and innovation in ICT.
    - The internet allowed for people to communicate easily over long distances.

Stage 4: Reurbanisation

Most recent activity which involves the revitalising of city centres which improve town areas.

- Involves the process where town areas are improved or gentrified by public and private funding which then attracts people to move back to inner city areas where population had previously declined.
    - Gentrification is a process of changing the character of a neighborhood through the influx of more affluent residents and businesses.

- This attraction to the new redeveloped city centres may be due to the young and old enjoying the benefits of living near city centres.
- Linked to Urban Reimaging(chapter 49)

Example: **Guggenheim Museum in Bilbao, Spain**
- Iconic building that transformed the city's image from declining and industrialisation to make the city have an image of a cultural city.
- Attracted tourists from all over to visit

Example: **London Docklands, East London**
- Current day Canary Wharf
- Long sought after retail and office space
- Lea Valley's waters were cleaned to build the olympic park site, causing new wildlife habitats to form and lesser pollution flowing to residents living downstream

Urbanisation in Developing Countries

Urbanisation in DCs was a more gradual process.
In LDCs, the change is more rapid and concentrated in Asia, Africa and to a smaller extent Latin America.

1. Industrial Competition

When DCs seek new markets in LDCs, LDCs import manufactured goods → traditional industries may be destroyed as they are unable to compete with western equivalents
- Traditional craft economy disintegrates
- Drives people to move to cities for more opportunities.
- *Linked to the next point*

2. Communication Improvements

Media and the spread of television has made people living in rural areas aware of urban living standards → spreads hope of a better life in cities.
"Bright Light Syndrome" → migrants are given the false impression that another city or area is better and they believe that they will have a better life there

Shenzhen, China
The development of Shenzhen as a city with Special Economic Zones attracted TNCs and people to migrate to these regions with the hope of a better life.
- Especially for people living in poverty in rural; periphery areas.

3. Rapid Population Growth

As the global population grows, the pressure of population in relation to rural resources increases
- causing rural-urban migration.

4. Modernisation of Agriculture

Agriculture in LDCs have shifted towards **high capital input and high technology.**
- Results in fewer agricultural workers needed
- People migrate to cities as they perceive cities to have superior opportunities.

Global Trends & Projections

1. **More people to live in urban than rural areas**

- In 2007, global urban population first exceeded global rural population

2. **Levels of Urbanisation DIffer Between Regions**

- 40% of African population and 48% of Asian population live in urban areas
    - mostly rural
- Urbanisation levels are expected to increase in all regions
- Africa and Asia urbanising faster than the rest
- Projected by 2050, most of the urban population will be concentrated in Asia (50%) and Africa (21%).

3. **Rural Population Expected to Peak Soon**

44 Measuring Sustainable Urban Development

A. Measuring sustainable urban development - the economic, social and environmental dimensions of sustainable urban development. - the use of relevant indicators to monitor sustainable urban development. - the difficulty in deciding on what aspects to be measured and the selection of appropriate indicators.	

Introduction

Sustainable development is development that meets the needs of the present without compromising the future generation's ability to meet their own needs.

Sustainable urban development may be defined as the process of integration and evolution among the subsystems that make up a city which aim to:

- Provide the local population a stable level of wellbeing in the long term without
- compromising the possibility of development of surrounding areas and
- controlling the harmful effects of development on the environment.

This is especially important due to urbanisation and processes in cities damaging the environment.

- Urban areas are not sustainable on their own and must borrow their carrying capacity form elsewhere
- Especially with respect to resource use and waste production as cities grow. (link to ecological footprint from NHSW)

Dimensions of Sustainable Urban Development

The holistic nature of SD and the importance of intergenerational equity makes the assessment of SUD complex. There are 4 pillars of SUD which covers the economic, social and environmental dimensions of SUD.

- **Environmental Management [Environment]**
  - Refers to the controlling of harmful effects of development on the environment
  - Management of soil, forests, waste, air quality
  - Adaptation and Mitigation of Climate Change
- **Social Development [Social]**
  - Refers to the provision of the stable level of well being and one that does not compromise the possibility of development of surrounding areas.
  - Education, Health, Food and Nutrition
  - Water Access and Sanitation,
  - Green public transportation

- **Economic Development [Economic]**
    - Green productive growth
    - Creation of decent employment
    - R&D
- **Urban Governance**
    - Helps with inequality and efficient resource allocation
        - As the people that lack access to essential resources and services impose greater impact on the local and global economy.
    - This can be done by urban planning, reduction of inequality and the strengthening of civic/political rights.

Indicators Used to Measure Sustainable Urban Development

We need to use relevant indicators to monitor the economic, social and environmental dimensions of sustainable urban development.

1. Environmental Indicators

Indicators used can measure the state of the sources and sinks of the environment.

- Source indicators measure how much a certain level of resource use departs from its sustainable use, considering both the state of natural resources and the biological processes that sustain them
- Sink indicators evaluate the capacity of local atmosphere, soil or water bodies to absorb emissions and waste
- Ecological support system indicators measure the change in the state of ecosystems, protected areas and biodiversity
    - Monitors how essential life support systems are maintained over time without degrading its quality
    - However it may not be specific about the type of ecosystem and how the human activities degrade them.

(African) Green City Index by the **Economic Intelligence Unit (EIU)**

- The African GCI measures 15 cities and has 25 indicators
- 13 qualitative and 12 quantitative indicators
- Emphasises on environmental sustainability
- Includes source and sink indicators like CO_2 emissions from electricity consumption and waste generated per capita etc.
- Has an indicator for evaluating Water Sustainability Policy
    - About managing water sources effectively
- Specific indicators are different they take into account what data is available and the unique challenges in each region
    - European index includes indicators measuring renewable energy consumption
- Bandings are used in regions where levels of data quality and comparability do not allow for a detailed numerical ranking

2. Human Impact and Welfare Indicators

Urban environmental problems include issues like public health and quality of life

- Ranges from health to standard of living (typical economic indicators by the World Bank)

United Nations Center for Human Settlements(UNCHS) Indicators
- Emphasises the socioeconomic and institutional dimension of urban sustainability
- Indicators include: "household below poverty line", "child mortality", "access to potable water" and "income distribution".
- Shows a focus on issues like poverty and deprivations.

Difficulty in Deciding What Indicators to Use

Sustainability is a complex and contested notion with various interpretations and interests

- Indicators need to be understood and interpreted in context.

Challenges include:

1. **Lack of Access to Information**

Particularly evident in LDCs

- Researchers usually sought for most recent data, but different cities have different capacities in gathering information and publishing them quickly
    - because of differences in the capacity of cities to gather and publish information quickly, the comparison points are several years apart
- Makes it hard for comparison between countries
- *The Economist Intelligence Unit has produced estimates from national averages or other available, relevant data.*

2. **Informal Settlements can Skew Data**

Often cities report high levels of access to basic services like potable water, waste collection and sanitation but this may not be true as there are informal settlements present which are not accounted for.

- Urban agglomerations lack a single datasource

(African) Green City Index by the **Economic Intelligence Unit (EIU)**
- There is difficulty of measuring the environmental impact of informal settlements
- Hard to determine the extent to which informal settlements are covered in published data sources. (when secondary data is used)

3. **Lack of Transparency and Accountability**

Specific data published by authorities may be lacking as restrictions may be placed on information by authorities.

4. **Different Impretations of SUD**

Different indexes may focus on specific indicators.

- Green city index focuses on environmental indicators while the UNCHS indicators focus more on the social and economic aspects of SUD

45 Urban Livability

A. Urban liveability - defining and measuring urban liveability - liveability and its relationship with sustainable urban development - political, socio-economic and environmental factors that affect urban liveability	❑

Liveability reflects the wellbeing of a community that is generally understood to encompass elements of a metropolitan area that contributes to safety, economic opportunities, health and convenience which is a place where people want to live and work now and in the future.

- Depends on how a city is designed
- Liveability is a relative term whose precise meaning depends on the place/time/assessment purpose and the value system of the assessor.
- As such measures should be of both objective/quantitative evaluations and subjective evaluations that show perceptions of urban spaces.

Link Between Urban Liveability & Sustainable Urban Development

Sustainable Development refers to "**development that meets the needs of the present without compromising the ability of future generations to meet their own needs**."

- Includes the anthropocentric and ambiguous assumption about the "needs of the future generation"
- SD should include ideas of long term economic opportunity. Environmental quality and social equity

Sustainable Urban Development refers to the "integration of subsystems in a city which provides the locals with a stable level of well being in the long term without compromising the possibility of developing surrounding areas and controlling the harmful effects of development on the environment."

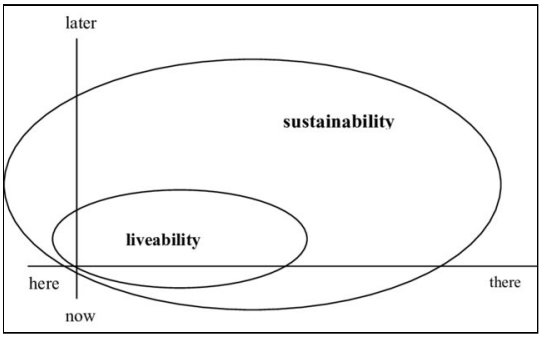
- SUD is guided by a sustainable planning and management vision that promotes interconnected green spaces, a multimodal transport system and mixed-used development.

Liveability is more about the 'now' and 'here', focused on immediate and tangible conditions of an area.

- Related to the walkability, economic potential, housing, accessibility to services and amenities → adds up to the community's quality of life.
- Grew out of a view that environmental, economic and equity issues should be considered at a narrower spatial scale relevant to individual people, neighbourhoods and communities.
- Notions of liveability change rover time and geographically, due to different conditions and values.

Sustainability refers to long term development which calls for constraints on human desires in order to ensure that the well being of future generations are met, with a more worldwide view.

- The Duijvestein's model places liveability on a subset of sustainability but it assumes no aspect of liveability is contrary to sustainability outcomes(which isn't very true)



Factors Affecting Urban Liveability

Objective Factors

1. Climate [Environmental]

Important factor affecting liveability

- Mild climates without temperature extremes (too hot/too cold) is ideal
- As such, temperate climates score high on liveability
- Amount of rainfall is also important
    - Too much or too little is not good

2. Environmental Quality - [Environmental]

Refers to the characteristics of the natural/built environment.

- Green spaces can reduce urban heat island effect
- Measure of pollution or noise.

Vienna, Austria

- Vienna is a Marine West Coast Climate
- Reliable and frequent low-intensity rainfall
- MAT → 11.4˚C DTR → 20.5˚C
- Low level of air and drinking water pollution

3. Infrastructure - [Socio-Economic]

Availability of services and facilities like roads, public transport, water, sewage treatment plants, electricity supplies, housing and communication services

- Makes a city more liveable
- Also refers to the services present
- responds to the differing needs of social groups

Negative example is in the water privatisation chapter → Thames Water and Suez in Jakarta.

4. Healthcare and Education [Socio-Economic]

In general, good healthcare and access to educational facilities like training centres can help to increase liveability.

London, England

- In the UK, schools that are state funded are free for all pupils
- Independent schools often have a good reputations for high standards of teaching and learning
- Allows for almost all pupils to go on to prestigious universities after they leave.

5. **Safety and Stability [Political]**

Most important part of liveability of a place

- Takes into account crime statistics and civil strife.

Iraq and Afghanistan

- Many of the world's least liveable countries come from war torn countries like Iraq, Afghanistan and Syria.

Subjective Factors

Things that are personal likes and dislikes, emotional and spiritual.

- Cannot be easily measured or expressed as numbers
- A city must be able to support the changing needs and well being of people at different stages of their lives.

Indicators of Urban Liveability

1. **Economist Intelligence Unit(EIU) Global Liveability Index**

Assigned a rating of relative comfort for over 30 qualitative/quantitative factors across 5 broad categories:

- ❖ Stability (25%)
- ❖ Healthcare (20%)
- ❖ Culture and Environment (25%)
- ❖ Education (10%)
- ❖ Infrastructure (20%)

This was developed to **identify cities attractive to highly skilled people**.

- Uneven weightages may not relate to the city's individual meaning of liveability as varying cities prioritise different aspects of urban liveability differently.
- A focus on certain parts of urban planning like improving education may have less effect on improving the liveability score.

EIU Global Liveability Index

- Top countries were Vienna, Austria (1st) and Osaka, Japan (4th)
- Singapore was 40th

2. **Global Liveable and Smart Cities Index (GLCI) by Asia Competitiveness Institute**

By the Lee Kwan Yew School of Public Policy, National University of Singapore. Has 5 major environments considered:

- ❖ Economic Vibrancy & Competitiveness(20%)
- ❖ Environmental Sustainability and Friendliness (20%)
- ❖ Domestic Security and Stability (20%)
- ❖ Social Cultural Conditions (20%)
- ❖ Political Governance (20%)

These indicators include unemployment rate, higher education achievement, government effectiveness and intensity of social conflict.

- Equal weightages allow for amore balanced and holistic understanding of liveability of cities
- Focuses on the ability of cities to achieve all-roundedness in various aspects of city life

- Multidimensional understanding of liveability

ACI Global Liveability and Smart Cities Index
- Singapore was 9th place in 2018, pulled down by environmental friendliness

3. Monocle Magazine's Quality of Life Index

Index that targets the *smart and savvy cosmopolitan crowd*.
- Significantly focuses on the urban culture in a city
- Includes normal socio-economic grades of liveability like quality of public transport infrastructure and unemployment rates
- However it also has indicators like "number of bookshops and museums" and "quality of food and drink"
- Does not paint a complete picture for different demographic groups
- Does not consider culture pertaining to the older generations.

Monocle 2019, Tokyo, Japan
- Rank 2
- Due to the presence of good food, culture and economic vibrancy of the city

Monocle 2019, Auckland, New Zealand
- Ranked 21
- Government set a property restriction by government to solve rising property prices which make the city less liveable
- Citing restrictions on property ownership by foreigners making the city less friendly towards expatriates who want to live/work there
- Makes the locals lives better as they can afford housing

46 Management of Non Hazardous Solid Waste

A. Management of non-hazardous solid waste - ecological footprints of cities - urban metabolism: linear nature of production, consumption and disposal in cities - strategies to manage non-hazardous solid waste	

Introduction

Waste is defined as the material excreted by an organism or to be thrown away by society because they are no longer useful and if kept may be detrimental.

- Waste discarded by one body may have constituents that are useful for another

Non Hazardous Solid Waste refers to any solid or semisolid material which **does not have any immediate danger to the environment or to human health if managed properly**.

- Includes municipal or household waste
- Construction or demolition debris
- Metal scraps

Problems of waste disposal in **DCs** usually are due to **high costs** and **difficulty in disposing of waste**

Problems of waste disposal in **LDCs** usually are due to problems with **collection** of waste.

Ecological Footprint of Cities

Ecological footprint is defined as the **land area and natural resource capital on which the city draws to sustain its population and production structure.**

- Measured in global hectares
- In the past, size and economic base of cities were constrained locally by the size or quality of resource endowments of its surrounding areas
- Now, wealthier nations can draw resources from far beyond their immediate regions
- They have increasingly appropriated the carrying capacity of rural regions in other nations, often with little regard for their impacts.
- The ecological footprint of cities help cities to manage their ecological assets more wisely
- Especially in LDCs with high rates of rural-urban migration

Cities may draw resources from wider regions

- Cities depend on inputs of raw material and goods of various natures from the surrounding regions
- Larger and more affluent cities tend to make greater demands as consumption per head rise

Wider regions may act as waste sinks

- Waste generated by cities are also transferred to surrounding water bodies or land sites
- Where solid or liquid wastes are disposed without treatment
- This weak environmental regulation attracts TNCs to set up operations nearby.

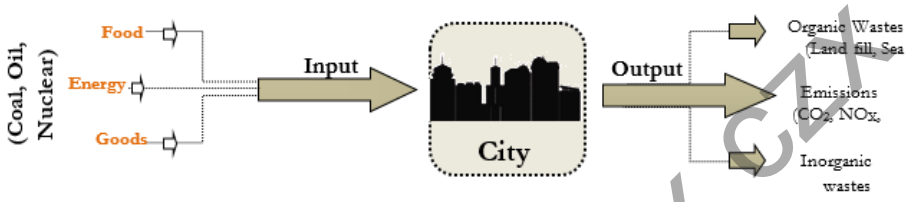
Example: **Maquiladoras, US-Mexico Border**

- Export processing zone, so US companies take advantage of cheap mexican labor
- EPZ is made up of many cities
- MExican border towns have become garbage dumps for millions of barrels of organic solvents like benzene, raw sewage and battery acid produced by the production activity there

Linear Nature of Urban Metabolism

Urban metabolism is a model that describes and **analyses the flows of materials and energy within cities.**

- Shows how the natural and human systems interact

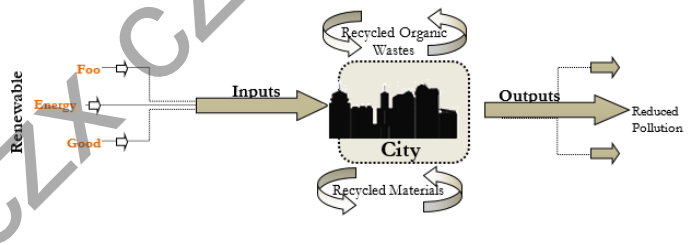


a- Linear Metabolism Cities (Consume and pollute at a high rate)

The **linear nature of production**, **consumption** and **disposal** of cities mean that resources flow through urban system with **little concern about their origin or destination of waste**

- Raw materials are extracted, combined and processed into consumer goods that end up as rubbish
- Promotes waste production and disrupts natural cycles
- Not sustainable

A better alternative is a **circular urban metabolism** like what happens in nature.



b- Circulative Metabolism Cities (Reduce consumption and maximize renewable)

- Every organisms output is an input that renews and sustains the whole environment
- Cities should strive to have **circular economies** both internally and in their relationships with the outside world
- However this requires deliberate long term planning of how resources are used in the systems and processes of a city.
    - LDC cities are more likely to be struggling with immediate concerns to put resources or invest in transforming into a circular urban metabolism.

Strategies to Manage Non-Hazardous Solid Waste

1. Waste Disposal [Landfills + Incineration]

Most LDC cities have solid waste that is uncollected and accumulated on wasteland.

- This can pose human induced environmental hazards like disease vectors like flies and rats or decomposing garbage which can contaminate water sources.

A. Landfills

Advantages	Disadvantages
- **Most common form of waste disposal**, where if designed and managed properly, the landfill sites may do little harm to the environment - can eventually **provide a surface for other land uses** such as playing fields for sports or reforestation initiatives.	- If not managed properly can contaminate surface and groundwater from leakage of leachates - Leaving refuse open to air can allow for infestation of rat and fermentation bacteria which generates methane and can cause fire hazards.
Example: **Pulau Semakau Landfill, Singapore** - 7km perimeter rock bund created to enclose part of the sea off Pulau Semakau to create space for the landfill - Bund is lined with impermeable membrane and a layer of marine clay - Prevents leachate from leaking and keeps refuse in the landfill - Incineration is used to reduce volume of the waste by 90% - Electricity generators and transfer buildings are used to make the operations there self sufficient	

Disposal in general is disfavoured in the waste hierarchy as it causes environmental problems and is unsustainable in the long run.

2. Recycling

Recycling addresses the main issue of excessive waste production, the linear nature of urban metabolism.

- Allows for metals. plastic and glass to be collected from solid wastes and transforms it into useful objects, so it allows for consumption and production to be sustainable in the long run.
- In DCs. there is more formalised recovery and recycling schemes.

Advantages	Disadvantages
- Economic benefits in LDCs where small scale informal manufacturing industry can form - Materials recovered can be put into a variety of uses - Provides employment for individuals who otherwise would have none. Example: **The Zabbaleen in Cairo, Egypt** - The zabbaleen in Cairo, Egypt collect about 60% of total solid waste in Cairo and recycle up to 80% of what they have collected. - They even have refined collection and sorting methods by building their own	- If recycling schemes are not managed well, issues including the city's local sociocultural contexts need to be considered when implementing large scale top down schemes. Example: **The Zabbaleen in Cairo, Egypt** - When international waste management companies started operating in Cairo, the Zabbaleen lost their access to municipal waste - As such, they lost their livelihoods - Furthermore, the multinational private sector companies in charge of solid waste management did a bad job which caused

labour-operated machinery and systems.	garbage to accumulate on streets, highways and waterways.

3. Waste Prevention

The most preferred way to manage waste is to prevent it at the source, allowing for the reduction of waste generated for long term SUD.

A. Extended Producer Responsibility

Manufacturers of a product are required to take responsibility for the environmental impacts throughout the product's whole life cycle.

- Results in laws and policies created based on the principle of EPR and the "polluter pays" principle

Advantages	Disadvantages
- Reduced waste and reduces stress on landfills - Encourages producers to redesign products to have lesser waste produced, like in their packaging Example: **"Green Dot Packaging Ordinance", Germany** - Germany makes use of EPR in crafting laws that require producers to take back their packaging and pay the FULL COST of recycling and collection of waste - Known as the Green Dot Packaging Ordinance	- Unpopular and costly for producers - Some TNCs may try to cheat and make false claims that they export their waste for recycling overseas - Local authorities may not be able to check whether such waste is disposed or recycled

47 Management of Slums

A. Management of slums - characteristics of urban slums and the reasons for their development, including the role of migration - strategies to improve the lives of slum dwellers	❑

Introduction

A slum household is a group of individuals living under the same roof in an urban area which lacks one or more of the following:

- Durable housing,
- Sufficient living area,
- Access to improved water,
- Access to sanitation &
- Secure tenure

❖ **Millenium Development Goal 7**, "Ensure Environmental Sustainability"
  ➢ Target D "Achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers"
❖ **Sustainable Development Goal 11,** "Sustainable Cities and Communities"

Characteristics of Urban Slums

Linked to Urban Poverty and its Associated Deprivations.

1. Lack of Basic Services

Linked to the inadequate provision of public infrastructure

- Lack of access to sanitation facilities, safe water sources, waste collection systems, electricity supply and rainwater drainage

2. Substandard Housing / Illegal and Inadequate Building Structures

Slums are associated with a high number of **substandard housing structures**, built with non-permanent materials unsuitable for housing in local climate conditions.

- This can consist of earthen floors, waste materials like cardboard, tin and plastic.

3. Overcrowding and High Density

Associated with low space per person, high occupancy rates, cohabitation by different families and high number of single-room units.

4. Unhealthy Living Conditions and Hazardous Locations

Associated with the lack of basic services, lack of drainage and uncontrolled dumping of waste and open sewers.

Example: **Orangi Town in Karachi, Pakistan**

- Lack of toilets have caused residents to use 'soak pits' where sewage is soaked into the ground and results in mosquito breeding
- Caused widespread malaria and dengue fever

5. Insecure Tenure

The lack of secure tenure results in occupants not having legal entitlement to occult the land

- Result in most slums being considered informal
- Results in perpetual slum growth
- Occupants would have less motivation to improve their own living conditions as they do not own the land

6. Poverty and Social Exclusion

Slum conditions are physical and statutory manifestations that create barriers to human and social development.

- These areas may contain certain vulnerable groups like immigrants and ethnic minorities.

Reasons For Slum Development

Some slums are working communities in their own right, with their own economy and social structure.

1. Migration / Urbanisation

Developing countries are **urbanising rapidly,** reasons for such rural-urban migration can be seen in chapter 43.

- **[Push]** Due to rural population growth, declining agriculture labour, industrial competition
- **[Pull]** Due to promise of higher income and promise of higher standard of living.
- Due to higher rates of urban rural migration, **demand for affordable housing outstrips supply**
    - People have to seek solutions to housing issues which perpetuate slum formation.

Example: **Dharavi Slum in Mumbai, India**

- Rural indian people migrated into urban mumbai as there was an increase in job opportunities
    - Especially in the service sector which resulted in a boom in slum dweller numbers in the 1900s.
- Dharavi slum is found near to two suburban railway lines
    - Slum dwellers have access to the city center for their livelihoods.

2. Poor Governance

Urban slums are often the result of a lack of capacity of governments to respond to poverty, rapid urbanisation to **provide housing to grow urban population**.

- There may be a lack of coordination of economic developments urban planning and land allocation
- **Government's planning tools may not be sufficiently responsive to the reality on the ground**
- Governments may have hostile attitudes towards urbanisation as they fear that providing urban services to slums/poor residents would attract more migrants which cause slums to grow.

Example: **Orangi Town in Karachi, Pakistan**

- Orangi town was developed when Pakistan achieved independence in 1947 where refugees from India began moving into Karachi rapidly
- After that, in 1971, another wave of refugees began fleeing from the newly independent Bangladesh into Karachi

- Pakistan government gave permission for refugees to settle on vacant land
  - Resulted in rapid growth which they could not manage
  - Still remains as an unofficial settlement

3. Socio-Economic Inequality

In a capitalistic city, slums tend to sit outside the formal market system.

- Increasing inequality, population growth and economic stagnation coupled with socio-economic exclusion has caused deterioration of the living environments
- Dangerous living conditions can lead to cheaper rent and thus more migration

4. Lack of Secure Tenure

Tenants **do not have legal entitlement to land occupancy.**

- Does not protect residents from eviction processes
- Inhibits opportunity for residents to acquire credit which limits tenant's ability to improve their home
- Secure tenure is a necessary precondition for further socio-economic development like public services

Strategies to Improve the Lives of Slum Dwellers

1. Public Housing

Slum dwellers can move into large-scale housing which would be of better quality than current types of housing.

- Housing can be made of more permanent and stronger materials like concrete, allowing for slum dwellers to enjoy safer housing and building structures
- Greater access to basic services

Advantages	Disadvantages
- Often more affordable for the people as government subsidies and economies of scale allow for lower production costs . Example: **Public Housing in Singapore** - Singapore heavily invested in public housing projects when it first started large scale development - Allowing for the small city to house its residents with many high rise flats with help of **extensive urban planning.**	- LDCs may not have financial capabilities to lower the cost of housing units - Low income groups would be less able to afford - Flats may be near peripheries, not near employment Example: **Karachi, Pakistan** - Karachi Development authority planned to construct 30 000 - 40 000 flats to rehouse residents from urban redevelopment schemes but - stopped when they completed 800 flats due to a lack of funding.

2. Resettlement

This strategy focuses on the enhancement of use of land and property where slums are located at.

Advantages	Disadvantages
- When carried out with proper procedures and cooperation with slum households, this can improve housing quality with slum households and improve housing quality and access to	- Short term response to slums - Livelihoods may be affected and there may be a lack of access to urban services.

basic needs. Example: **Addis Ababa, Ethiopia** - There was reduced health risk after resettlement as the slum dwellers were moved to outskirts which - Resulted in improved water and sanitation as well as lesser overcrowding	Example: **Addis Ababa, Ethiopia** - Relocating slum dwellers to distant sites causes people to lose their jobs and sources of income - They may also be accustomed to engaging in informal activity like food vendors and stall hawkers within the slums. - Social networks may be lost, along with informal support systems.

3. Participatory Slum Upgrading

Normal slum upgrading involves providing secure tenure to residents and the improvement of water supply and sanitation.

- Normally initiate and developed by governments
- Governments have been incapable of following through with these services in the past.

PSU involves more holistic approaches to neighbourhood improvement, where the government takes a more facilitative role in training the locals, maintaining financial accountability and adhering to quality norms.

Advantages	Disadvantages
- **Individuals have a stake in development** - Helps to preserve the informal social structures in slums Example: **Orangi Pilot Project in Orangi Town, Karachi, Pakistan** - NGO is *Orangi Pilot Project-Research and Training Institute (OPP-RTI)* - Helped residents to construct sewers to 72000 dwellings - Intervention is developed through research into household resources and aspirations in Orangi - Funds in the project is contributed by the households, where residents do not just pay for the pipes installed, but they also maintain it - Now has better housing, sanitation, health and education - Current new projects are put in place in other parts of pakistan	- Requires political will from government to dissolve some power by providing secure tenure to the people, especially for slums that **exist on prime land that may be good for economic activity.** - Or it may require intervention from NGOs which finance the projects on a larger scale. Example: **Dharavi Slum in Mumbai, India** - Slum dwellers in Dharavi, Mumbai, India are always under threat of eviction as they are near the city centre.

48 Management of Traffic Congestion

A. Management of traffic congestion - reasons for traffic congestion - impact of traffic congestion on cities and urban dwellers - strategies to ease traffic congestion in cities	❑

Introduction

Mobility refers to the ability to move around cities.

- But it is also seen as more than the functional expression of the need to get from one place to another.

Transportation affects the shape of cities, its ecologies, societies, culture and economics.

Reasons for Traffic Congestion

1. Increased Car Ownership

The rapid increase in the rates of car ownership has increased the number of cars on the road

- Can be attributed to the **growing middle class** of some countries and the **prestige** of owning a car → more cars on the road.

- In LDCs, urbanisation and rural-urban migration has allowed for the **expansion of urban economic activities**
    - **Low income immigrant settlements on a city fringe exerts pressure on transport systems**
- Physical spread of LDC cities **increase the use of motorised transportation** and **longer transport distances**

Example: **Horrible Traffic in Bangkok, Thailand**

- Estimates calculate that there are more than 5 million vehicles on Bangkok's streets each day
- Road networks only can support 2 million.

2. Inadequate Transport Networks

Cities are unable to keep up the upgrading of road networks with the growth of cars ownership.

- In LDCs, Indian and Southeast Asian cities often have cores with a mesh of narrow streets that are only accessible by non-motorised vehicles(bicycles etc)
- Uncontrolled intermixing of motorcycles and pedal based vehicles → cause different vehicles to move at different speeds → slower ones clog up roads which make it harder for cars to pass → increased chance for congestion to occur

Increased populations lead to overcrowding of public transport systems

- There may be a rise in private car usage due to social stigmas against public transport systems.
    - Public transport may be deemed unsafe and dirty, so there are lesser commuters

  - As a result public transport companies have less revenue
  - Companies need to raise fares and lower frequencies to support costs of providing the services
  - Decrease in public transport efficiencies
- Public transport also faces "off peak inadequacies"
  - Hard to scale up production just for peak hours as transport is underused during other periods
  - Not economically viable for public transport to be scaled up just for peak hours

Example: **Curitiba, Brazil**
- Curitiba's forward-thinking and cost-conscious planners integrated public transportation into all the other elements of the urban planning system.
- They created a system that focused on meeting the transportation needs of all people rather than those using private automobiles
- one of the most heavily used, yet low-cost, transit systems in the world
- about 70% of Curitiba's commuters use the Bus Rapid Transport to travel to work, resulting in congestion-free streets and pollution-free air

3. Conflicting Developmental Needs

Cities with limited governmental resources have to be allocated between housing, transport and investment for economic development (link to role of state)

- Often times, the transportation sector takes a back seat as it is lowest priority compared to other sectors with pressing issues to address like housing.

4. Non-Recurring Events

One off events may cause roadways or transportation arteries to be blocked off and inaccessible.

Example: **Monsoon in Mumbai, India, 2019**
- Caused waterlogging and traffic jams in the Western Express Highway in Mumbai, India
- Pluvial flooding

Impacts of Traffic Congestion on Cities and Urban Dwellers

1. Environmental: Emissions and Pollution

Automobile fuel consumption and emissions from industries that **produce, maintain and fuel them** contribute to **high levels of greenhouse gas emissions → increasing the rate of climate change.**

- Road traffic contributes to poor air quality which can cause respiratory diseases like asthma, bronchitis and lung cancer
- Also responsible for **photochemical smog**
- Pollution tends to concentrate in inner cities with high rates of traffic congestion
  - felt by the lower income groups the most as high income groups can flee to the suburbs
- More acute in LDCs where **environmental laws are lax.**

Example: **Mexico City, Mexico**
- Mexico city has high levels of air pollution with high levels of NO_2, O_3 and SO_2
- O_3 and NO_2 can combine and form photochemical smog
- SO_2 can cause bronchitis

2. Economic: Loss of Time and Productivity

Includes direct and indirect causes of congestion.

- Traffic congestion slows down the ability for the transportation of goods and services around the city
- Low income households impacted more as this disadvantage is compounded if they live in peripheral areas with long commutes to places of employment
- Subsidised fuel costs and increased use of fuel also causes costs to not fully dall on drivers but also other people and institutions as subsidies are funded by taxpayers.

Example: **Bangkok, Thailand**

- According to Kasikorn Research Centre, the traffic on Bangkok's street can cause damage of about 11 billion Baht every year. (approx 300 million euros)

3. Social: Health Effects and Land Use Changes

The emissions of cars can cause health problems like bronchitis

- Increases the stress on physical and mental health like increased anxiety and road rage
- Also can be due to noise pollution
- Increasing dominance of cars in cities are shown to lower rates of social interactions with people
    - Lesser social spaces as roads need to be constructed + poor urban planning causes social life and standard of living to degrade.

Strategies to Ease Traffic Congestion in Cities

1. Public Transportation

Public transportation is capable of carrying more people per vehicle than private cars.

- Public transport provision can allow for lesser overall vehicles on the road → decreasing the overall amount of traffic

Advantages	Disadvantages
- Can be sources of cheaper transport for people as it is subsidised by the government - Can make city more liveable especially for groups like the elderly.	- Requires heavy planning and the use of specialised institutions to oversee maintenance. Example: **Jakarta, Indonesia** - Bus system is not well maintained and they have irregular bus frequencies where timings are not accurate - Safety concerns over women taking public transport.

Example: **Curitiba, Brazil**

- Curitiba's forward-thinking and cost-conscious planners integrated public transportation into all the other elements of the urban planning system.
- They created a system that focused on meeting the transportation needs of all people rather than those using private automobiles
- one of the most heavily used, yet low-cost, transit systems in the world
- about 70% of Curitiba's commuters use the Bus Rapid Transport to travel to work, resulting in congestion-free streets and pollution-free air

2. Urban Design Policies

Urban planning can provide alternatives and create more alternatives to using private transportation like by making cities more walkable.

- Better city design that have more transportation methods and makes cities more liveable
- Can involve changing the layout of cities (urban form), cycling paths and widening of walkways

Advantages	Disadvantages
- Pedestrian streets anc cycling infrastructure can help to reimage cities to seem more liveable. Example: **Amsterdam, Netherlands** - The city has allowed for cyclists to navigate through the area by elaborate networks of cycle paths and lanes - Netherlands invested €552 million (euros) to improve their infrastructure even more in 2018	- Expensive to do and there is a need to consider if it is applicable to the socio-cultural or environmental contexts of each city. Example: **Pedestrian streets in Singapore** - The city turned the shopping district Orchard Road into a pedestrian street on every first saturday of every month - Did not work out as singapore is a hot and humid Af climate, so people rather not walk outside

3. Transportation Pricing Policies

The refinement of transportation pricing can include road taxes or car taxes.

- This can help to restrict car ownership by either quotas or market mechanisms
- Promotes the use of public transportation or alternatives

Advantages	Disadvantages
- Taxation on road use and vehicles can generate revenue for the government - Carbon taxes and potentially reduce emissions. Example: **Certificate of Entitlement, Singapore** - The Land Transport Authority determines the number of newer vehicles allowed for registration depending on road capacity and the number of cars scrapped before awarding the certificate of entitlement to new car owners	- Difficult to measure external cost of transport like environmental and social costs - May leave out poorer people behind as rising income levels reduce the effectiveness of these prices → issues about equity - Some parts of the city may not even be congested but are affected by the tax Example: **Congestion Charging in London, United Kingdom** - Requires vehicles to pay 8 pounds to enter the central business district - Reduced traffic by 15%

3.2.3 Improving Livability in Cities

49	**Urban Reimaging**

A. Raising the quality of urban living space – Urban reimaging - reasons for urban reimaging - strategies to improve the image of cities - impact of urban reimaging on urban dwellers	❏ Outline the range of ways urban images are represented ❏ Explain the reasons for urban reimaging in the context of city marketing ❏ Analyse the strategies used to improve the image of cities ❏ Evaluate the impact of urban reimaging on different groups of people and the environment.

Introduction

Urban reimaging refers to the **enhancement or promotion of positive urban images of a city.**

- **Most impressions we have of cities are not from direct experience but from exposure to representations in things like the media**.
- Can be seen as a part of **city marketing**.
- Can be used to push forth selected images to a target audience:
    - Residents
    - Visitors
    - Investors
- Promotes a specific brand or identity for a city.
- Cities select certain strategies carefully to ensure effective images are put forth
    - However these strategies should not underplay the complexities of these images
    - Overly 1-dimensional interpretations are bad.

Reasons for Urban Reimaging

1. Curbing Urban Decay

Especially in developed countries, inner cities are often deteriorating as there is very little maintenance, resulting in more pollution and disease.

- New international division of labour caused primary and secondary sector jobs to be driven out of DCs to LDCs
    - Low skilled workers face unemployment as the activity like heavy industry employment would have lesser transferable skills to other sectors like the service sector.
    - Manufacturing activity shifted away from 'core' countries in Western Europe and North America to 'periphery' countries like the Four Asian Tigers (SG, HK, South Korea & Taiwan).
- Reimaging can **bring in investors to set up businesses**.
    - Investments can be attracted by better transport networks and infrastructure.
    - Inject spending and FDI into the city to boost the economy through the multiplier effect.

2. Attract Tourists and Consumers

High quality tourist attractions, promoting overseas and creating a shopper's paradise can attract tourists → this also can create jobs in this sector.

- Revenue from tourist dollars and consumers help to boost the economy as profits can contribute to the multiplier effect.

Example: **Guggenheim Museum in Bilbao, Spain**
- Iconic building that transformed the city's image from declining and industrialisation to make the city have an image of a cultural city.
- Attracted tourists from all over to visit

3. Renew Civic Pride

Urban decline causes people to move out of the area as it is no longer pleasant or economically beneficial to stay there.

- Reimaging gives new life to an area
- allowing for people to feel like they have a sense of belonging and a stake in a delightful community.
- People will be inclined to commit more and contribute more to community

Colombo, Sri Lanka [LDC, Tropics!]
- Colombo has been struggling to attract enough foreign capital and FDI to achieve more progress
- Colombo experiences high rates of crime, pollution and traffic congestion
- There is also a shortage of land and modern business facilities
- Reimaging is needed to improve the city's position globally as a trade port, as a centre of commerce and industry.

https://www.theguardian.com/cities/2018/aug/02/sri-lanka-new-dubai-chinese-city-colombo

Strategies to Improve the Images of Cities

As different audiences may produce different interpretations of the same imagery.

- There is struggle to define and promote images of cities as reimaging can involve physical reshaping of the landscapes
- May concern economic development of these urban areas
- May cause cultural politics where competing visions come into opposition
- Reimaging can involve **synecdoches** that are images that represent cities as a whole.

1. Iconic Architecture

Architecture can be used as a tool for economic development.

Advantages	Disadvantages
- Eye catching buildings can reposition cities favourable in the competitive global environment - Socially significant and resonant form of reimaging for the population Example: **Guggenheim Museum in Bilbao, Spain** - By renowned architect Frank Geyry	- Has very little success globally - Requires sufficient funds and extensive planning - Needs to be coupled with other efforts to improve infrastructure Example: **Guggenheim Museum in Bilbao, Spain** - Local authorities needed to pour money into

- Transformed city's image from being a declining and deindustrializing one - to being a global tourist destination and cultural centre	new businesses and training schemes - New tram, metro lines and more retail or cultural centers.

2. Developing Flagship Projects (Rebranding)

Flagship projects may also include hosting major sporting events like the Olympics or the World Cup

- Aims to generate economic benefits for the city
- Repackaging of unique assets of cities to improve the image of cities and change global perceptions.

Advantages	Disadvantages
- Improves living conditions, attracts investments and tourists. Example: **1992 Olympics Barcelona, Spain** - Helped to redevelop old industrial centers that had high levels of pollution, crime and a general lack of amenities - Help to promote images that the city is a centre of leisure - Poblenou district was redeveloped into the olympic village	- Gentrification pushed out longtime residents due to rising estate prices - Costs to the wider community, where money is funnelled into hosting the games which can be going to funding other worthy causes in the city. Example: **Rio Olympics, 2016, Brazil** - State chose to displace poor communities living in favelas to portray favourable images - **Spent $13 billion to organise and build facilities that are currently no longer used and maintained** - Known as **"white elephants"**

3. Brownfield Redevelopment (Regeneration)

This refers to the **conversion of obsolete areas of a city into fresh and revitalised areas**.

- Old obsolete areas are often full of abandoned or vacant buildings that are let over from industrialisation of the past
- Can be part of a larger urban regeneration project, where investments are pumped into improving programmes or infrastructure in the city.

Advantages	Disadvantages
- Can help to regenerate inner cities that are old industrial areas and employing policy to redevelop decayed areas that are often prime land	- Needs to be coupled with other further efforts to improve the lives and sustain the efforts to uphold the new images created in the LT. - Good governance blah blah blah blah smoke
Example: **London Docklands, East London** - Current day Canary Wharf - Long sought after retail and office space - Lea Valley's waters were cleaned to build the olympic park site, causing new wildlife habitats to form and lesser pollution flowing to residents living downstream - Formation of an enterprise zone where firms were given corporate tax relief, government grants as well as lenient planning and capital allowances, attracted many new businesses. - Canary Wharf was at the centre of this transformation and financial institutions such as KPMG, HSBC and Barclays all moved into the area.	

- 120,000 new jobs were created and 25 million square feet of new office space was created. This was coupled with an injection of £6.5bn of private investment and £1.8bn of public investment

Impacts on Reimaging Cities

1. **Economic Impacts**

[Positive]: Promotes tourism and helps to attract foreigners to the country.

- Tourist dollars spent can help to boost the economy via the multiplier effect
- Helps to improve the unemployment rate as jobs in the tourism industry may increase
- Attracts TNCs as they can set up new offices in the area
    - Increased employment and transfer of skills to locals

[Negative]: However, the jobs that are created like jobs in the construction industry may be temporary..

- Furthermore, the jobs that are created in the area may not fit with the skillsets of locals

2. **Social Impacts**

[Positive]: The urban reimaging strategies may have economic impacts which in turn have secondary social benefits as there is increased standard of irving from the new developments

- Regeneration or rebranding efforts to help create new images of city centers may improve transportation, education and other support systems in the city

[Negative]: There can be housing issues that are caused by reimaging strategies.

- Reimaging strategies involving redevelopment of areas may cause housing to be demolished or housing prices to increase
- Cities tend to destroy more dilapidated buildings in the inner city which may house the poorer people as the buildings are often cheaper and poorer people can live near to work in the city.
- Reimaging forces up property prices in the area → resulting in gentrification → as such there is lesser supply of housing that is affordable for low income residents → they are left homeless if the government does not intervene.

3. **Environmental Cleanup**

Depending on the images that are to be presented, the city may choose to use technology and other means to minimise the ecologicalfootprint of cities.

- Resultant pollution and high disease rates
- Green spaces can curb the urban heat island effect which can allow for cities to decrease energy usage from usage of air conditioning and more
- Visible physical improvements are done to decrease the pollution and waste like installation of photovoltaic solar panels in buildings, efficient land use and preservation of natural habitats.
    - Setting up of improved recycling systems that are more extensive throughout the city helps to reduce the amount of waste generated by the city *[Link to Non-Hazardous Solid Waste]*

Example: **Lea Valley, East London**

- Due to the 2012 London Olympic Games, Lea Valley's waters were cleaned to build the olympic park site
- Resulting in new wildlife habitats to form and lesser pollution flowing to residents living downstream