1.1 Population Change

Explain population trends and patterns in births (Crude Birth Rate), natural increase and mortality (Crude Death Rate, infant and child mortality rates), fertility and life expectancy in contrasting regions of the world. Analyse population pyramids. Explain population momentum and its impact on population projections.

crude birth rate: births per 1000 people per year; higher if rural, poor, no pension, lower if higher education: China 42 among university graduates, 95 if illiterate
general fertility rate: births per 1000 child-bearing women (14–49) per year
total fertility rate: mean number of children per woman, better than crude rate; 1960–2000 fell everywhere: Africa 7 -> 5, Europe 2.5 -> 1.5, worldwide 5 -> 2.5
replacement level: total fertility rate necessary to maintain current population, 2.1, just 19 countries below replacement level in 1970; grew to 50 countries by 2005

crude death rate: deaths per 1000 people per year; higher if bad jobs (coal workers), old (retirement towns high death, long life; but MX young, short life, low death), inner city, shanty towns, rural (Brazil rural NE lives 27 years less than rich SE), wars (Afghanistan), AIDS (Africa population would be 25% higher without AIDS)
disease: MEDC dies from degenerative diseases of affluence: heart stroke, obesity; LEDC dies from infectious diseases of poverty: malaria, cholera, schistosomiasis
child mortality rate: deaths per 1000 children (1–5) per year, 1990–2006 25% drop
infant mortality rate: deaths per 1000 live births (<1) per year; SSA 86, MEDC 6

average life expectancy: years a newborn in a country expected to live; 1950–2005 grew everywhere: Africa 38 -> 61 (1990) -> 52, Europe 67 -> 78, world 49 -> 65
natural increase: birth - death rate; growth rate: natural increase + net migration
world population in billions: 1b in 1830, 1930, 1960, 1975, 1987, 1999, 7b in 2011; slowing, 90% future growth in LEDCs; doubling time: log 2 over log growth rate or 70 over growth rate; 74 countries have a doubling time of under 30 years
population pyramids: represent population structure, males to left, females to right; bulges: in-migration, concave slope: high death rate, steep sides: low death rate, gaps: out-migration, natural disasters, disease outbreak, war
population momentum: population grows despite falling birth rate due to youths; now 3b youth, only 1.8b dying, so 600m extra couples, 1.8b children, most ever
momentum factor: crude birth rate times life expectancy, >1 positive, <1 negative, lower is more developed; global birth rate fall faster than life expectancy rise

demographic transition model: five stages of industrialized population, based on GB
Stage 1: high birth, death, fertility, infant mortality rates; indigenous, GB pre-1740
Stage 2: high birth, fertility, falling death rates, rapid growth; Kenya, GB 1740–1880
Stage 3: falling birth, fertility, low death rate, low growth; CN, Brazil, GB 1880–1940
Stage 4: low birth, death, fertility, infant mortality rates, stable; NL, GB 1940–2000
Stage 5: low birth, fertility, infant mortality, rising death rates, shrinking; JP, Sweden
North America: falling birth rate, high migration: consumerism, late marriage, aging
Europe: rapidly aging, 15% over 65, crude death rate 12, second-highest after Africa
Asia, South America: falling birth, death rates, stabler; urbanizing, industrializing
Africa: high birth, fertility rates; little income, education, infrastructure, equality
income positive correlation: life expectancy, literacy, gender equality, median age, internet/phone/broadband subscribers, school enrollment, urbanization, HDI, energy use, CO_2 emissions, and only for Stage 5 MEDCs, crude death rate
income negative correlation: crude birth rate, total fertility rate, natural increase, child mortality, infant mortality, underweight children, poverty (less than $2), residential over total energy use, dependency ratio, and for LEDCs, death rate

1.2 Responses to High and Low Fertility

Explain dependency and ageing ratios. Examine the impacts of youthful and ageing populations. Evaluate examples of a pro-natalist policy.

dependency ratio: number of dependents over number of working age people (15–65) is child dependency ratio (<15) plus aging ratio: old age dependency ratio (>65)
youthful populations: everyone happy, lots of babies made, momentum factor idk
ageing populations: number of elderly tripled past 50 years to 420m, 1b in 30 years; LEDCs most growth, medical; 50% of EU government dependants, 66% by 2030; more child care, gray economy shifts demand to education and healthcare, but shrinking tax base, less consumption, worse health, governments no money; solutions: delay pensions even more, encourage fertility, increase immigration, increase retirement age, make special jobs for elderly, encourage private savings Sweden: civilized depopulation, gave up, new goal is to give seniors good life

shrinking fertility: DE lose 12m by 2050, EU family average 1.5 children, JP deflation; average US women first child when 21 (1970), now when 25 (2000); Eastern EU largest fall since 1989: low life expectancy, high emigration, alcoholism, suicide; factors: longer education, move out later, marry later, see children as a liability
effects: EU economic growth 2.2% -> 1.2% by 2040; threatens social safety net, strain healthcare/pension systems, labour shortage, better working conditions
Russia incentives success: $9600 for second child, fertility 1.3 (2006) -> 1.45 (2007)

traditional policy: Dani polygamous, few resources; early menopause at 20, stable
pro-natalist policy: Singapore

1.2 Responses to High and Low Fertility

Evaluate examples of an anti-natalist policy.

regulatory: China, Nigeria

incentive: Singapore, India

quality of life: Kerala

1.3 Movement Responses—Migration

Discuss the causes of migrations, both forced and voluntary. Evaluate internal (national) and international migrations in terms of their geographic (socio-economic, political and environmental) impacts at their origins and destinations. Notes on this topic are in HL Extension Section 3.

migration: The movement of people, involving a change of residence. It can be internal or external (international) and voluntary or forced. It does not include temporary circulations such as commuting or tourism.

internal voluntary: urbanization, counterurbanization, rural–urban migration
internal forced: war, natural disasters, government (Indonesia, ethnic majority)
external voluntary: economic opportunity; external forced: refugees, slaves, asylum
chain migration: rural -> town -> city; circular migration: migrants return periodically
seasonal (months): farmers, contract labourers; temporary (years): guest workers
migration usually short, step-by-step, local, by young, rural, single, adventurous men

immigration: into country, creates push factors for emigration: out of country
in-migration: internal immigration, promotes out-migration: internal emigration
push factors: war, starvation (hard); poverty, persecution, rising population (soft)
pull factors: money, living standards, education, family, services, health, adventure
restraining factors: cost of living, traditions, laziness, family, language, lack of money

1.4 Gender and Change

Examine gender inequalities in culture, status, education, birth ratios, health, employment, empowerment, life expectancy, family size, migration, legal rights and land tenure.

culture: in Quran, men and women equal before God but different responsibilities: men: defend, hunt, work; women: clean, cook, raise children, farm (60% of food) hijab symbol of respect, modesty, anti-consumerism, anti-hedonism in Islam but seen as oppressive in West; 99% of TR Muslim, >60% wear hijab but very secular LEDC: in some, women part of community wealth, no land tenure, all property belongs to husband or son, beasts of burden, do more heavy labour than men MEDC: after WWI, women larger role in labour, technology freed domestic time

status: more women work in services but only 25% scientific researchers are women
education: 67% illiterate adults are women, lower literacy rate, no time for school but now ratio of girls to boys in primary education around equal except in SSA, lower ratio in secondary education but again around equal in tertiary education; no education -> no birth control -> higher fertility -> more people -> less jobs
employment: female salary 75% of males, glass ceiling: barrier to further promotions despite affirmative action: positive discrimination for women to fight disparities, LEDC domestic work, women 3.9 hours men 1.2 hours; MEDC women 4.5 men 2.4 women do 50% work for 10% income, own 1% property; unpaid work worth $11t
empowerment: 14 heads of state, 17% of ministers, 13/500 largest companies CEOs are women but only 25% of Canada's parliament, 38% Norway, 49% Rwanda

life expectancy: women live longer than men but 40% of African women die of HIV
health: 500k women die from childbirth every year, globally 317 per 100k live births;
ratios: primary fertilization, secondary birth 105, tertiary adult 101, quaternary senile, ratio of males over females; CN at birth 1979 106, 2005 120; 37m more men <20, abortions, gender-selective infanticide: 25% of LEDC pregnancies end in abortion, 50m abortions yearly, 10m illegal abortions in India, 500k girls lost every year; Canada 106, Armenia 111 (Orthodox), Azerbaijan 113 (Muslim, former USSR)

land tenure: secure right to land encourages long-term management, food security; no land tenure: no credit, no agricultural associations, no incentives, no profit; obstacles: male inheritance, sexist customary law, equality laws only if urban
investment in female education increases family health/income more than in male; jointly-registered land more profits, capital; increased yields by 24% in Kenya; Middle East household income could increase by 25% if women work outside
Gender-Related Development Index: like HDI, but measures differences in genders', life expectancy, income, knowledge (literacy, enrollment); worst in Middle East
Gender Empowerment Measure: power (income), political decisions (parliaments), economic decisions (professionals), measures difference between genders

2.1 Measurements of Disparities

Define indices of infant mortality, education, nutrition, income, marginalization and Human Development Index (HDI). Explain the value of the indices in measuring disparities across the globe.

core and periphery: The concept of a developed core surrounded by an undeveloped periphery. The concept can be applied at various scales.
GNI: Gross national income (now used in preference to gross national product). The total value of goods and services produced within a country together with the balance of income and payments from or to other countries.

LEDCs: also called backward, developing, Third World, South, periphery countries; dependent on raw material, most workers in agriculture, unstable governments
qualitative indicators describe development, not useful for ranking but supplement
quantitative indicators: social (literacy rate, student-teacher ratio, internet use), health (life expectancy, mortality, undernourishment; prevalence or depth), economic (energy consumption, percent under $2/day, percent in industry: primary: farming, secondary: processing, tertiary: services, quaternary: science, Gini coefficient: area above Lorenz curve divided by area of the whole triangle; Lorenz curve: cumulative population vs. resources, 0 = equality, 1 = monopoly

marginalization index: measures social exclusion, residential instability, dependency, ethnic concentration, material deprivation; in MX, based on child illiteracy (<15), adults without primary education (>15), percent with income less than minimum, percent living in dwellings with overcrowding, earthy floor, no toilets/electricity
HDI composite index: developed by UN Development Program in 1990s, based on healthy life (life expectancy), standard of living (GDP/capita), and knowledge (66% weight to adult literacy rate, 33% weight to gross enrollment ratio)
other composite indices: GEM, GDI (same as HDI but compares women to men), Human Poverty Index: HPI-1 measures adult literacy rate; percent of births not expected to live to 40; underweight, without safe water, without health services, HPI-2 for MEDCs, measures adult functional illiteracy rate; percent of births not expected to live to 60; below income poverty line; long-term unemployment

quantitative indicators allow comparison, Gini coefficient very good comparisons but only measures equality (everyone gets same), not equity (gets fair share)
composite indices cannot measure absolutely, only relatively or within a country; normalized indices cannot compare countries in different groups (HPI-1, HPI-2), different countries have different definitions of poverty lines, incomparable; Canada Low-Income Cut-Off: 20% over median income percent on food/shelter
LEDC statistics unreliable; GNI does not consider wealth distribution (Qatar), informal sector (subsistence), happiness (Bhutan, Gross National Happiness)

2.2 Origin of Disparities

Explain disparities and inequities that occur within countries resulting from ethnicity, residence, parental education, income, employment and land ownership.

factors: infrastructure, capital availability, resources, political system, companies; vicious cycle: low income -> low savings -> low investment -> low productivity

ethnicity: Nepal life expectancy, upper-class Hindus 61, Muslims 49; India castes; US: white/black/Asian; percent with homes 75/46/55, income $51k/$31k/$60k; Canada HDI 5th, but if First Nations' separate, HDI 63rd; 33% without high school 5x infant mortality, 8x tuberculosis; income on-reserve $14k, off-reserve $22k
residence: Canada Maritimes resource-poor, more primary industry, low population Central resource-rich, strong agriculture, high US trade, dense, political power; Prairies agriculturally rich, oil sands, high in-migration; BC resource-rich, ports; North resource-poor, isolated, high cost, mostly high-income migrant workers; Maritimes less income more unemployment; North more income less healthy; Ottawa transfers equalization payments; AB, ON net contributors, Maritimes not LEDC less tax, so fewer social services (safety net, housing, medical, education) shanty towns worst, nothing at all; notes on this topic are in Option G Section 2.
land ownership: Canada First Nations no private ownership so cannot get collateral; Latin America most unequal, controlled by government and economic elites, highest five Gini index in Africa; next 15 in Latin America except South Africa #10
colonization: China India colonized, 1858–1949 income fell, was higher than EU; helps urban infrastructure but benefits go to colonizer, increases disparities

2.3 Disparities and Change

Identify and explain the changing patterns and trends of regional and global disparities of life expectancy, education and income.

patterns: poorest in sub-Saharan Africa, South Asia; richest in NA, Western Europe; Canada aboriginal vs. non-aboriginal income gap fell; 2001 19.1%, 2006 15.8% US white vs. black gap grew because less manufacturing, black workers, lost jobs

trends: globalization; Asia fastest economic growth, Newly Industrialized Countries; SSA growth rate, foreign reserves, FDI, remittances increasing, debt falling, good HDI rising everywhere but MEDCs faster than LEDCs; GDP rising everywhere but CIS (Soviet Union transition), Africa (Sierra Leone, AIDS), OPEC (falling oil prices), last 50 years death rate -55%, life expectancy +12, GDP x18, literacy 48% -> 82%

2.3 Disparities and Change

Examine the progress made in meeting the Millennium Development Goals (MDGs) in poverty reduction, education and health.

MDGs, strategy to reduce disparities; set in 1990, target in 2015, data from 2010

1. Eradicate extreme poverty and hunger: halve hungry people and those <$1/day success five years early: <$1.25/day 47% -> 22%, 700m fewer people in poverty
2. Universal primary education: not likely, children out of school 102m -> 57m, stall
3. Promote gender equality: not met, much gender disparity in secondary education
4. Reduce child mortality: by 2/3; need more effort, dropped from 87 to 51 (-41%)
5. Improve maternal health: reduce mortality rate by 3/4; from 400 to 210 (-47%)
6. Combat HIV/AIDS, malaria: need more effort, only 55% of 14.4m AIDS treatment; but malaria mortality fell 25%, treated 51m tuberculosis patients, likely to meet
7. Ensure environmental sustainability: not met, carbon +46%, fast biodiversity loss, halve people without safe water: success five years early: +2.1b, 76% -> 89% but sanitation +1.9b, need more effort; improve lives of 100m slum dwellers: 200m
8. Global partnership: develop open financial system, not met: low tariffs affects 3% deal with LEDC debt, met: debt/export ratio 12% -> 3%, but bilateral aid fell 13% cooperate with private sector, spread tech, affordable drugs: not met no change

2.4 Reducing Disparities

Discuss the different ways in which disparities can be reduced with an emphasis on trade and market access, debt relief, aid and remittances.

Evaluate the effectiveness of strategies designed to reduce disparities.

remittances: Transfers of money/goods by foreign workers to their home countries.

3.1 Atmosphere and Change

Describe the functioning of the atmospheric system in terms of the energy balance between solar and longwave radiation. Explain the changes in this balance due to external forcings (changes in solar radiation, changes in the albedo of the atmosphere and changes in longwave radiation returned to space). Discuss the causes and environmental consequences of global climate change.

global climate change: The changes in global patterns of rainfall and temperature, sea level, habitats and the incidences of droughts, flood and storms, resulting from changes in the Earth's atmosphere, believed to be mainly caused by the enhanced greenhouse effect.

thermosphere (80–500 km): gas thin, shortwave radiation ionizes nitrogen, 1000°C, mesopause: high-energy radiation all absorbed by thermosphere, cold -90°C

mesosphere (50–80 km): no dust, ozone, clouds, water vapour to absorb heat, coldest, most windy (3000 kmh); lower more oxygen, warmer, stratopause -15°C

stratosphere (20–50 km): 90% of earth's ozone, absorbs shortwave UV radiation, temperature inversion, most UV rays already absorbed above, so lower cooler, warmer than troposphere so prevents it from rising away; tropopause -50°C

troposphere (0–20 km): 50% mass of atmosphere in lowest 6 km; bottom 17°C; pollution, dust, water vapour absorb longwave radiation, 78% N, 21% O, 1% Ar

insolation: incoming solar radiation, hot shortwave UV; moon, earth clouds absorb, emit cool longwave infrared; greenhouse gases better at absorbing longwave

19% insolation in atmosphere (2% cloud, 17% air); 34% insolation reflected to space (2% surface, 7% atmosphere, 25% clouds); 47% insolation absorbed by earth (19% directly on surface, 23% through clouds, 5% scattered by atmosphere)

depends on latitude: 38°N/S has net surplus energy but higher/lower more albedo (snow reflects 80% vs. trees 20%), lower angle (less intense), more atmosphere

external forcings: volcano ash, sulfuric gases make sulfate aerosols, stay for years; cooler, MX 1982 El Chichón reduced insolation from 94% to 86% for two years sunspots 11-year cycle, maximum activity has slightly more energy, lots more UV but after 1975 uncorrelated with global warming, despite Maunder minimum

Milankovitch cycles: 108k year stretch, eccentricity: shape of orbit (0 = circular), 0.005 to 0.058, now 0.017 and falling; aphelion furthest, perihelion closest, glacial when circular, interglacial when more eccentric, less time at perihelion; relative increase of insolation at perihelion is four times eccentricity; now 7%

42k year tilt, obliquity: Earth's axis tilts from 21.5° to 24.5°, now 23.4° and falling; less oblique, warmer winters, warmer air, more moisture, more snow, glacials

21k year wobble, axial precession (axial tilt) + apsidal precession (semi-major axis): now south pole points away from sun at aphelion, south more seasonal change

100k year incline: orbital inclination (relative to solar system), not by Milankovitch

greatest pattern in glaciation since 2 mya is 100k years but only eccentricity appears at 100k years, should have smallest effect; positive feedback or other reasons

enhanced greenhouse effect: anthropogenic increased greenhouse gas emissions, resonant frequency absorbs longwave that would leave; 33 C° cooler with none

global warming causes: more carbon dioxide, rock weathering, ocean acidification, Milankovitch cycles, ice melt, deforestation, changes in humidity, clouds, albedo

evidence: since 1880 temperatures rose 0.8 C°, CO_2 concentration increased 36%, 2000 Lake Chad evaporated, 2002 Larsen B Ice Shelf disappeared in 5 weeks, permafrost thaws, taiga drunken trees, land sinks, 1000x faster extinction rate, shorter winters: Western pine beetle epidemic, mosquitoes now affect Nairobi, past 40 years: Arctic ice 40% thinner, 80% Caribbean coral dead, more disasters

counterevidence: human carbon footprint 3% of total, scientists vested interests, 1940–1980 CO_2 rise most rapid but temperature fell; H_2O, CH_4 more important, 1960–1990 global dimming, 4% decline in insolation because aerosols; masking? Late Ordovician 450 mya CO_2 >5000 ppm (10 times today) still major glaciations; but 4% less insolation then, rock weathering, volcanoes stopped, soon CO_2 fell

benefits: more summer rain, warmer climates better agriculture, fewer cold waves, Russia huge untapped energy reserves, forests into tundra, Northwest Passage

drawbacks: glaciers melting, sea level rise, floods, more iron so ocean acidification; warmer oceans, thermal expansion: more El Niños, cyclones, tornadoes, storms; more heatwaves: less water, more erosion, soil degradation, desertification; 2003 Darfur War: drought, desertification, overpopulation led to bloody conflict; Greenland meltwater could halt thermohaline circulation, start European ice age, total financial costs estimated $5t over next century; also social, cultural costs

3.2 Soil and Change

Explain the causes of soil degradation.

soil degradation: A severe reduction in the quality of soils. The term includes soil erosion, salinization and soil exhaustion (loss of fertility).

soil formation: weathering breaks rocks into small particles, mixes with organics to make soil; 500 years to replace 25 mm of topsoil; need 150 mm for agriculture

mature soil has soil profile: organic layer at very top is humus, has most nutrients

soil erosion: natural process, removal and transfer of soil from one place to another, factors: temperature, vegetation, aridity, slopes, fire, soil; caused by wind, water, humans: deforestation, agriculture, overgrazing, urbanization increase erosion by removing vegetation, adding fertilizer; loosens topsoil, less humus nutrients

salinization: build-up of salt in soil; waterlogging: rise of salty water table, kills crops caused by irrigation, fertilizers, pesticides, heavy machinery, soil compaction; arid regions not enough rain to leach salts from soil; more water spreads impact

soil acidification: too much ammonium-based nitrogen fertilizers, no symptoms but soil becomes toxic, production declines by up to 30%; can treat by adding lime

soil exhaustion: not enough nutrients, from soil acidification, shifting cultivation, etc. slash and burn: burn crops, ash returns nutrients, good with long fallow periods; but more people -> demand -> shorter periods -> soil degradation -> low supply

3.2 Soil and Change

Discuss the environmental and socio-economic consequences of soil degradation, together with management strategies.

causes: 28% agriculture, 35% overgrazing, 30% deforestation; 66% agriculture in NA
erosion shrinks cropland by 10m ha/year; salinization loss from irrigation $11b/year
more land lost to salinization than gained from irrigation, 2/3 of countries affected
arable land 1961–2002 fell from 0.42 to 0.23 ha per capita, 1/3 cropland abandoned
desertification: all soil becomes infertile, Sahara growing southwards by 25 km/year, costs $45b/year but global cost of anti-desert interventions just $10b–$22b/year

water erosion, make terraces, plant crops on contours, add more organic (mulching), keep crop residues, use grassed waterways and keep vegetation to slow runoff
wind erosion, plant wind breaks, strip crop for natural dams, let field stubbles stay
salinization, scraping, sanding, subsoiling, mulching, flushing, leaching, draining, plant trees, use blue-green algae, desalinization not the answer: costly, polluting
acidification, use less acidifying fertilizer, grow deep-root and acid-tolerant species, irrigate better to stop leaching, sow crops soon after fallow periods for nutrients
soil exhaustion, leave field stubble to compost, rotate crops, longer fallow periods

3.3 Water and Change

Identify the ways in which water is utilized at the regional scale. Examine the environmental and human factors affecting patterns and trends in physical water scarcity and economic water scarcity. Examine the factors affecting access to safe drinking water.

physical water scarcity: Water resource development is approaching or has exceeded unsustainable levels; it relates water availability to water demand and implies that arid areas are not necessarily water scarce.
economic water scarcity: Water is available locally but not accessible for human, institutional or financial capital reasons.

drinking water: water used for domestic purposes (drinking, cooking, and hygiene)
safe water: meets WHO standards; water stress: supply < 1700 m^3 annually/capita
reasonable access: >20 L/day from improved source within 1 km safe drinking water
water use: withdrawal (withdrawn, altered, returned; pulpmills), consumption (withdrawn, not put back; agriculture), in situ (kept in natural state; recreation), in stream (kept in river; hydro power), inadvertent (pollution), or evaporation
Earth 70% water: 97% salty, 2% ice, 0.8% groundwater, 0.02% glacier, 0.01% surface
>1b no reasonable access, 1/3 in high stress countries, consumption >20% supply, irrigation 35% of global water use but 67% of withdrawal, 86% of consumption
by 2025 agriculture will need 1.2x more water, industry 1.5x, domestic 1.8x because more meat consumption, manufacturing industries, domestic utilities; irrigation MEDCs -1.5%, LEDCs +12%: arable land area limit almost reached except Africa
factors: level of economic development, 0.9 Spearman's correlation with GNI (PPP); SSA 43% urban, 24% rural; MEDCs 99% urban, 92% rural access to sanitation; natural disasters, Pakistan 2010 flooded 20%, 10m had to drink unsafe water; LEDCs sacrifice environment for economy; displaced populations less access; poor agricultural practices: soil erosion, leaching, contamination, eutrophication
China water overallocated, too focus on economy, fragmented policy, withdrawals; North China Plain lost 80% of wetlands, China's glacier melt fastest rate in world, 1400 pollution accidents in 2005, half on water; 300m without access to water
centralized management: Yangtze delta gone for >200 days per year; Beijing impose limits, solved; relies on large infrastructure projects, not management changes

3.4 Biodiversity and Change

Explain the concept and importance of biodiversity in tropical rainforests. Examine the causes and consequences of reduced biodiversity in this biome.

biodiversity: diverse gene pools, makes rainforests more resilient, gives varied diet, unknown vast potential for medicinal developments, help recover from disease, only 2% vascular plants screened for chemicals; Taxol from Pacific yew, cancer
tropical rainforest: hot, perennial plant growth, must all be evergreen to compete, high biodiversity from competition, 250 species in 1 hectare vs. 6 species in GB; 80% all insects in jungle, 8m/ha; regulate climate, clean water, promote tourism
causes: shifting cultivation, slash and burn, swiddening all lead to deforestation; but global rate declining since 1980s; predict global forests will grow by 10% by 2050, most deforestation in tropical LEDCs sell timber; agricultural or urban expansion, Africa 50% from fuelwood need; more erosion, forest floor very low nutrients
Brazil deforestation: 1/3 of rainforest, most biodiverse: >56k plant 1.7k bird species, Brazil 15% of all rainforest cleared since 1970s; correlates with economic health so Trans-Amazon Highway open forest to farmers, ranchers but sediments made highway unstable, inundated; soils quickly exhausted, rainforest now wasteland

3.5 Sustainability and the Environment

Define the concept of environmental sustainability. Evaluate a management strategy at a local or national scale designed to achieve environmental sustainability. Notes on this topic are in Option A Section 4 (water, FREMP) and Option G Section 4 (Vancouver Livable Region Strategy, Greenest City 2020 Plan).

Sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland Report)
1997 Kyoto Protocol: ratifiers agreed to reduce CO_2 emissions by 5.2% below 1990 levels by 2012; reduces emissions by 30% but only postpones 2C° rise for 6 years, cost could solve all sanitation issues instead but green economy also makes jobs
2001 Intergovernmental Panel on Climate Change: temperature rise 1.7C°–6.1C°, sea level rise 9 cm–88 cm in 1990–2100; but not PPP, so overestimated growth

4.1 Patterns of Resource Consumption

Evaluate the ecological footprint as a measure of the relationship between population size and resource consumption. Identify international variations in its size. Notes on this topic are in Option G Section 4.

Discuss the two opposing views (neo-Malthusian and anti-Malthusian) of the relationship between population size and resource consumption.

resource: something useful; natural (soils), human (workers), or capital (tractors)
carrying capacity: maximum population an environment can sustain indefinitely
exceeding carrying capacity leads to overshoot, then die-off, finally slow recovery
Malthusian, Thomas Malthus: food producing growth linear, population exponential
neo-Malthusian, Paul Ehrlich: control growth by preventative checks (lower fertility) or positive checks when exceeding carrying capacity (famine, disease, violence)
Ester Boserup: population determines agriculture: GMO, fertilizer, land reclamation food growth > population growth for past 200 years, only problem is distribution
anti-Malthusian, Julian Simon: price measures scarcity but price falling (oil, metals); higher price spurs research, substitution, recycling; an extra person is a resource
1980, Simon bet Ehrlich natural resources will be cheaper; Ehrlich chose five metals, prices all went up 1950–1975 but all fell in 1980s (but 1979 oil price doubled)
1995, Simon claimed everything will improve; two climatologists bet $1000/trend, for 15 will worsen (temperature, fisheries, cropland, AIDS, wealth gap, CO_2, SO_2); Simon declined, only bets direct measures (life expectancy, leisure time, wealth), but these all unsustainable; renewable resource depletion more symptomatic

4.2 Changing Patterns of Energy Consumption

Examine the global patterns and trends in the production and consumption of oil.

Examine the geopolitical and environmental impacts of these changes in patterns and trends. Examine the changing importance of other energy sources.

oil production 1999–2009 +11%; SA > US > RU to RU > SA > US; largest increase in Middle East since 1980; after 2005 Middle East declines, Russia 51% of increase; by 2025 only SA, IQ, RU, UAE, Kuwait can increase; peak oil when no reserve left
oil reserves: 30% conventional (cheapest), 25% extra heavy, 30% bitumen/oil sands (most expensive); Athabasca oil sands (1967 30k bbl/day, 2005 760k, now 1.3m)
oil consumption 1965–2006 tripled; US > CN, JP, DE, RU, IT, FR together >50% total, 1973 small decrease (OPEC embargo), 1980–1985 major decline (Asian crisis); main energy source since 1970; 1999–2009 US 16m -> 18m, JP 5m -> 4m bbl/day, CN 1990–2006 consumption 2.3m -> 7.4m bbl/day, production 2.8m -> 3.8m
environmental impacts: extraction damages coasts, pollute groundwater, spills oil, Athabasca: 40m tons greenhouse gases, enough natural gas to heat 3m houses, 80 km^2 of oilsands byproducts in tailing ponds, uses 11m L of toxic water per day
geopolitical impacts: Gulf War, OPEC power, 22% oil in state sponsors of terrorism, Arctic sovereignty conflicts; notes on this topic are in Option B Section 4.
oil: 34% of world energy, popular because infrastructure exists (pipelines, tankers), low export costs, rich companies have lobbying power, alternatives unavailable
nuclear: 11% of world electricity, increased since 1970s but falling now; efficient, 8.4m L gasoline for 1 kg enriched uranium, no greenhouse gases, lots of uranium but still non-renewable, uranium mining dangerous, transportation costly/risky, terrorist threat, waste disposal hard, nuclear accidents: Chernobyl, Fukushima
coal: 30% of world energy, 40% of electricity, most common fossil fuel, 8b tons/year, makes steel, cement, liquid fuels; 66% CN electricity coal, only 40 years reserves; in gasoline, diesel, kerosene; catalytic converters reduce NO_X; but coal very dirty, emits methane, particulates, mercury, SO_2, low efficiency, take days to power up

renewable energy: 50% biomass, 35% hydro, 9% wind, 5% geothermal, 1% solar; 1900 world 50% renewable; now 20%, most in LEDCs, >2b depend on fuelwood
biomass: burn firewood for fuel, spread manure for fertilizer, ferment sugarcane; Brazil 1975 Pró-Álcool, ethanol to replace gas, so 2006 net energy independent, 1975 production 600m L, 3x cost of gas; 2010 ethanol 27.6b L, cheaper than gas, cost $1b/year but saved 1.5b bbl gas = $75b = 100m tons of carbon, pollution; biomass carbon neutral, less pollution, evenly distributed, steady distribution, but takes away agricultural land, deforestation, hard to transport: bulky, watery
hydro: 1920s 40% of energy, 1980s 20%; but still gives 85% of renewable electricity, >1b people with power; high initial cost but low production cost, multi-purpose, clean, can meet demand surges; but notes on this topic are in Option A Section 3.
wind: fastest growing energy source, can grind grain, pump water, make electricity, no pollutants, no waste, no water, inexhaustible wind, recyclable, cheap to run; but kills birds, must dig deep into earth, costly to build, unreliable, looks bad
geothermal: 26% of energy, 87% of hot water for Iceland, no more peat/coal import, no combustion, plentiful thermal energy; but limited to tectonic plate boundary
solar: efficient on small-scale, safe, clean, unlimited, $50k to power average home, growing fast; but still expensive, inefficient, depends on weather, dirty materials
ocean: thermal/mechanical energy from tides, still experimental, only one, in Japan; could easily provide >100k TWh/year but if near ocean, unreliable, expensive

4.3 Conservation Strategies

Discuss the reduction of resource consumption by conservation, waste reduction, recycling and substitution. Notes on this topic are in Option G Section 4.

Evaluate a strategy at a local or national scale aimed at reducing the consumption of one resource. Notes on this topic are in Option A Section 4.

conservation: more efficient ways to use, usually out of desire to increase profits
reduction: less use, by raising prices (petrol, electricity), alternatives (online paper)
recycling: re-use, with compost (fertilizer, fish feed), aluminum, plastics; LEDC jobs but hazardous (Guiyu), costly (paper easily polluted, cheaper to dump in landfill) Burnaby: garbage -> steam; sawdust -> boards; metal -> rebar; ash -> asphalt
substitution: new use, coal -> gas, 2015 NY Styrofoam ban -> aluminum, paper, corn

A.1 The Water System

the hydrological cycle: Examine the inputs, outputs, stores and transfers of the hydrological cycle. Discuss the causes and consequences of the changing balance between water stored in oceans and ice.

the water balance: Explain the concept of maximum sustainable yield of freshwater in terms of a balance between inputs and outputs.

maximum sustainable yield: The maximum extraction of water that can be maintained indefinitely for a given area.

stores: atmosphere -> vegetation -> surface, ice -> channels -> soil -> groundwater
down transfers: rain, interception, stemflow, throughfall, infiltration, percolation
side transfers: overland flow, floods; interflow, throughflow; baseflow, recharge
up transfer: capillary rise; outputs: evaporation, transpiration, leakage, runoff
sea level rise: 58% thermal expansion, 28% glaciers, 7% W. Antarctic, 7% Greenland deltas 70% more people by 2050; 1900–2000 17 cm rise; IPCC: 28–43 cm by 2100, coastal erosion, wetland floods, aquifer salinization, wildlife habitat destruction
global warming: less glacier runoff (needed for hydro power, fish runs, irrigation), may halt Gulf Stream, thermohaline circulation; allow Arctic navigation, fish, oil; reduce heating bills; melt permafrost, release methane, fresh water, arable land
ocean output > input (no shade, windy); land input > output (relief/convection rain)
max yield exceeded if precipitation/infiltration falls, withdrawal/evaporation rises

A.2 Drainage Basins and Flooding

drainage basins: Examine the functioning of a drainage basin as an open system with inputs, outputs, transfers, stores and feedback loops. discharge: Define stream discharge. Examine its relationship to stream flow and channel shape.

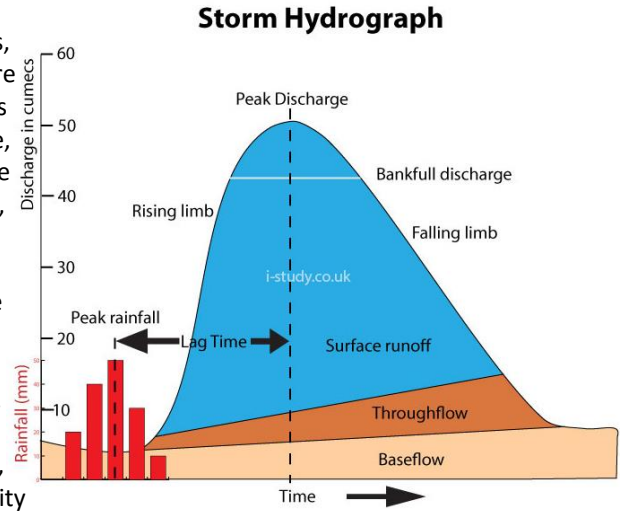
hydrographs: Describe the characteristics of a hydrograph. Examine the reasons for spatial and temporal (short-term and long-term) variations in hydrographs. Examine the role of hydrographs in forecasting the magnitude, spatial extent and timing of floods.

floods: Discuss the natural and human causes and consequences of a specific flood

drainage basin: The area drained by a river and its tributaries.
drainage divide: Also known as a watershed or interfluve, it is the line defining the boundary of a river or stream drainage basin separating it from adjacent basin(s).

Strahler stream order counts tributary depth; bifurcation ratio = order n+1 / order n
drainage density = total length over basin area; less if old, flat, permeable, vegetated
discharge = velocity × cross-sectional area; wetted perimeter = length of bed, banks
efficiency, hydraulic radius = area over wetted perimeter; best at bankfull discharge
velocity $v = R^{2/3}S^{1/2}/n$ (hydraulic radius, bed slope, Manning's roughness coefficient): n (uniform–irregular) = 0.02–0.08 (sand), 0.03–0.09 (gravel), 0.05–0.1 (boulders)
Bradshaw: downstream more area, velocity, load; less roughness, slope, load size
long profile, elevation vs. distance; knick points from lithology (waterfalls, rapids), sea level (rejuvenation, downcutting, incised meanders, terraces), load changes

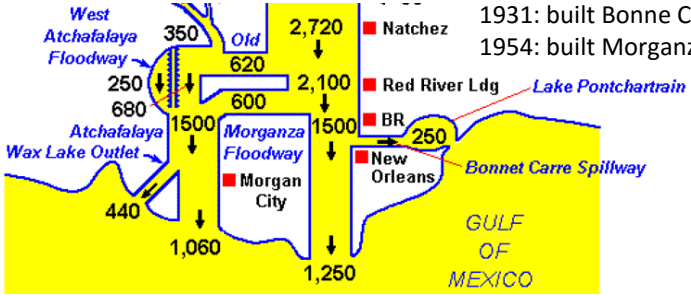
urban areas impermeable, more drainage channels, so shorter lag time, more steep rising/falling limbs
circular basin short lag time, so higher peak discharge
large basins low infiltration, so flatter falling limb
flat basins high infiltration, so lower peak discharge
variations: amount of rain, temperature changes, soil infiltration capacity, rock type, permeability, vegetation interception, gradient, drainage density



irrigation canals, fallow fields more discharge; terraces, contour ploughing less
hydrographs measure water volume at gauging stations at intervals; predicts floods by combining data from many hydrographs and considering local topography but must extrapolate and cannot predict if defences can withstand impact

2013 Alberta High River floods, highest ever measurement 50 km upstream at 1 am; prepared for 110 mm, predicted 150 mm day before, actual 325 mm in 48 hours, 10x flow, 2:30 gauges had 1k m^3/s, 4 am told fire chief to prepare for 650 m^3/s; state of emergency 7 am, flood warning 8:45 am, 1270 m^3/s; peak at 1800 m^3/s
no evacuation time, 5 deaths, $5b damages, most insurable damages in CA, $1.7b

Mississippi River: 90% discharge comes from Ohio River, 1927 flood: 600k homeless
1931: built Bonne Carre, successful
1954: built Morganza diversion, success



A.3 Management Issues and Strategies

dams and reservoirs: Examine the hydrological changes resulting from the construction of dams and reservoirs. Examine the costs and benefits of dams and reservoirs as part of multi-purpose schemes.

floodplain management: Explain the stream channel processes (erosion, transport, deposition) and explain the resultant landforms found on floodplains. Examine the human modifications of a floodplain and their effect on the size and probability of floods. Evaluate the costs and benefits of alternative stream management strategies.

groundwater management: Explain the functioning and management of artesian basins and aquifers, distinguishing between natural and artificial recharge. Examine the environmental impacts of groundwater abstraction.

dams increase storage, evaporation, mass movements on shaky rocks (1963 Vajont), decrease water table, discharge, downstream flooding but less flushing to clean, load deficit so clearwater erosion, less vegetation/nutrients but easy navigation; reservoir traps sediment, stagnant, diseases; but safer supply, wildlife habitat

Aswan High Dam: 1960–1970 $1b, 4 km × 111 m; Lake Nasser 550 × 35 km, 111 km^3

irrigated 400k ha barren land, 300k ha double-cropped; 10b kWh/year, 2m tons oil, 90% reduced floods, 500m/year economic benefit: tourism, Lake Nasser fishing

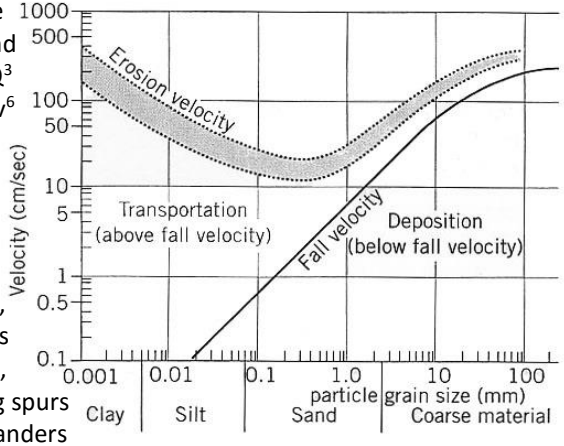
initially 3000 fishery jobs lost, sardine yields down 95% total fisheries down 77% but by 2009, 400% more $100m/year fertilizers, fishery catches triple 1970 yields

evaporation: had less than half of expected water; Nile Delta erosion 2m/year, salinization in 33% of irrigated land; higher saline water table; 1981 earthquake, 100m tonnes/year infilling; 100k Nubians displaced; Abu Simbel temples moved

erosion: hydraulic action weak; sediment strong: channel abrasion, load attrition, chemical corrosion; more erosion if soft rock, more load, acid, speed, discharge

load types: dissolved (in solution), wash (fine silt, suspended), bed (coarse material) bed load bounces (saltation), big rock rolls (traction), driftwood floats (flotation)

Hjulström curve, velocity vs. size



clay, silt more cohesive than sand

capacity: largest load amount, Q^3

competence: largest grain size, v^6

boulders deposited in streams, sand floodplain, silt estuary, dissolved load in the ocean

deposition if river slows down, when entering a sea or lake, if more load (after landslide), if low rain or overflows banks

upper course: waterfalls, gorges, rapids, potholes, interlocking spurs

middle course: alluvial fans, meanders

lower course: oxbow lakes, braided rivers, levees, bluffs, deltas, wide floodplains

stream on alternating hard and soft rock erodes like a staircase, creating rapids

stream on hard rock erodes soft rock below; undercuts back wall, overhang falls, forms plunge pool, eventually retreats; becomes rapids or cuts a U-shaped gorge

canyons usually formed by entrenched rivers downcutting resistant uplifting rock

rising base level: river aggrades, floods; falling base level: river incises, rejuvenation

steep rivers form alluvial fans on plains; flood risk: 2008 Koshi River, 1m homeless

braided river: small shallow channels between aits, if high load, variable discharge

interlocking spurs (water erodes weak rock joints), unlike meanders (water bipolar)

meanders flow through deep pools, and around shallow riffles; thalweg fastest flow, alternates between depositing point bars (slip-off slopes) and eroding river cliffs

corkscrew helicoidal flow moves load among meanders; asymmetrical cross-section

sinuosity: river length over birds-eye distance, meandering river sinuosity > 1.5

lateral migration through concave bank scour, valley slope instability, flood scour

oxbow lake when floods cut meanders, later becomes backswamp, meander scar

levees: flood deposition embankments, unconsolidated alluvium makes floodplain

yazoo stream: tributary parallel to main river, separated by levees (Yazoo River, MS)

river terrace: new floodplain separate from old, when base level or load changes

graded stream: a stream with a smooth long profile; transports load most efficiently

urbanization: storm drains increase velocity, bridges increase upstream flooding, embankments decrease width increase height, buildings decrease vegetation, asphalt decrease infiltration/percolation/storage/evaporation increase velocity

hard engineering: channel enlargement (costly), straightening (worse downstream), diversion spillways (needs land), embankments with sluice (raise flood levels), dams/reservoirs (needs land), levees (costly, raises channel bed, worse if fails), flood proofing (not large-scale), dredging (needed frequently, bad for fish)

soft engineering: floodplain zoning (only if undeveloped), settlement removal (bad), strip cultivation, contour plow, terraces (not big floods), controlled floods (bad), wetland restoration (reduce farming land), river restoration (undoes the work)

porosity: intergranular pore density, gravel > 40%, sandstone < 30%, shale < 10%

permeability: ability to allow fluids to flow; sand, limestone high; clay, silt, shale low

water table divides vadose/phreatic zones, soil/ground water, through/base flow

recharge areas high hydraulic head, infiltration; discharge areas springs, rivers, sea

aquifers hold water, aquitards slow water, aquicludes stop water; artesian springs made if confined aquifer piezometric surface above ground level; pumpless well

recharge down bore holes, large porous surface reservoirs, or stream recharge well

Great Artesian Basin AU artesian aquifer, 20% surface area, 536m m^3 taken per year but recharge takes thousands of years, mining lowered water table by 120m, reduces baseflow, coastal saltwater intrusion, lower pressure, compresses rocks, subsidence, sinkholes: Mexico City sank > 8 m, Bangkok 10 cm/year, US 44k km^2

management strategies: desalinization (only if coastal), repair leaks (lots of them), artificial stores (impact hydrology), recycle grey water (only individual impact), drip irrigation (costly), water metering (politics), water treatment (costly)

A.3 Management Issues and Strategies

freshwater wetland management: Describe the role of wetlands as a water resource. Evaluate the effectiveness of the management strategies that have been adopted in a major wetland.

irrigation and agriculture: Examine the environmental impact of agriculture and irrigation on water quality: salinization, agro-chemical run-off, the pollution of groundwater and the eutrophication of lakes, rivers and wetlands.

wetlands: Areas that are regularly saturated by surface water or groundwater.

6% of earth's surface: woody swamps (high minerals), grassy marshes (low oxygen), mossy bogs (acidic, low nutrients), peaty fens (alkaline, minerals, low nutrients)

values: tourism, transport, biofiltration, biodiversity, flood control, storm protection, mangroves, erosion defence, methane storage, groundwater recharge/discharge, Spahgnum moss absorbs 20 times dry weight, food: cranberries, estuary fisheries

half of all wetlands lost in 100 years: urbanization, pollution, agricultural demand

Florida Everglades: Lake Kissimmee to Lake Okeechobee 80 km, river length 160 km, water level 1–1.7 m higher than today, 94% of floodplain wet > 50% of the time, 1971 $20m channelized to 90 km to control floods, supply water, protect farms but lost 14k ha wetlands, 92% drop in winter waterfowl numbers, hypoxic water

1999 $578m restoration: dechannelize, backfill C-38 canal, make 11k ha wetlands, restore 100k ha floodplain, higher evaporation but more recreation, ecotourism, now 5 times wading birds, normal oxygen, Lake Okeechobee less eutrophication

agriculture most water use, 30% in MEDCs, 82% in LEDCs; 90% of irrigation in LEDCs gravity flow cheap, erodes, salinizes, waterlogs; drip systems efficient but costly

irrigation 1/3 of crops, more food availability, productivity, jobs, lowers food prices

eutrophication: high nitrogen (fertilizers), phosphorus (farm sewage) -> algal growth, algal blooms deplete oxygen, block sunlight, clog canals, algal toxins kill good fish

US 72% rivers 56% lakes impacted by agricultural pollution: manure, salts, nutrients, pesticides, herbicides, nitrogen, phosphorus, heavy metals, pathogens, sediment

Aral Sea fourth-largest freshwater lake; Amu Darya, Syr Darya 111 km^3 annual flow, hot, dry, flat plains, steppe grasslands, low moisture salty sand, used for 6k years

1924 Uzbekistan in USSR, irrigation 1928 1.2m, 1950 2.2m, 1990 4.2m, 2009 3.3m ha

raw cotton yields: 1921 14 tons, 1935 1m tons, 1950 2m, 1990 6m, 150k km ditches but 75% water lost in canals; volume shrank by 90%, salinity 10 g/L to 100 g/L, Moynaq 60k fishing jobs, now 100 km away; 1988 May 434k Saiga antelope died

1980s annual flow only 2 km^3, needs 30 km^3 to maintain; 20/24 fish species gone, 1990 death rate twice 1970, 80% women anemic, esophageal cancer 50x average

1950s 30 days without rain per year, now 150; exposes salts, pesticides, bioweapons

no unified policy: 1995 Karakum Canal diverted 18 km^3, fountains huge evaporation, collectivization heavy machinery mass erosion, dust clouds, not enough money to enclose canals (only 12%), pump Caspian Sea water, charge river tax, desalinize

A.4 Competing Demands for Water

conflicts at the local or national scale: Examine the competing demands for water in a specific river basin. Evaluate the strategies that have been adopted to meet these demands.

conflicts at the international scale: Discuss an example of an international conflict related to freshwater.

Vancouver water conservation: CA 2nd most water consumption per capita after US, 60% consumption residential; since 1993 per capita in-home winter water use fell >1% a year, since 2005 >2%; now total water use in 1987 more than in 2007

businesses: water auditing, SmartSteps, BuildSmart to increase water conservation

at home: education, elementary half-hour live theatre presentation, the A2Z of H2O, regulation, 1993: lawn sprinkling, 1995: buildings need low-flow toilets, showers, subsidies, 1995 rain barrels, 2005 indoor water saving kits, 2006 outdoor too!

2007 new filtration plant for Capilano, Seymour reservoirs; less turbid, more water

Smart Meters $500–$1000 per home, reduce use by 10%–15%, save $35–$55 a year

Fraser River Estuary Management Program: since 1994, merged into BIEAP in 2008, most productive salmon river in world, most wintering waterfowl in Canada but lost 70% of wetlands since 1800s; goal: no net loss; plan: colour-code shoreline, red, most productive: 70%, cannot alter habitats except for health/public safety yellow, moderately productive: development allowed but must make more red green, least productive: development allowed without needing compensation

other plans: monitor water quality, protect important areas, reduce dredging, reduce debris from log handling, preserve viewscapes, recreation, and trails

results: upgraded two wastewater treatment plans in 1998, main reason for quality; dredging: well under sediment budget; log storage: 93 needed change, all done; toxic contaminants: 1985–1998 85% less; wildlife habitats: 1986–2000 +9.23 ha

Colorado River: flow southwest from Rocky Mountains 2334 km to Gulf of California, flows through Colorado, Utah, Arizona, Nevada, California, final 120 km Mexico; but so much irrigation that it dries up; salinity 50 ppm at head, 1200 ppm in MX; climate dry, warm, coastal; arid, high evaporation but good for growing plants; urban growth, California 1945 7m, now 37m; affluence, Palm Springs pools, golf

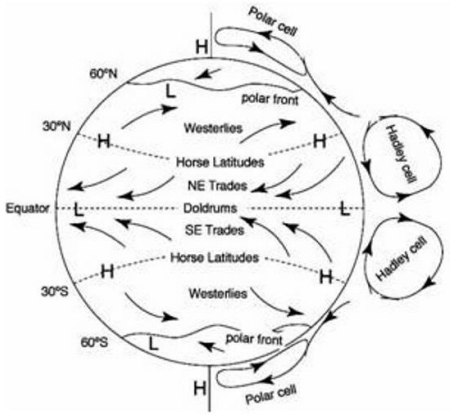
1922 River Compact: divide flow into upper and lower basins at Lees Ferry, Nevada; based on 18.5b m^3 annual flow but fluctuates, was unusually wet, actual 16.6b; built many dams to regulate flow (Hoover Dam), long canals (All American, Gila)

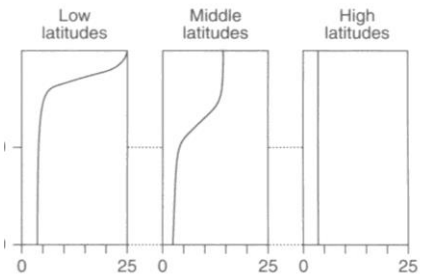
1944 US/MX Treaty: guarantee MX 1.85b m^3 but often soaks into bed, evaporates; once vast wetland, now dry salt flat; Copacha Indians dislocated; MX poverty; agreed to limit salinity to 115 ppm, 1992 built Yuma Desalting Plant, 270m L/day but costly, only operated one year between 1993 and 2008, very ineffective

B.1 Introduction to Oceans

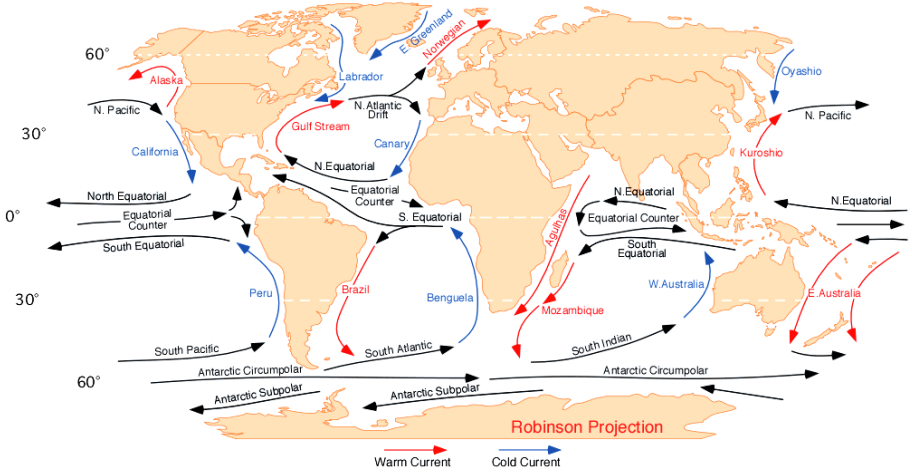
distribution of oceans: Describe the distribution of oceans and ocean currents.
oceanic water: Describe the horizontal and vertical spatial variations in the temperature and salinity of ocean water.
morphology of oceans: Describe the main features of oceanic crust and ocean floor morphology. Explain the occurrence of oceanic volcanic features, trenches, transform faults, mid-ocean ridges and rifts in terms of plate margins.

wind: low pressure warm air rises in calm intertropical convergence zone
polar cell, Ferrel cell, Hadley cell: dry air descends in horse latitudes, Coriolis effect deflects westward, angular momentum conservation





winter oceanic temperature vs. depth



convection in asthenosphere causes upwelling; oceanic sima, continental sial crust
divergent rifting makes ridges; convergent subducting makes trenches, island arcs
transform faults zigzag ridges; volcanoes in Ring of Fire (most), Mid-Atl. Ridge (third)
divergent thin crust pressure, convergent flux melting: mantle melts; also hotspots
guyots have flat tops due to surface erosion; seamounts never reach the surface
continental margin separates oceanic crust: rise, slope, shelf, then abyssal plain

B.2 Oceans and Climate

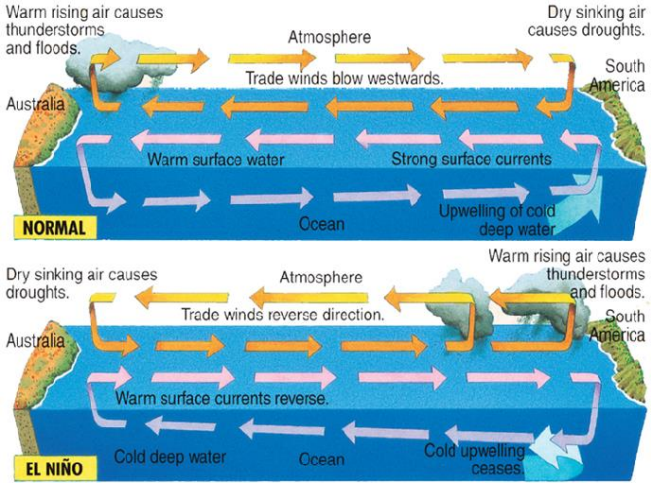
energy transfers: Explain the thermal transfers of energy within oceans and the importance of oceanic conveyor belts.
El Niño Southern Oscillation (ENSO): Explain the atmospheric–oceanic interactions associated with ENSO. Explain the El Niño and La Niña phenomena and their climatic, environmental and economic effects.
carbon dioxide: Explain the role of oceans as a store and source of carbon dioxide.
oceanic conveyor belts: A global thermohaline circulation, driven by the formation and sinking of deep water and responsible for the large flow of ocean water.

warm currents raise polar temperatures in winter; water moves from cool to warm
shallow water cooled in N. Atl. (evaporative cooling) and Southern (polynyas no ice)
deep water warmed in Indian, S. Pacific; equilibrium keeps mid-latitude thermocline
turbulence in upper mixed, deepest at equator; oceans 30% global energy transfers
surface currents, circular gyres wind-driven, Coriolis except Antarctic circumpolar

litorral zone: intertidal
neritic zone: cont. shelf
pelagic zone: open sea
benthic zone: seabed

euphotic: epipelagic
disphotic: mesopelagic
aphotic (without light): bathy-, abysso-, hadal-

pycnocline: density
halocline: salinity
thermocline: temp.



1997–1998 ENSO: US $25b economic impact, cancelled out: more sales, less skiing, less heating, but $2.6b property and $2b agricultural losses, 1% of total crop output
Alberta: 8°C hotter, oil industry good; but drought, 14% of normal rainfall, fire risk
BC: less accidents, ICBC saved $3m/day; but logging roads thawed, sawmills closed
Peru: less fish, six years of normal rain in 12 days in March, 250k km damaged roads
Indonesia: worst drought in 50 years, late monsoons; burned 20m acres rainforest
PNG famine, Texas heat wave, Mexico wildfires; 23k worldwide deaths, $33b costs

largest carbon sink, slows atmospheric changes; biological pump: negligible help but solubility pump: most in cool water, upwelling outgases, CO_2 -> H_2CO_3 -> $HCO_3 + H_3O$
oceans absorbed 40% of anthropocentric CO_2, 8.2 pH -> 8.1 pH, 30% acidity increase
algae, seagrasses benefit; but reduces carbonate saturation so calcifying species die
projected pH and carbonate levels of 2100 dissolves sea butterfly shells in 45 days

B.3 The Value of Oceans

resource base: Identify the biotic and abiotic resources of continental shelves, oceans and ocean floor deposits.
fishing: Examine the spatial and temporal consequences of overfishing.
waste: Discuss the implications of the pollution of oceans by the disposal of radioactive material, oil and chemical waste. Describe the sources and distribution of pollution in the oceans.

fish 16% of world protein: fishmeal in feed and fertilizers, fish oil in moisturizers
>5k sea sponge drugs: anti-biotic (Manoalide), -viral (Vidarabine), -cancer (Ara-C)
abiotic: 80% trade transported by ship, communications, power: wave, ocean, tidal
2005 BC ocean 8% total, $11.6b: $3.8b recreation, $3.3b transport, $1.4b seafood
ocean floor deposits, potential but rarely exploited, habitat; 60% US Mg seawater
manganese nodules: Mn, Fe, Si, OH, up to 75 kg/m^2 1–3 mm/mya, easily collected
cobalt crusts on volcanic substrates, 2% cobalt, available in few countries on land
black smokers: hydrothermal vents, geothermically heated water has Cu, Zn, Ag, Au

most expansion in late 1980s; by mid-1990s a third of ocean, two thirds of shelves
primary production <90% of required levels; only unproductive high seas left
1960–1995 land agriculture doubled, 10% area increase; fisheries 2.4x, 300% area
30% low-value anchovies, sardines; processed into feed, e.g. for shrimp, salmon
1997 landing declines in Atl. vs. peak: NW 1968 -55%, SE 1978 -67%, NE 1976 -12%
FAO: 30% fish stocks already depleted by overfishing: Atl. cod, haddock, redfish
fish production from capture fisheries increase: 1950s 6%, 1980s 1.5%, 1990s 0.6%
lower trophic level: NW Atl. piscivores 42% -> 12%, zooplanktivores 28% -> 39%

B.6 Coral Reefs and Mangroves

Examine the development and the environmental and economic value of coral reefs and mangrove swamps. Examine the causes and consequences of their loss.
corals/zooxanthellae symbiosis; algae remove waste, give oxygen; 90% efficient
fringing reefs -> barrier reefs -> atolls; SEA most biodiversity, 95% reefs threatened
15 tons of seafood/km^2/year; fisheries, tourism, protection cost $1m in 25 years
coral bleaching: stressed polyps expel algae; 2030s warming 50% reefs; 2050s 95%
1997–2007 58% -> 75% threatened; overfishing most threat, more people -> +80%
23 countries reef tourism >15% GDP; protect coasts; 275m people within 30 km
reefs benefit $30b/year; 25% of fish species; 1980–1993 60 bleaches, 2002 >400
Jamaica 1980s ENSO, Hurricane Allen, 99% urchins died: 1970s 50% reefs, 1990s 5%
mangrove swamps <- salt-tolerant, in mud flats <- estuaries tidal silt deposition
75% commercial tropical fish in mangroves, shield coastlines, retain soil/nutrients,
higher water quality, flood mitigation, CO_2 sequestration, renewable fish/wood
10% of land-to-sea dissolved organic carbon in mangroves; maintain CO_2 balance
Asia 400k ha mangroves into shrimp farms but salty soil, disease, bad JP economy
1980 20m ha -> 2000 15m; Bangladesh wild shrimp decline despite largest export

B.4 Geopolitics of Oceans

sovereignty rights: Discuss the sovereignty rights of nations in relation to territorial limits and exclusive economic zones (EEZ).
Evaluate a conservation policy implemented to provide sustainable fish yields.
Examine a geopolitical conflict in relation to an oceanic resource, other than fishing.
exclusive economic zone: An area in which a coastal nation has sovereign rights over all the economic resources of the sea, seabed and subsoil, extending up to 200 nautical miles from the coast. (1 nautical mile = 1.85 km, 200 nmi = 370 km)

North Sea, Sea of Japan most polluted; debris kills 1m seabirds, 100k mammals/year
136b kg plastic/year needs 8% of oil; 10% goes to ocean; transports invasive species
SU: 7k tons solid, 1600 m^3 liquid radioactive waste, 18 subs' reactors in Kara Sea, but frozen over, have not detected fish contamination; but must decommission
Vancouver sewage has Mg, Pb, Cr, Cu, PCBs, PAHs; pumps raw sewage in heavy rain, bioaccumulation, storm drains have oil, grease, detergents, pesticides, fertilizer
2010 Deepwater Horizon 3.19m bbl oil for 87 days; toxic dispersants, killed 33% fish, hit 1000 mi coastline, tourism; 140m L from spills, 1374m L down the drain/year

1982 UN Conv. on the Law of the Sea, 157 signatories, Part XI Int'l Seabed Authority so US unsigned; all from baseline: mean low-water or if indented, straight line
UNCLOS III: internal waters prohibited, 12-nmi territorial waters innocent passage, 24-nmi contiguous zone hot pursuit area, 200-nmi EEZ: navigation, flight, cables,
continental shelf: 200-nmi or margin up to 350-nmi or 100-nmi from 2.5 km isobath: 60-nmi from foot of slope or sediment thickness/distance > 1%: seabed rights

Grand Banks cod 1959 360k tons, 1968 810k (80% foreign), 1977 150k, 1992 none
Int'l Commission for the NW Atl. Fisheries 1970 set Total Allowable Catch quotas, SU, ES, FR, PT overexploitation; 1962–1977 northern cod biomass dropped 82%
1977 EEZ except nose/tail/Flemish cap; 1979 NW Atl. Fisheries Org. replaced ICNAF, reduced TAC to 60% of maximum sustainable yield; predicted 1990 400k tonnes
gov't subsidized capacity; 1981–1990 EI 50% of fishermen's income, 1980s used $8b
1993 moratorium, lost 40k jobs; 2010 10% original stock: cool, low food, bad genes
strategies: moratorium, EEZ, limit trawlers/nets, less bycatch, kill predator seals
challenges: fish migrate, 1995 Turbot War, OK, costly equipment, unpopular
Barents Sea: 1970s 1.5m tons, 1980s 900k; 1990 quota 160k, recovered 2013 1.3m

2008 USGS: Arctic 412b boe, 20% of world total undiscovered; 2014 oil 31b bbl/year
Northwest Passage international (>12-nmi) or internal (frozen ice Is land, no ships)
1969 supertanker Manhattan, 1985 icebreaker Polar Sea: more US/CA treaties
DK/CA Hans Island in middle; US/CA Beaufort Sea 141st meridian or perpendicular
Lomonosov Ridge, Mendeleev Ridge in Amerasian Basin, RU: extensions of Eurasia
Barents Sea (NO/RU) Loop Hole resolved 2010, equidistant from median, meridian
2008 Ilulissat Declaration: block any new international legal regime (Arctic Council)
CA military: 2005 $720m icebreaker, $1.3b by 2021; Nanisivik; Operation Nunalivut

B.5 Coastal Margins

physical characteristics: Examine the relationship between coastal processes (tides, wave action, littoral drift, wind action), lithology, subaerial processes and different coastal landforms. Identify the major landforms of beaches, dunes and cliffs along advancing and retreating coasts.

management strategies: Discuss the conflicts that arise from competing land uses and from attempts to manage coastal hazards (tsunamis and storm surges, erosion, cliff failure), pollution, habitat restoration and aquaculture.

Describe the conflicting pressures on a particular coastline. Discuss the management strategies adopted to resolve these pressures and evaluate their effectiveness.

longshore drift: The movement of sediment along a coast by wave action.

advancing coasts: Depositional coasts that are growing as a consequence of sediment deposit and/or the infill of coastal marshes. Advancing coasts may also arise from a negative change in sea level (sea level fall or uplift of land).

retreating coasts: Coasts along which the dominant processes are erosional, resulting in the coastline moving inland. Retreating coasts may also be caused by a positive change in sea level (sea level rise or a fall in land level).

marine processes: abrasion (load scraping), solution (acidic water on limestone), attrition (load rounding), hydraulic impact (wave compresses air, 30 tonnes/m^2)

subaerial processes: mass movement, corrosion, weathering (salt, frost, bio), runoff

more factors: fetch (water length under given wind), reefs, vegetation, temperature

littoral drift when prevailing wind brings swash up at an angle to backwash down

flat concordant strata parallel to coastline, jagged discordant coasts perpendicular

wave refraction makes fronts parallel, focuses energy on flanks, dissipates in bays

rip currents: strong backwash through breakers funneled between longshore bars

constructive: low height/gradient/energy, long period (8–10 s), strong swash

destructive: high height/gradient/energy, short period (5–6 s), strong backwash

tidal erosion little energy, but exposes coasts: wave-cut notch collapses into bench

centripetal and gravitational forces: lowest neap tide, highest spring tide at perigee

steep cliff becomes lower-angle subaerial cliff and lengthened 1° wave-cut platform

caves, wear through headland -> arch, collapse -> seastack, below high-tide -> stump

isostatic rebound: raised beaches; eustatic fall: ria (river valley), fjord (glacial valley)

deltas: arcuate (fan, Nile), cuspate (juts out, Tiber), bird's foot (splits jut, Mississippi)

beds: bottomset (turbidite), foreset (inclined bulk), topset (horizontal extension)

beaches: berms (tide ridges), storm beach (highest berm), cusps (graded sand arcs)

backshore above high-tide, foreshore on low-tide, nearshore to bar, offshore after

sequence: crescentic bar -> megacusp -> welded bar; rip channel -> offshore bar

deposition: sandbars/shoals (offshore undertow), baymouth bars (block mouths), spit (proximal end headland, distal end unload), cuspate foreland (merged spits), tombolo (bar/spit linking island to mainland), lagoon (water isolated behind bar)

dunes: sand accumulation > colonization: bar, incipient dune, foredune, hinddunes

vegetation zoning: inland nutrients from soil, shoreline nutrients from salt spray

dunes protect from storms, maintain sand reserves, provide biodiverse habitat

but human coastal development shoreline recession, vegetation loss blowouts

tsunamis after earthquake, Deep-ocean Assessment and Reporting of Tsunamis

storm surges after mainly long fetch, low pressure; fast storms high surge if open:

2005 Katrina 16-feet surge 80% flooded, $108b property damage; no dykes built

1970 200 km/h Bhola cyclone 500k deaths; but 2007 260 km/h Cyclone Sidr 15k:

early warning systems, 3.2m people evacuated; 20% Bangladesh within 1m sea,

raised houses, baira cultivation, mangroves will help; largest remaining forest

aquaculture fastest growing food sector, 83% CN, 6% IN, mostly LEDCs, 50% carp

water diverted, trout raceways deplete aquifers, recirculation needs costly aeration

1989 wild trout collapse near IE salmon cages; artificial feed reaches benthic zone,

microbial decomposition deoxygenates, nutritious fish effluent eutrophication:

Scotland cage salmon waste ≡ 75% human sewage; algal neurotoxins in shellfish

CN scallop, sea cucumber, kelp polyculture: less antifouling, fertilizers, herbicides

BC aquaculture strict regulation, 6000 jobs, $800m economic impact, mostly salmon

urbanization: congestion, dredging, ports -> lower water table, saltwater intrusion

industry, fisheries, petroleum -> pollution, overfishing, habitat loss, eutrophication

hard engineering: sea wall (long-term high-energy, but costly, ugly, scours beach):

revetment (sloped, absorb energy), rip-rap (rock armour), gabion (caged rip-rap)

groynes extend out, stop longshore drift, cheap but cause erosion, unnatural

offshore breakwaters parallel to shore, reduce wave energy but trap sediment

soft engineering: beach nourishment (18m m^3 sand 250k/year, 350k Miami tourists),

artificial reefs (surfing, less energy, habitat for algae, barnacles, corals, oysters

but 1970s Osborne Reef 2m steel-bound tires loose, destroyed natural reef),

dune stabilization (special stabilizing vegetation) managed retreat (new habitat)

cliff management: drainage (dry cliffs weak), regrading (works on clay but uses land)

UBC cliffs: 50m unconsolidated sand; top glacial till; thin silt, peat 18m from bottom

North Arm many cement industries, log booms; 40 km fetch, NE longshore drift

1935 North Arm jetty; eroded Graham's gully; 1953 breakwater to stop saltwater

1974 pit run gravel berm, destroyed in 3 years; 1981 cobble berm, groynes, fence

gravitropism: trees lean, easily blown down, creep evidence; cut down, revegetated

1970s bare, rapid retreat; now vegetated and stable but still steep, berms eroded

2000 berm at cliffs top, protect Museum of Anthropology, must consult Musqueam

conflict: FREMP, Agricultural Land Reserve (farmers vs. land price, private property),

1959 2.3m m^3 Tsawwassen Ferry Terminal; 1970 Roberts Bank, 1992 GCT Deltaport;

busiest coal port in NA, 20m tons; 2003 First Nations lawsuit: loss of foreshore

2014 Fraser Surrey Docks +4m tons; no health consultation, open coal barges risk

South Fraser Perimeter Road goes to all five crossings; more CO_2, bad for Burns Bog

Burrard Inlet: port, industry, tourism; 2007 70k L crude oil, 2013 two tons canola oil

G.1 Urban Populations

urbanization: Define urbanization and explain the variation in global growth rates and patterns. Explain the processes of centripetal movements (rural–urban migration, gentrification, re-urbanization/urban renewal). Explain the processes of centrifugal movements (suburbanization, counter-urbanization, urban sprawl).
natural change: Explain the contribution of natural change to patterns of population density within urban areas.
the global megacity: Explain the global increase in the number and location of megacities (population over 10 million).

urbanization: An increasing percentage of a country's population comes to live in towns and cities. It may involve both rural–urban migration and natural increase.
re-urbanization: The development of activities to increase residential population densities within the existing built-up area of a city. This may include the redevelopment of vacant land, the refurbishment of housing and the development of new business enterprises.
suburb: A residential area within or just outside the boundaries of a city.
suburbanization: The outward growth of towns and cities to engulf surrounding villages and rural areas. This may result from the out-migration of population from the inner urban area to the suburbs or from inward rural–urban movement.
counter-urbanization: The movement of population away from inner urban areas to a new town, a new estate, a commuter town or a village on the edge or just beyond the city limits or rural–urban fringe.
urban sprawl: The unplanned and uncontrolled physical expansion of an urban area into the surrounding countryside. It is closely linked to suburbanization.

rural: only dormitory services; urban: provides services to surrounding countryside
urban if >10000 people (PT), >200 (NO), if capital (Maldives), if has limits (Mauritius)
MEDC/LEDC urban growth 4/2 (1950–1970), 0.9/3.3 (1970–2011), 0.5/2 (2011–2030)
2011–2050 urbanization (not urban growth): MEDC 78% -> 86%, LEDC 47% -> 64%
world urbanization 10% (1900), 50% (2006), 67% (2050), mostly LEDC rural -> urban
CN Shenzhen urban EPZ; Cambodia made urban -> rural but 11% (1965)-> 23% (2000)

gentrification: renovate run-down inner city buildings, higher value, kicks poor out
urban renewal: redevelopment, tourism, business: London Docklands, Yaletown
urban sprawl ruins habitat, decreases permeability, Bangkok +32 km^2 more per year
most US/AU shopping in suburbs: expressways, car parks, postwar low-interest loans 1950–1970 medium density grids, but later 1970–1990 large suburban estates
counterurbanization when small towns grow faster, first manufacturing then retail, decentralize, cheap land, clean air, less congestion/crime (London 1930s–1990s)
exurbanization: young rich go rural, but with urban lifestyle; old, poor cannot move
suburbanization, counterurbanization -> inner decay, urban blight: US east to west, less taxes, only poor left, no services, vandalism, cheap land -> redevelopment
natural changes in urban density/character, no people movement involved: urban sprawl -> conurbation: cities merging, 50m people in Bos-Wash Corridor, urban consolidation: higher density intensification (condos become high-rises), infilling gaps (Arbutus), adaptive use (Marpole): more efficient, less personal land

1970 only Tokyo, New York City; now 36 megacities, only 9 in MEDCs, 22 in Asia; 2025 Asia +9, 8% world in megacities, 15% of urban residents; now only 5%, 10% megacities growth rate MEDCs 0.3%, LEDCs 2.3%, without Shenzhen 1.5%
growth from rural migration: poverty, malnutrition, high death rate, unemployment, Africa 90% new housing are shanty towns, squatter occupation; can use police to demolish, connect basic services, or mass create high-rises (Singapore 1989)

G.2 Urban Land Use

residential areas: Explain the location of residential areas in relation to wealth, ethnicity and family status (stage in life cycle). Examine patterns of urban poverty and deprivation (such as slums, squatter settlements, areas of low-cost housing and inner-city areas). Examine the causes and effects of the movement of socio-economic groups since the 1980s.
wealth: LEDC rich in good services city centre, poor in outskirts, shanty towns, slums MEDC poor in high density inner city, rich commute from decentralized suburbs, spatial exclusion when wealthy security defense restrict access (walled estates)
ethnicity: immigrant segregation: positive (keep culture) or negative (excluded), urban village: residential district with common culture (Chinatown, Little India); ethnic clustering: Surrey South Asians; Richmond east of No. 3 Road 80% Chinese
family status: mid-income child in semi-detached suburbs, young adult in inner city, married in starter home, middle aged in owned family home, old in bungalow low-income child in public housing, young adult renting in inner city for jobs, married in inner city flat, middle aged in suburbs, old in city retirement homes

deprivation: physical (housing quality, electricity, piped water, pollution, vandalism), social (crime, healthcare, education, government welfare, lone parent), political, economic (employment access, insurance); Downtown Eastside vs. Vancouver:

average household size, percent one-person homes	1.2, 87%	2.3, 38%
average income per capita, percent under 19 years	$12k, 5%	$48k, 19%
average income per household, percent employed	$23k, 19%	$58k, 50%

37% of thefts, 34% robberies, 37% offensive weapons in Vancouver CBD (24 in total)

slums in unwanted areas: swamps, steep slopes, city outskirts, industrial complexes; overcrowded, unsafe, diseases, insecure tenure, little electricity, water, jobs but point of assimilation, aid migrants, no commute, strong kinship, informal sector
32% of urban in slums, in Africa 60%; old slums in city centre, new slums in suburbs
Mexico City: 15% in public housing projects but bad maintenance, became slums: degrade public space, bad relations, cheap construction, limited space -> crime

G.2 Urban Land Use

areas of economic activity: Explain the spatial pattern of economic activity, the zoning of urban and suburban functions and the internal structure of the central business district (CBD). Describe the informal sector, its characteristics and location in urban areas. Examine the causes and effects of the movement of retailing, service and manufacturing activities to new locations.

brownfield site: Abandoned, derelict or under-used industrial buildings and land that may be contaminated but have potential for redevolpment.

bid-rent theory: retail > industrial > residential > agricultural; accessibility valuable, peak land value intersection in CBD; distance decay: further, cheaper, shorter but private transport, now suburbs more accessible than inner city congestion

financial, corporate offices at CBD edge; LEDC vertical land: shop, factory, residence

CBD most offices, stores, banks, businesses, transport, highest buildings, land price, highest pedestrian density, shopping quality; little industry, residents, greenery

CBD decline: old, counterurbanization, good suburban malls, sprawl so CBD too far

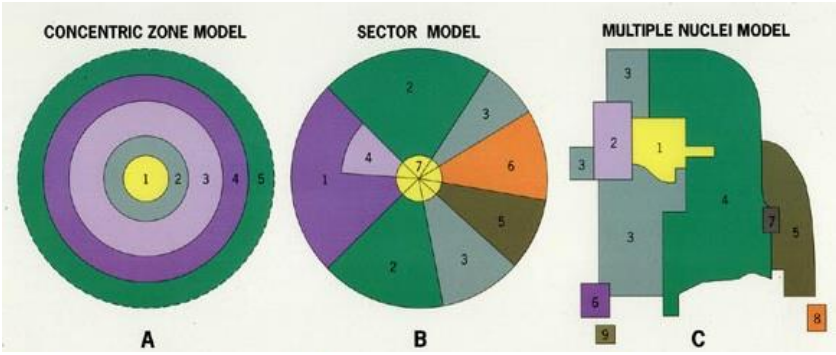
Burgess (1920s): concentric, inner city -> working class -> residential -> commuters; does not consider landforms, transport; no sharp boundaries; only in MEDCs

Hoyt (1939): sectors because of railways, bus routes; all models based on Chicago

Harris and Ullman (1945): multiple nuclei, CBDs, clustering (industry with retail)

Murdie (1969 Toronto): pizza, overlaid factors: physical (natural barriers, transport), political (administrative, development), economic (industry, services, retail), social (economic (sector), ethnic (clustered), family (concentric) status)

LEDCs: CBD -> high-rises -> permanent houses -> shanty towns; industry by roads



informal sector: outside legal and tax structures; no crime, but includes prostitution easy entry, family ownership, small scale, labour intensive, no education, no safety more women than men, informal sector 60% India GDP, 95% Kenya entrepreneurs

retail: small families, suburbanization, more cars, freezers, working women, elderly so 1980–1990 80% new retail in suburb greenfields: economies of scale, cheap, 1980 5% retail sales out of town, 1998 40%; more diffuse environmental impact

services: ICT so outsourcing, counterurbanization but producer services still in CBD, take over brownfield sites for CBD accessibility; health, schools hard to move

industry: green belts, middle class -> counterurbanization; ICT, trucks footloose

G.3 Urban Stress

urban microclimate: Examine the effects of structures and human activity on urban microclimates, including the urban heat island effect and air pollution.

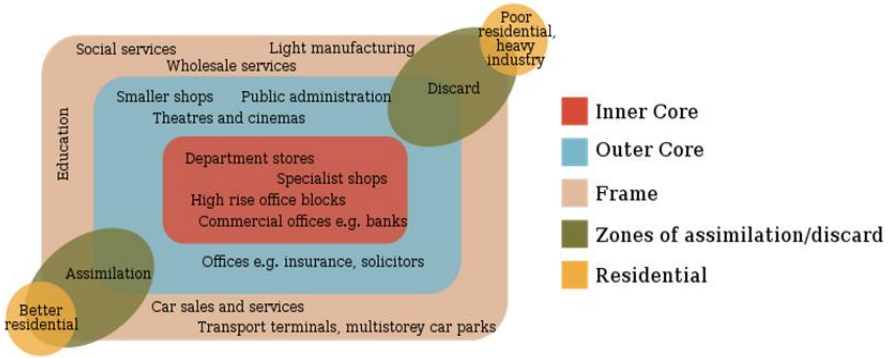
other types of social stress: Examine the other symptoms of urban stress.

cars, industry, burning biomass make air pollutants (CO_x, NO_x, SO_x, hydrocarbons), suspended particulate matter (dust, loess, soot, benzene) make cloud nuclei so urban areas 10% more cloud cover, rain; 1952 London Great Smog killed 4000

less moisture (less heat needed, fast drainage), more intense storms (convection), lower wind speed, heat diffusion (buildings, vertical slopes, urban roughness)

urban heat island effect: sealed surface, roads, paths, asphalt, dark roofs low albedo heat city at night (3°C–4°C); cars, industry, domestic heating in day (1°C–2°C)

expressways so no buses, footpaths; but Bangkok none: 44 days/year idling in jams, 20% police heart/lung disease; Yamuna River 2% in Delhi, gives 71% pollution



overcrowding: too dense, not enough homes/jobs, underemployment, overstaffing

excessive size: too much urban sprawl, takes arable land, long commutes/trucking

depletion of green space: pressure to make into housing, but gives natural habitat, recreation, tourism, oxygen; plant trees, develop brownfields, make greenways

poor quality housing: gentrification, unemployment, rural–urban migration so crime, no economy, strains welfare, NGOs, 2007 Vancouver rent 8% >$450, 2013 31%; affordable housing, jobs; Vancouver spent $8m, 2010 75% in shelters, 2011 90%

waste overburden: annual solid waste per capita 1.9 tons (1998) -> 2.3 tons (2006); Metro Vancouver Zero Waste Challenge: education (3 R's), green bins, producer recycling (Extended Producer Responsibility), Covanta Burnaby Waste-to-Energy 1996 44% landfill diverted waste -> 2005 53%, 280k tons garbage -> 1.15 PJ/year

crime: urban stress, homelessness, poverty, mental sickness, anonymity, weapons so drugs: public injections unsafe, 1993 30–49 year old men drugs most deaths; 2003 Insite, NA's first legal injection facility, reduced diseases, healthcare costs

congestion: more people, more cars, bad transit, bottlenecks (bridges, tunnels) so $2.3b–$3.7b per year in 9 largest CA areas: noise, stress, carbon (3%, 1.5m tons), waste fuel (7%), waste time (90% of cost), lower real estate values, quality of life; limit population, increase carbon taxes, carpooling, public transit, parking price, decentralize, limit factories, better cars, more lanes (more cars, worse long term)

G.4 The Sustainable City

the city as a system: Describe the city as a system in terms of inputs (energy, water, people, materials, products, food) and outputs (solid, atmospheric and liquid waste, noise, people). Distinguish between a sustainable circular system where inputs are reduced and outputs are recycled and an unsustainable (open/linear) city system with uncontrolled inputs and outputs.

case studies: Referring to at least two city case studies, discuss the concepts of sustainable city management and the urban ecological footprint.

sustainable strategies: Evaluate one case study of each of the following: one socially sustainable housing management strategy, one environmentally sustainable pollution management strategy, and one strategy to control rapid city growth resulting from in-migration.

ecological footprint: The theoretical measurement of the amount of land and water a population requires to produce the resources it consumes and to absorb its waste under prevailing technology.

sustainable urban management strategy: An approach to urban management that seeks to maintain and improve the quality of life for current and future urban dwellers. Aspects of management may be social (housing quality, crime), economic (jobs, income) or environmental (air, water, land, resources).

urban processes: manufacturing, movement-> outputs: products, services, wealth

Vancouver Livable Region Strategic Plan: 1. Protect the Green Zone (got Blaney Bog, Burns Bog but lost 22 ha of 53700 in ALR; 30% agriculture on <2% land, success) 2. Build Complete Communities (1991 13.6% in regional town centres, 2001 15% 1991 48% single-detached, 2001 43% (diversifying), more work in home regions) 3. Achieve a Compact Region (65% in Growth Concentration Area, target is 68%) 4. Increase Transport Choice (1998 3.9m 10.3% public transit, 2004 4.9m 10.8%)

Greenest City 2020 Action Plan: goal reduce greenhouse gas to 6% below 1990 level 1. Green Economy, double green jobs and green companies from 2010 to 2020, currently 3%, develop Green Enterprise Zones (False Creek, Downtown Eastside) most green buildings, local food, e.g. EMBERS weatherization, >50% professional 2. Climate Leadership: reduce community-based emissions by 33% below 2007, now 5% below 1990 level, population +27%, jobs +18%: 55% buildings, 37% cars, reduce gas by regulation 39%, buildings 24%, transit 22%, energy 11%, waste 4% 3. Green Buildings: must all be carbon neutral by 2020; strictest regulation in NA 4. Green Transport: make most trips bike/transit, reduce driving distance by 20% 5. Zero Waste: waste 50% below 2008, green bins, keep deconstruction material 6. Access to Nature: all five-minute walk to green space, 150k new trees by 2020, now 92% can walk, 138k trees; make right-of-way into park, green Hastings Park 7. Lighter Footprint: reduce ecological footprint by 33% below 2006; mostly food 8. Clean Water: cleanest in world; increase rates by 50%, all 2012 houses meters 9. Clean Air: cleanest in world; encourage electric cars, regulate wood-burning 10. Local Food: grow 50% more food than 2010; now 3260 gardens, 5k by 2020

ecological footprint neo-Malthusian, units: productive area, global hectares (gha), includes arable land, pasture land, oceans, forests for resources or infrastructure and land to absorb wastes; total per capita 2.1 gha available; actual use 2.7 gha

consumption = population × technology × lifestyle; US 9.4 gha, Bangladesh 0.6 gha

carbon footprint: anthropocentric greenhouse gas emissions, units: carbon tonnes

offset schemes absorb carbon: afforestation, sequestration, cows methane capture

GB London 12% population but 20% GDP 8% CO_2, dense but uses rural resources

Vancouver: food 2.13 gha, transport 1.10 gha, buildings 0.84 gha, waste 0.68 gha; 10 tonnes CO_2 per capita; 1/3 of all food ends up wasted from spoilage/plates; transportation largest greenhouse gas emissions, 80% of all fuel (20% for planes), buildings 42% of electricity demand, 60% of heating demand; water 0.002 gha

1966 BC Strata Titles Act allowed developers to subdivide apartments into units; condo market more competitive than rental; federal tax revised, capital gains reinvested in rental housing not exempt from tax; rental housing stock declined

Short-Term Incentives for Rental: denser, faster permits, less strict parking/unit size if 100% rental for at least 60 years; Rate of Change: no net loss of rental housing units in year before development application; saved 14k rental units by 2019

Housing and Homelessness Strategy, 2012 to 2022: goal, end street homelessness, 628 homeless in 2002, 1605 in 2011; 811/1576 street in 2008, 145/1605 in 2011 housing continuum: shelters, single-room occupancies, rentals, suites, condos; but SROs conversion losses; 1960s 30k new rental, 2000s 6k, needs incentives; 1980–2008 9% income increase, 280% condo price increase, highest in Canada; 1. Increase Affordable Housing Supply: new land use, zoning, grants, incentives; 2. Encourage Housing Mix: target shelters and SROs, encourage variety of types, protect rental stock (improve Rate of Change regulations, incentivize upgrades); 3. Enhance Housing Stability: support renters, focus on homelessness, be leader; Homeless Emergency Action Team, 82% fall in street homelessness since 2008; funded Bosman Residence, Dunsmuir House; Cambie Corridor Plan 20% rental; zoning: 2009–2011 750 new secondary suite/laneway houses (all Green Homes)

HL.1 Measuring Global Interactions

global participation: Describe and evaluate an globalization index as a measure of global interaction. Describe how the index may be represented spatially.

global core and periphery: Discuss the spatial pattern of global interactions through the mapping of core areas at the focus of interaction (network hubs/nodes), the peripheries and areas relatively unaffected by these interactions.

globalization: "The growing interdependence of countries worldwide through the increasing volume and variety of cross-border transactions in goods and services and of international capital flows, and through the more rapid and widespread diffusion of technology" (source: IMF).

globalization indices: The KOF index measures three main dimensions: economic (38%), political (23%) and social (39%), and nations are ranked accordingly. It is designed by the Swiss Federal Institute of Technology on a yearly basis.

KOF: actual flows (trade, FDI, remittances), restrictions (import barriers, tariffs, taxes), personal contact (telephones, tourism, foreign population, international letters); information flows (internet, TV, newspapers), cultural proximity (McDonalds, Ikea, books); political (embassies, international organizations, UNSC missions, treaties)

growing trend, 122 countries, most Belgium; but no info on North Korea, Iraq, etc.

represented spatially by choropleth map (countries shaded in proportion to density), or cartogram (areas distorted to convey information) of globalization variables (foreign investment, phone lines, airline traffic); Brandt Line cuts North/South

HL.2 Changing Space—The Shrinking World

time–space convergence: Explain how a reduction in the friction of distance results in time–space convergence. Examine the relative changes in the speed and capacity of air and ocean transport of goods, materials and people.

extension and density of networks: Examine the changes in a transport, internet or telecommunications network in terms of the extension of links and nodes and the intensity of use at a national or global scale. Describe the role of information and communications technology (ICT) in civil society and the transmission and flow of images, ideas, information, and finance. Examine the contrasting rates, levels and patterns of adoption of an element of ICT in two countries.

time–space convergence: The reduction in the time taken to travel between two places due to improvements in transportation or communication technology.

EU to NA, sail 55 days, steamship 7 days, plane 1 day, jet 7 hours: more accessibility

air transport: fast, no congestion, good for high-value transport (people, high-tech), but infrastructure costs, inflexible routes; 1.4b passengers, became much faster: New York to Shanghai piston 40 hours, jet 17 hours; cargo 193b tonnes-km/year

ocean transport: free routes, good for bulk (iron, coal, wheat), crude oil, containers, but very slow, limited deep-water ports; 11m passengers, became much larger: average capacity 1987 1000 TEU -> 2007 2500 TEU; most 5000 TEU -> 14500 TEU, 400% more container ships, container freight 25% -> 70%; 61t tonnes-km/year

ICT gives more efficiency, reach, impact, speed, and volume of communication; allows e-commerce, TNCs, outsourcing, worldwide collaboration, R&D diffusion

yearly commercial geostationary satellite launches: 1960s 15, 1980s 69, 2000s 320

digital divide: inequality; internet users: Thailand, 90% urban; UK, 50% with degrees, 75% from MEDCs with 14% of population; 1998 148m, 2001 326m, 2009 1.5b

penetration: world 32%, NA 78%, Africa 13%; Sweden 94%, USA 81%, Brazil 50%; Canada: 2000 40%, 2005 68%, 2012 86%; India: 2000 0.5%, 2005 5%, 2012 11%, BC 84%, NB 70%; quartile first 76%, fourth 92%; university 95%, high school 92%

internet users, India: young, 85% male, 72% urban, 46% degrees; Canada: 50% male

HL.3 Economic Interactions and Flows

labour flows: Explain the causes and effects of one major flow of labour between two countries.

information flows: Explain the role of ICT in the growth of international outsourcing.

outsourcing: The concept of taking internal company functions and paying an outside firm to handle them. Outsourcing is done to save money, improve quality or free company resources for other activities.

labour migration from LEDCs to MEDCs with heavy labour demand due to growth; 1950s EU -> US/CA/AU, 1970s Middle East -> EU, 1980s SEA -> Tiger Economies

international migration rising due to globalization, liberalization, more information

1961 TR migration to W. DE to ease pressure on TR labour market, overpopulation

by 1973 780k workers to EU, 80% to DE but halted due to OPEC; then families came

Turks 25% of foreign-born in DE, largest ethnic minority: currently 3.5m in 82m

60% Turks in cities; 25% DE >60, 5% TR in DE >60; 53% through family, 17% born DE

Turks least integrated immigrants in Germany, from 1–8 TR 2.4 vs. EU general 5.5

14% TR in DE pass secondary school; 93% marry other TR in DE; high unemployment

most outsource to India: cheap labour, good English, emerging educated middle class ICT rapid growth, high profit, bring advanced skills, green economy, good for India 1992 $150m software outputs, 2000 $5700m, $4b export, 50% yearly growth rate, 35% per year since, 2008 $50b software exports; 2.2m people, 20% total exports

confined to software development hotspots: Mumbai, Kolkata, Bengaluru, Pune; Karnataka state gave telecommunications infrastructure, encouraged investment

more US unemployment, parallels car outsourcing to Mexico, South Korea, but gives India jobs; redistributes employment, increases efficiency, cheaper products

HL.3 Economic Interactions and Flows

financial flows: Examine the importance of loans, debt repayment, development aid, remittances, foreign direct investment and repatriation of profits in the transfer of capital between the developed core areas and the peripheries. Examine the influence of governments, world trading organizations and financial institutions (such as the World Trade Organization, International Monetary Fund and World Bank) in the transfer of capital.

transnational corporation (TNC): A firm that owns or controls productive operations in more than one country through foreign direct investment.

economic flows increasingly integrated by TNCs, liberal agreements, technology, ICT
pre-1914 gold standard, global financial markets; but until 1945, isolation, no forex
1944 Bretton Woods: Allies decided that global markets should be open, made General Agreement on Tariffs and Trade (World Trade Organization), Int'l Bank for Reconstruction and Development (World Bank), Int'l Monetary Fund (IMF)
1970s flexible floating exchange rates; more and more globalized, firms can locate offices and factories in different countries; Airbus 1.5k suppliers in 27 countries
but Africa, CIS share of world trade steadily declining; casino capitalism, mad money
offshore financial centres: Bahamas, Qatar; Cayman Islands 500 banks; 70 physical

net flow from LEDCs to MEDCs despite financial aid because of debt repayments
World Bank provides financial, technical assistance to LEDCs; loans, credits, grants
IMF oversees international monetary system to avoid crises, maintain stability
WTO in 1995 after GATT, regulates international trade, encourages liberalization
but free trade favours TNCs over small farms, raises wealth gap; anti-globalization

HL.4 Environmental Change

degradation through raw material production: Identify the effects of agro-industrialization and changes in international production and consumption ond the physical environment. Discuss the environmental consequences of increasing international demand for one raw material (oil). Examine the concept of food miles and the environmental consequences of increasing volumes of air freight.

transnational manufacturing: Discuss the reasons for and consequences of the relocation of polluting industries and waste disposal to countries with weaker environmental controls and safety regulations.

homogenization: Explain the evolution of uniform urban landscapes; the effects of common commercial activity, structures, styles of construction and infrastructure.

food miles: A measure of the distance food travels from its source to the consumer, given either in units of actual distance or of energy consumed during transport.

Green Revolution: mechanization, chemicals, cultivars increased wheat yields 250%
pesticide use 1961 31m tons, 2008 200m tons; 2% of US farms make 50% of all food
80% world food from 20 species; herbicides: less tilling, more erosion, superweeds
30% US farms corn; top four US beef producers market share 1970 <20%, now >80%
TNCs vertically integrated, Latino labour, give farmers debt; chickens too fat to walk
Brazil most poultry, beef exports; 75m cows, 2.2m ha soybeans, double since 2000
2003–2008 cleared 110k km^2 Amazon; Cerrado has 80% of waterways; 40% cleared
75% Brazil's CO_2 from land clearing; Cargill built port in Santarém, 1400 km highway

air 3% of global climate change, contrails maybe 1% more, supersonic jets make O_3
but local food needs fertilizers and tractors; LEDC agriculture often manual labour
food in cold storage or heated greenhouses sometimes use more energy than airlift

transnational manufacturing: TNCs want to avoid tariffs, get new markets, cut costs
LEDCs want jobs, give tax breaks; Kuznets curve: markets raise then lower inequality
footloose industry: can relocate, MX maquiladoras: export plants (clothes, cars, TVs)
takes water, emits benzene, acids, debris, gases; MX low wages, tax, bad regulation
1983 agreement: must return toxic waste to US; 1994 NAFTA let TNCs keep it in MX

Minamata disease: unknown epilepsy; 1956–1968 methylmercury in wastewater
1.8k died, $86m compensation; fishermen lost jobs, but democratized JP more
e-waste: lead (brain damage), cadmium (kidney), chromium (liver), mercury, acids
50m tons/year, Guiyu recycles 1m tons; no agriculture, barreled water, $0.70/hour
80% infants lead poisoned, 6x more miscarriages, most dioxins in air anywhere
illegal by 1992 Basel Convention, but US has not ratified, HK little regulation

homogenization: same TNCs, McDonald's, Starbucks, KFC; Christmas, strip malls
world cities: same political/financial stuff, skyscapers, bid-rent, migrants, tourists
GB clone towns: main street >40% chain stores; Exeter only one independent store

HL.4 Environmental Change

transboundary pollution: Describe one major pollution event affecting more than one country and examine the consequences of and responses to this event. Examine the growth of environmental awareness as a consequence of these global interactions. Examine the role of one international civil society organization in fostering improved environmental management.

acid rain: burn C_XH_Y make SO_2 + H_2O -> H_2SO_4 diluted sulphuric acid, kills trees/rocks, Sudbury soil lack natural alkalinity, 7000 lakes, fisheries hit by smelter emissions
Canada–US Air Quality Agreement: control air pollution; limit SO_2, NO production

1948 International Union for Conservation of Nature: >1000 member organizations
1962 Carson's *Silent Spring*; 1966 space; 1970 first Earth Day; 1972 *Limits to Growth*
1967 Torrey Canyon spill; Agent Orange, Antarctic DDT, feared cooling; 1972 UNEP
1979 GHGs; 1985 ozone hole, CFCs; 1986 Chernobyl; 1997 Kyoto: CO_2, CH_4, N_2O, SF_6

Greenpeace successes: Sinar Mas palm oil; pressured Unilever, Burger King, Nestlé
2002 large-scale UN ban of driftnets; 1995 Shell decides against dumping oil rigs
1999 EU decides to ban GMOs from their markets; but 2010 first GMO, 49 by 2014

HL.5 Sociocultural Exchanges

cultural diffusion: Describe cultural traits in terms of language, customs, beliefs, dress, images, music, food and technology. Examine the diffusion of cultural traits from the international movement of workers, tourists and commodities.
consumerism and culture: Describe the role of TNCs and the media in spreading consumer culture. Select two different branded commodities and examine the spatial and temporal pattern of adoption on a global scale.
sociocultural integration: Examine the role of diasporas in preserving culture in one country and the adoption of minority traits by host societies. Examine the impact of cultural diffusion on one remote indigenous society through the influence of international interactions. Examine the ways in which international interactions may result in the homogenization and dilution of culture. Define and exemplify the concept of cultural imperialism.
cultural imperialism: The practice of promoting the culture/language of one nation in another. It is usually the case that the former is a large, economically or militarily powerful nation and the latter is a smaller, less affluent one.

culture: framework of shared meanings, expression of community world view
diffused by trade, investment, migration: Africa, only Ethiopia non-colonial language, world 6000 extant languages, 60% <10k speakers, ICT means 3000 left by 2100
80% all electronic info in English; Voice of America propaganda during Cold War, 2005, 10 media firms 80% world media revenue, 7 in US: big, rich, homogeneous, US consumerism, Hollywood, pop music; Soviet anti-nationalism; French streets
tourism since 1950 LEDC > MEDC; more foreign exchange, jobs, awareness, art sales but commoditizes/corrupts culture, divides families, harms natural environment
1992 Bali, Indonesia 3m people; tourists 1969 30k, 1993 4m after 1972 UNDP plan
Kuta 9k people, 1970 2 hotels, no restaurants; 1975 over 100 hotels, 27 restaurants

diaspora: dispersed from historic land; 6m in Ireland, 3m Irish citizens out, 80m total
10m emigrated after 1700; 40% Irish-born abroad in 1890; Great Famine 1840s but even faster after: religious discrimination, 1848 Young Ireland failed, US gold rush
1830s–50s 624k Irish to Canada, census 1867 24%, 2006 14%: 4.4m Irish, 4th largest, cheaper than US: closer, on empty timber ships; most Irish Catholics in Montreal
QC: St. Patrick's Basilica, Loyola College, Saint Mary's Hospital for Anglophone Irish
ON: March 17 Irish Heritage Day; has only recognized Gaeltacht outside of Ireland

194k Dani in Indonesia Irian Jaya Highlands found 1938; heavy rain, steep, poor soil
pre-contact little clothing, sedentary irrigated agriculture by women, yams, walked, pig-kill ceremony every few years, malnutrition, two-storey hut, pneumoconiosis, ritual warfare: men kill for fun, eat loser; religion: charms, mummies repel spirits
1954 Christian missionaries: local language, schools, clinics, church; 80% converted, ended ritual warfare, cannibalism; pig-kill more often; washing clothes too hard, other vegetables, travel to markets, money instead of pigs, new tools, cookware
1962 Indonesia: ignored, restricted travel, Operation Koteka failed, wore no clothes, 1980s built square houses too cold, Muslims pigs unclean, schools in Indonesian

HL.6 Political Outcomes

loss of sovereignty: Discuss the links between the diminishing effectiveness of political borders and the flow of goods, capital, labour and ideas, and the role of one multi-governmental organization such as the North American Free Trade Agreement (NAFTA). Discuss the shift of power from nation state to TNCs as a result of their economic size and dominance. Compare the wealth of TNCs with that of nation states.

nation state: area of politically legitimate sovereign (state) ethnic society (nation), controls self-administration, trade/war relations; now TNCs, IGOs, NGOs power but nation states control treaties, policy, army, national banks; compete for FDI
regional economic bloc: free-trade area no internal tariffs (NAFTA); customs union same external tariffs (MERCOSUR); common market goods free to move (EEA); economic union harmonize economic policies, supranational control (Eurozone)
borders: geometric (strait), physical (natural features), arbitrary (military), cultural
top 200 TNCs world GDP 1965 17%, 1995 33%; 76% of world trade; all in 9 countries
36 companies >$1b advertising; McDonalds 40% on children; US youth 20k ads/year
Wal-Mart $486b revenue, 2.2m employees; Singapore $426b GDP PPP, 5.5m people

HL.6 Political Outcomes

responses: Examine the resurgence of nationalism in one country as it attempts to retain control of its resources and culture. Discuss anti-globalization movements. Discuss the attempts to control migration into one country.

1707 Act of Union, Scotland in GB, own schools, laws, church; 1997 74% devolution, survey 63% more Scottish than British; foreign affairs, defence, finance still GB; teacher union agreement; first year 8 acts, before 2 about Scotland in Whitehall
2014 independence vote 55% no; Scottish National Party says cultural renaissance: Creative Scotland, Dundee V&A, Edinburgh Festivals, Gaelic media; North Sea oil

anti-globalization movements more effective in MEDCs, threaten LEDC jobs
Our World Is Not For Sale, International Forum on Globalization, Global Exchange, 50 Years is Enough, Friends of the Earth, GRAIN International, United Students Against Sweatshops, War on Want, Fair Trade International, World Social Forum, Direct Action Network, People's Global Action, Oxfam International
find focus areas, for/against, tactics, organization style, effort to support local culture
for: environmentalism, decentralization, animal rights, indigenous rights, democracy
against: unregulated capitalist expansion, TNCs, child labour, debt, military, GMOs; WTO (freer world trade), World Bank (LEDC loans), IMF (manages LEDC debt)

Canada immigration: 250k/year, 40k–120k illegal; CBSA doesn't monitor exits
temporary: must have passport, good health, money, ties to home, plan to leave
permanent: needs 67 immigration points: education 25, official language 24, age 10, experience 21, arranged employment 10, adaptability 10; or family and means; or self-employed, investor ($200k), entrepreneur (must hire at least a Canadian)
enforcement: Navy, RCMP, CISA, IRB, CBSA (get acronyms): 119 crossings, 3 airports

HL.7 Global Interactions at the Local Level

defining glocalization: Distinguish between the terms globalization and glocalization.
adoption of globalization: Examine the extent to which commercial activities at a local scale have become globalized. Examine the reasons why the level and rate of adoption varies from place to place.
local responses to globalization: Discuss civil society responses to globalization; the adoption, adaptation or rejection of globalized goods, services and cultural traits. Evaluate the relative costs and benefits of local commercial production to the producer, the consumer and the local economy, compared with the costs and benefits of globalized production.
alternatives: Describe the role of civil societies in raising awareness of local and global environmental, social and cultural issues. Examine the role of civil societies in supporting local economic activity and strengthening local cultural values. Discuss the position held by anti-globalization groups. Evaluate the quality of life of a contemporary non-globalized society.

glocalization: The globalization of a product is more likely to succeed when the product or service is adapted specifically to each locality or culture in which it is marketed. The increasing presence of McDonald's restaurants worldwide is an example of globalization, while changes made to the menus of the restaurant chain, in an attempt to appeal to local tastes, are an example of glocalization.
civil society: Any organization or movement that works in the area between the household, the private sector and the state to negotiate matters of public concern. Civil societies include non-governmental organizations, community groups, trade unions, academic institutions and faith-based organizations.

glocalization by relativization (align values to communicate), emulation (copy values), interpenetration (two-way cultural flow); opposed by deglobalization (keep local)
can adopt (take as-is), adapt (change), or reject; acculturation: adopt cultural traits
reverse adaptation: glocalization; hybridization: mix; appropriation: adopt minority
more receptive if more links (trade, business, transport), diversity (ethnic, cultural); evidence of acceptance: TNC power (buy cheap goods, get tech, work for them)

Democratic People's Republic of Korea: made 1948, Kim Il Sung philosophy, juche: self-reliance, decide based on moral welfare, symbolized by Tower of Juche Idea, have chajusong, independence by cultural, ideological, technological revolution; nationalist isolationist, cannot subordinate to others: globalization, flunkeyism
South Korea vibrant economy; North Korea severe power, goods, food shortages; total energy use less than medium South Korean town, different priorities but no info; South exports electronics, North exports guns, drugs, counterfeit money
government controls all media, landlines; no cell phones, internet, moon landing; criticism illegal, personality cult; but genuine respect, West controlled by TNCs, free housing, health care, improved literacy, life expectancy, status of women