

Year 12 Geography

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Chapter 1

Global Sustainability Aquaculture

1.1 Syllabus

Sustainability in the contemporary world

- Sustainability and sustainable development, including pillars of sustainability - social, economic, environmental and cultural
- Principles of ecologically sustainable development - precautionary principle, intergenerational equity, conservation of biological diversity and ecological integrity
- Opportunities and challenges in planning for and achieving global sustainability
Including:
 - the role of global forums, agreements and cooperation
 - levels of action at a range of scales, from the United Nations Sustainable Development Goals to practices in local communities, including actions by governments, intergovernmental organisations (IGOs), non-government organisations (NGOs), corporations, community organisations and individuals
 - Indigenous Peoples' practices and benefit sharing
 - political, economic, technological, social, cultural and environmental influences

Evaluating sustainability

- The reasons for evaluating and monitoring global sustainability
- A range of criteria for evaluating the sustainability of economic activities

Investigation of a global economic activity

Students study ONE global economic activity, for example:

- agriculture
- energy production
- fishing
- forestry
- manufacturing
- mining

- tourism.

For the global economic activity studied, students:

- evaluate the sustainability of the activity, using one or more criteria
- examine a range of strategies for sustainability
- critically analyse ONE strategy.

Students investigate:

- The nature and spatial patterns of the global economic activity
- Influences on the global economic activity
Including:
 - biophysical
 - economic
 - technological
 - political/organisational
- Current trends and future directions

1.2 Relevant Statistics

1.2.1 Nature

- Total aquaculture production in 2022 was 130.9 million tonnes
- 2022 was the first time that global aquaculture surpassed capture production
- 59.1 million tonnes of production from inland water aquaculture
- Technological advancements in pond-based aquaculture have been adopted, increasing efficiency and reducing environmental impact. Eg. the in-pond raceway system (↑production, ↓waste accumulation) is being increasingly adopted in China
- The 564 farmed species are taxonomically recognised

1.2.2 Spatial Patterns

- Concentrated in Asia due to abundance of coastlines
- China's share in aquaculture reached 80.3% in 2022

TABLE 3 WORLD AQUACULTURE PRODUCTION OF AQUATIC ANIMALS BY REGION AND SELECTED MAJOR PRODUCERS

	2000	2005	2010	2015	2020	2021	2022	Share in regional total, 2022 (%)	2020/2022 variation
	(thousand tonnes, live weight equivalent)								
Africa	400	646	1 289	1 788	2 266	2 328	2 317	100	↗
Egypt	340	540	920	1 175	1 592	1 576	1 552	67.0	↘
Nigeria	26	56	201	317	262	276	259	11.2	↘
Ghana	5	1	10	45	64	89	133	5.7	↗
Uganda	1	11	95	118	124	139	101	4.4	↘
Others	28	38	64	134	225	249	271	11.7	↗
Americas	1 423	2 177	2 515	3 280	4 443	4 494	4 958	100	↗
Chile	392	724	701	1 046	1 486	1 427	1 509	30.4	↗
Ecuador	61	139	273	427	775	904	1 123	22.6	↗
Brazil	172	258	411	578	630	649	738	14.9	↗
United States of America	457	514	497	426	448	461	478	9.6	↗
Others	341	543	633	804	1 105	1 053	1 111	22.4	↗
Asia	28 422	39 190	51 233	64 682	77 513	80 485	83 399	100	↗
China	21 522	28 121	35 513	43 748	49 620	51 221	52 884	63.4	↗
India	1 943	2 967	3 786	5 341	8 636	9 403	10 230	12.3	↗
Indonesia	789	1 197	2 305	4 342	5 227	5 536	5 414	6.5	↗
Viet Nam	499	1 437	2 683	3 462	4 668	4 736	5 160	6.2	↗
Bangladesh	657	882	1 309	2 060	2 584	2 639	2 731	3.3	↗
Myanmar	99	485	851	997	1 145	1 167	1 197	1.4	↗
Thailand	738	1 304	1 286	921	1 012	991	1 001	1.2	↘
Others	2 177	2 796	3 500	3 810	4 623	4 792	4 783	5.7	↗
Europe	2 053	2 144	2 533	2 956	3 271	3 570	3 503	100	↗
Norway	491	662	1 020	1 381	1 490	1 665	1 648	47.0	↗
Russian Federation	74	115	120	152	270	295	320	9.1	↗
Spain	311	225	257	297	277	280	276	7.9	↘
United Kingdom of Great Britain and Northern Ireland	152	173	201	212	220	239	203	5.8	↘
France	267	245	203	163	191	193	200	5.7	↗
Greece	95	106	121	107	132	144	142	4.1	↗
Italy	214	182	153	149	126	146	133	3.8	↗
Others	448	436	457	496	566	608	582	16.6	↗
Oceania	122	154	190	178	225	250	235	100	↗
Australia	32	45	76	83	103	129	125	53.2	↗
New Zealand	86	105	111	91	119	117	106	45.1	↘
Papua New Guinea	0	0	2	2	2	2	2	0.8	↗
New Caledonia	2	3	1	1	1	1	1	0.6	↗
Others	2	0	1	0	1	1	1	0.2	↗

NOTE: Data on aquatic animals exclude crocodiles, alligators, caimans, aquatic products (corals, pearls, shells and sponges) and algae.

SOURCE: FAO. 2024. FishStat: Global aquaculture production 1950–2022. [Accessed on 29 March 2024]. In: FishStatJ.

Available at: www.fao.org/fishery/en/statistics/software/fishstatj. Licence: CC-BY-4.0.

1.2.3 Environmental

1.2.4 Economic

- Global trade had value of USD 312.8 billion in 2022

1.2.5 Social

- In 2022, an estimated 61.8 million workers were employed in commercial fisheries and aquaculture
 - Predominantly from Asia 85%
- Aquaculture provided employment for around 22 million people

1.2.6 Political

1.2.7 SDGs

SDG 2: Zero Hunger - Aquaculture provides for 50% of global seafood production. Sustainable aquaculture can reduce hunger and malnutrition, especially in developing countries due to their significant source of protein and micronutrients.

SDG 8: Decent Work and Economic Growth - The aquaculture industry provides jobs for millions of people worldwide, from hatcheries to processing facilities.

SDG 12: Responsible Consumption and Production - Aquaculture systems must be managed sustainably to avoid overuse of natural resources, reduce waste, and ensure efficient production. Promoting environmentally responsible practices like *integrated multi-trophic aquaculture (IMTA)* minimizes negative ecological impacts while maximising yield.

1.3 Introduction to Aquaculture

"Farming of aquatic species in controlled or semi-controlled conditions" Eg. Salmon, barramundi, lobsters (can be semi-controlled), crabs, prawns, oysters, scallops, seaweed Non food: pearl scallops, coral (people keeping pets), crocodile skin Pets: goldfish

In situ → In the environment

Ex situ → Isolated to the environment

Eg. Oyster farms in situ may be affected by external factors like a sewage spill

1.3.1 History

Although the Brewarrina fish traps are one of the oldest human constructions, they aren't real farms Roman oyster farm Chinese carp farm

Aquaculture is practised across a wide variety of locations and species. Can be:

- Marine (mariculture), estuary or freshwater (in-land)
Mariculture is currently underutilised, vast ocean space that isn't being used
- In-situ or ex-situ
- Fin-fish, crustacean, molluscs, or plants (usually algae)
Carp (trash fish)
- For human consumption, fishmeal, or fish oil
- For local consumption or for export earning
Norway and Chile grow the majority of the world's salmon, and is exports
Changes the nature that the fish grows

Aquaculture is **NOT** fishing

In 2018, aquaculture produced 114.5 million tonnes in live weight, with a total farm-gate sale value of US\$263.6 billion Aquaculture accounted for 46% of the total seafood production and 52% of fish for human consumption China produces and consumes the largest amount of aquaculture, but also more broadly Asian countries

There aren't that many inland waters, so inland fisheries do not have a significant amount of production ¹

Types of Economic Activity

- Primary - Farming
- Secondary - Manufacturing, producing
- Tertiary - Distribution of goods, using produced goods
- Quaternary - Researcher of salmon
- Quaternary - Researcher of salmon

¹Carp and tilapia are not nice - David Latimer

1.3.2 Distribution of Aquaculture

Aquaculture is mainly centred around Asia, with China representing around 60% of global aquaculture. Aquaculture is mainly centred around Asia, with China representing around 60% of global aquaculture. Fish is common in South-east Asia, especially with river fish eg. Vietnam. Other countries just catch their fish.

African countries do not have the development or GDP to farm fish. Culturally also doesn't eat fish.²

Developing countries are increasing their share of international fish trade. Countries with large fishing catches often have larger aquaculture production.

Various places have cultural preferences and natural advantages for the production of particular species.

- Predominantly carp³
- Seaweeds
- Tilapia
- Oysters
- Clams
- Catfish
- Prawns - Warm species
- Salmons, trout, smelts - Salmon is expensive
- Freshwater fishes

As China gets richer and richer, they will seek to eat more expensive fish, therefore increasing the demand.

1.4 Draft Nature and Spatial Patterns Text

The text below is a reasonable, band 4-5 response to the stimulus prompt **“Examine the nature and spatial patterns of ONE global economic activity”**. Use the FAO report below to help you edit the text into a strong Band 6 response, complete with a clear thesis, detailed information and vocabulary, and well structured paragraphs. Your finished text should be around 300-500 words in length.

Draft Text

Aquaculture is global economic activity whereby people grow fish for food and trade. Aquaculture takes places around the globe, giving people both food and money.

Aquaculture is really old, having been practised for years and years. However, people grow lots of different species today. It's important to state that aquaculture and fishing are different activities.

The economic activity of aquaculture can be carried out in both rich and poor countries. However, different countries tend to practise aquaculture differently and for different reasons. Aquaculture is mostly practised in rich countries.

Aquaculture is also practised in different environments. Moreover, these different types of aquaculture are not growing at the same speed. Some types of aquaculture are growing much more rapidly than others.

Comments

- Use stats
- In an "examine the nature and spatial distribution" question, evenly allocate writing to each part
- Specify location; Asia is very broad but aquaculture is focused around only 5

²"I don't like river fish, it's gross" - David Latimer

³"River fish have a bland, muddy flavour" - David Latimer, D1 river fish hater

1.5 Influences on the global economic activity

"How do different things affect the activity of aquaculture"

Nature, spatial patterns, future changes, sustainability

Biophysical	How the biophysical environment and ecosystems influence aquaculture
Economic	Demand and supply factors
Technological	New developments that increase sustainability
Political/Organisational	How is it controlled

1.5.1 Biophysical Factors

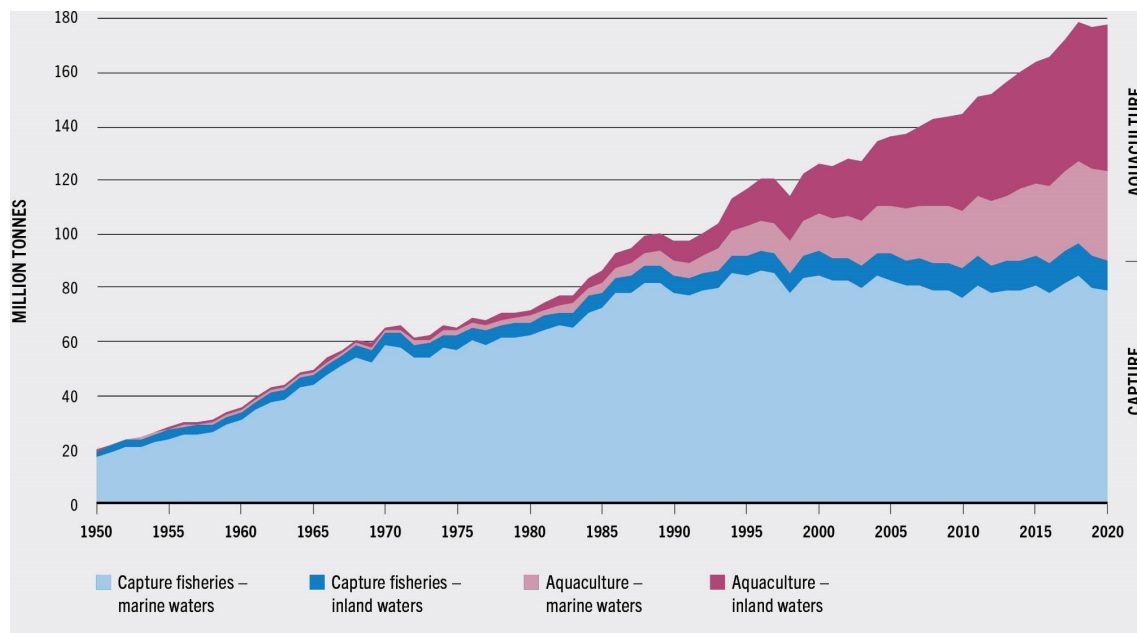
There are 622 species recognised by the FAO as being produced by aquaculture with each species requiring its own specific biophysical requirements

Local water conditions can impart "**merroir**" to seafood → the flavour it has

Local conditions flavour specialisation and give places competitive advantages

- Atlantic Salmon production is dominated by cold deep waters found in Norway and Chile
- Salmonids have become the largest single fish commodity by value
- Shrimp production benefits from brackish, warm tropical waters

Ex situ aquaculture attempts to separate aquaculture from the biophysical environment by controlling for temperature and chemistry. However, it is difficult to reproduce the conditions cheaply



Water Chemistry

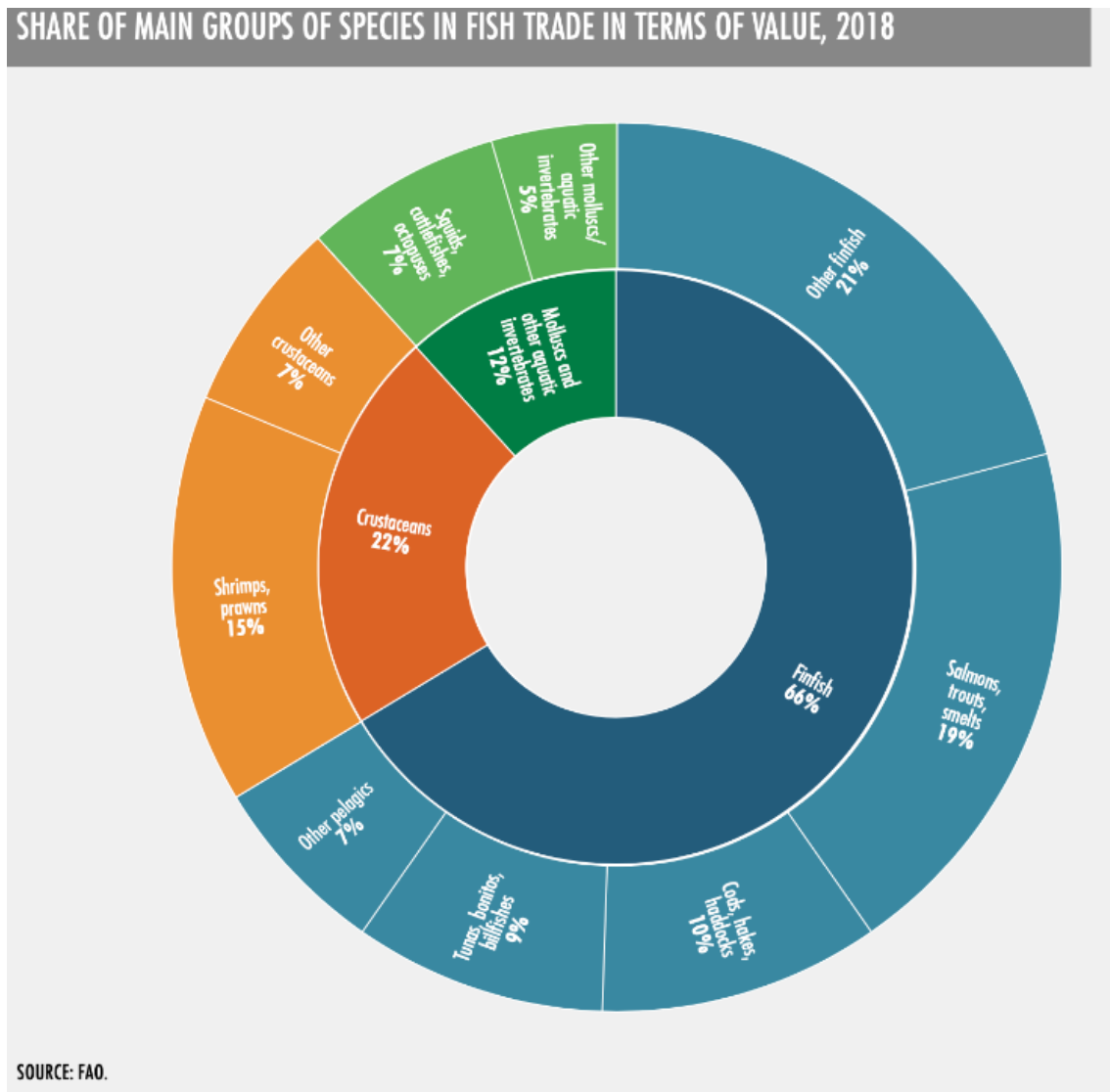
The local bedrock and substrates will impact various chemical characteristics to the water, such as nitrates, phosphates, heavy metals. Heavy metals are present due to mining operations that

Salinity is one of the most important characteristics of the water used in aquaculture

- Briny - High salinity
- Saline - Seawater, salt lakes
- Brackish - Estuaries, mangrove swamps
- Fresh - Ponds, lakes, river, streams

Eg. Oyster farmers will move their oysters up and down stream to control the way they grow

Salmon farms need high flow of water to account for the waste produced by the high concentration of salmon
Water plants can generally be grown anywhere



Climate

Atlantic Salmon require deep water with temperatures below 10°C giving Norway and Chile an advantage

Vannamei Shrimp require brackish, estuarine water that does not fall below 20 °C giving South-East Asian nations an advantage

Ecological

Aquaculture can have a highly detrimental interaction with local and global ecologies. For example:

- Carbon emissions from feed catch trawling
- By-catch from trawling
- Land clearing of mangroves

Aquaculture ventures often have to work with nearby human settlements. Some communities use this to produce multi-trophic production systems

Disease outbreaks are increasing in aquaculture due to **monoculture**

Eg. An in situ production system:

- Food pellets aren't completely consumed, increasing the concentration of food in an area
- The introduction of non-native species that are highly competitive
Bad weather can increase the likelihood of escapes
- Predators like birds can attack fish, increasing the overall level of fish stress
- Bulk antibiotics applied to fish farms can impact resistance in future
This can extend to humans consuming the fish
- Fat salmon are better to eat, however to become this way they are overfed and lazy. If salmon escape, they can breed lazy salmon in the natural environment ^{4 5}

To mitigate the greater environmental impacts:

- Make the farm ex situ
- Lower the density of the farm (However this lowers profit)
- Environmental Laws → Developing nations are also able to use lax environmental laws to develop coastal land for aquaculture

Positive Ecological Impacts

Oyster farming industries can filter estuaries and apply pressure to keep waterways clean - encourages community to reduce pollution

1.5.2 Economic Factors

Commodity Prices

Variable exchange rates and market prices for export commodities will modify production, including access to feed meal.

In recent years, other major producing countries have reported low market prices of staple species, reflecting market saturation at least seasonally and locally for these mass-produced species.

Salmon and avocado sushi was invented by Norwegians to encourage Japanese to purchase it. Before introduction, Japan was not a major salmon consumer but was wealthy and Norwegians had an excess.

The **commodification** of aquaculture produce also placed demand to exceed environmental capacity. Commodification drives the production of more goods.

⁴"How do you get a fat salmon" - Latimer

⁵"You want a fat, lazy salmon" - Latimer

Differences in HIC and LIC aquaculture

In some LICs, low labour costs can be a competitive advantage for production.

However, capital can be difficult to source in LICs - Greater degree of risk, less willingness for investors

HICs will use the high value of their markets to demand higher quality produce.

China has been accused of devaluing its yuan to promote exports. If their exchange rate is lower, their exports are cheaper, people will buy more, better for the Chinese market. (Denied by China ofc)

Urbanisation

People are increasingly living in cities with higher incomes and better infrastructure to facilitate fish purchases

Labour Specialisation

In HICs, changes in life expectations have made it difficult to find adequate labour - It is difficult to get people to work in far away aquaculture farms. Is promoted in Australia by using Tongan migrants as labour.

In LICs, small scale farms account for much greater rates of production

The International Labour Organisation (ILO) has identified that aquaculture utilises child and slave labour, but notes there is limited availability of evidence.

People from Myanmar run to Thailand to escape the government. However questionable law enforcement in Thailand promotes illegal labour. One solution to this is international agreements and tariffs, however this is unlikely because people want their shrimp cheap. It is then a responsibility of the consumer to check the source of produce

1.5.3 Technological Factors

Selective breeding and GMO (genetically modified organism) technologies are common in aquaculture.

Used to:

- Improve market appeal
- Address disease
- Promote growth

Often used in the salmon industry because salmon is more expensive

Development in technologies for production are also important:

- Four stroke engine replacements → are less polluting than two stroke engines that release exhaust into the water, increasing pollution
- Optical scanner → can be used to replace human labour, ie. capital
- Improved cage netting → stronger materials for netting, double walled netting, overhead enclosure. Reducing escapees

Transport and Retail Technologies

Improvements in refrigerated transport have boosted trade and consumption of aquaculture products.

Internet sales and marketing have increased people's access to farm gate sales and reduced the cost and control of market sales. People are now able to purchase directly from the supplier, cutting out the middle man in trade.

Geospatial technologies allow for tracking and more efficient trade.

1.5.4 Organisational Factors

International governance:

- Food and Agriculture Organisation (FAO) UN organisation that provides advice
- World Trade Organisation (WTO) polices trade
- International Labour Organisation (ILO) monitor conditions of labour

National scale:

- NSW Department of Primary Industries (DPI) peak controlling organisation, gives permits, permission
- NSW Food Authority eg. tells oyster farmers what they can and can't sell

The size of the Chinese market. Supply due to demand factors allows major traders to influence what is produced

Ownership

A wide variety of farm owners are responsible for global aquaculture production.

Increasingly, large companies are looking to undertake **vertical and horizontal integration**

As well as producers, in Australia, supermarkets are also able to control prices Large aquaculture companies are able to use **economies of scale** to gain control over large market shares

Vertical integration: Company aims to own the entire production process, however all the liabilities are placed on the company

Horizontal integration: Company purchases competing companies in the same industry, eg. Cermaq is a major salmon and trout producer owned by Mitsubishi. For some companies, aquaculture is not their main goal, rather food in general

Control

Supermarket chains exert significant power over consumers ⁶

Most people buy their food from supermarkets

Labelling and Decision Making

Sea food labelling rules change consumer preference and may require government intervention

Australian made labels don't provide that much information about the product. If it is produced in many countries, the label will not say every country it has been in.

Manufactured products are considered to be from that country. Eg. Malaysian prawns are labelled as Malaysian if raw, but if sauce is put on them in Australia, then they are manufactured in Australia

⁶The power of companies has always been extreme and have power in politics through funding

1.5.5 Political Factors

International Trade

Tariffs are a tax on an imported good. Governments impose tariffs so the local businesses can compete with cheaper imports

Subsidies are similar, but work in reverse. The government pays local farmers so that they can continue production. Protects domestic employment

Eg. Sugarcane farmers in Queensland are given money to maintain employment. Queensland is a swing state, so governments are always going to provide funding

A quota is a limit of number of items imported into a country.

Import and export barriers to free trade are used to protect local industries.

However, trade wars have also affected aquaculture products and commodity prices - particularly soybeans. Countries are likely to apply tariffs on each other, elevating economic tensions

Diplomatic relationships and the WTO are important in resolving disputes

The WTO also regulates Trade Related Intellectual Property Rights (TRIPS) which affects trademarks, geographic indications, patents and industrial designs

A particular barramundi species can be patented, allowing you to market the quality of the barramundi

Asia-Pacific Trade

Australia participates in a range of bilateral and multilateral agreements which facilitate greater trade with the Asia-Pacific region. Trade relationships are often overlapping

However, trade can also place environments at risk from exotic species and pathogens. It can cause confusion whether it is imposed as a biosecurity risk or as a trade restriction.

Legislation

Growth of aquaculture has outpaced the development of legislation and legal frameworks to govern the industry

Land clearing has been unchecked in some places

Development of a valuable industry has been given precedence over environmental concerns.

Research, monitoring and lobbying by NGOs like Greenpeace and WWF provides political pressure on nation-states.

International Geopolitics

UNCLOS (1982) - Defines the 200 nautical mile boundaries for Exclusive Economic Zones (EEZ)

Ramsar - Defines a number of internationally significant wetlands.

CITES - Prevents trade of endangered species. For example the trade of illegally fished caviar from the sturgeon fish which is now mostly farmed.

COP negotiations - Pressure on nations to change agriculture practices and prevent land clearing

Nine dash line defined by China is still hotly contested due to fishing resources. China is a large country with large food demand

Niger river catchment is the only source of water for some countries. Climate change means water is very

important in the catchment. Conflict and destabilisation means that water resources are very valuable. The pollution of water resources due to aquaculture or the use of water in general could contribute to the conflict.

1.6 Practice Question

Explain three influences that will likely determine the future directions of aquaculture globally. (6 marks)

Aquaculture is a rapidly developing global industry that has many opportunities for future growth. There are a variety of economic, technological and political influences that will likely determine the industry's future.

Economic influences control how much the aquaculture industry can expand, with demand playing a vital role in the production of aquaculture products. Demand factors directly influence the funding resources that businesses have to continue and expand. If there is a lack in consumer demand for aquaculture products, there will be a decrease in production, and hence a contraction in the industry overall. Currently, the consumption of aquaculture products is generally similar the world, except for the highly concentrated popularity in East and South-East Asian countries, especially China. In 2024, China consumed 57,474 tons of fish, over four times higher than the second largest consumer, Indonesia. With the recent economic prosperity of the Asian region, the aquaculture industry has the ability to grow significantly to match the needs of its demand.

Technological influences including emerging developments can also drive the growth of the aquaculture industry across the world. Developments in aquaculture often allow for more time and resource efficient production processes that maximise the affordability and viability of aquaculture. New technologies including the automation of processes such as feeding systems or water quality monitoring reduce impacts of human error, and can be cheaper to operate than using labour. This facilitates a more efficient operation, attracting potential investors and entrepreneurs. Emerging developments can also improve the environmental sustainability of aquaculture. For example, the transition from two-stroke to four-stroke boat engines increases fuel efficiency and can significantly reduce exhaust emitted into the water. Although four-stroke engines are not compatible in all situations, future technologies may further reduce waste generated from the aquaculture process. Technology hence has the ability to further expand the efficiency and sustainability of the aquaculture industry.

The changing nature of the aquaculture industry requires new political legislations to maintain a sustainable and fair economic environment. Like other production industries, aquaculture requires land and other resources that can have external impacts to the wider ecosystem and community. Hence, some government organisations and NGOs advise and enforce rules upon businesses and nation states to maintain the sustainable growth of aquaculture. Currently, there are limited regulations surrounding the operation of aquaculture despite it being estimated to have reduced mangrove forests in countries such as Indonesia and Thailand by over 30%. As well as this, it also increases the competition between countries for ocean areas. The South China Sea is a highly valuable area for potential aquaculture however is contested by its surrounding countries, with China extending its control over the region. With the increasing demand for food resources, areas such as this will need to be regulated to maintain equitable outcomes while still being available as a global commons.

1.7 Sustainability

33% of species are overfished, 60% are fished at maximum capacity

1.7.1 Challenges to Sustainability

- Capitalism drives over consumption and exploitation, caused and leading to commodification of aquaculture products
- Corporate control lacks respect for local values, ie. businesses are only interested in profit maximisation
- Ecological impacts can be externalised very easily, ie. negative externalities → social and environmental cost
- Lack of information and hence less consumer awareness limiting responsible purchasing decisions

1.7.2 Issues with Aquaculture

- Food chain bias with low conversion rates
 - People mostly consume apex predators, ie. the top of the food chain eg. salmon
 - Conversion rate is the efficiency of input to output of resources needed to produce a food → barramundi has high conversion rate, cows have low conversion rate
- Monocultures lead to high disease mortalities

1.7.3 Benefits of Aquaculture

- Seaweed farms filter pollutants from the water, as well as absorb CO₂ from the air and water
- Aquaculture supports secondary and tertiary industries such as transport. This diversifies the economy, making it more resilient

1.7.4 Economic Sustainability

Aquaculture has high export returns for national economies, especially prevalent in South and South-East Asian countries

Developing countries have growing fish industries, increasing more rapidly than developed nations. Although this allows developing countries to reach developed status faster, its heightened growth may also be attributed to the lack of regulations regarding labour and land clearing.

Aquaculture can create economic diversity through tertiary services such as:

- Consultation
- Resource management
- Infrastructure

This economic diversity provides more resilience and stability.

1.8 Indigenous People's Practices and Benefit Sharing

- Philosophical approaches
 - Scientific knowledge
 - Holistic approaches
- Australian land management knowledge
 - TUMRA
- Potential medicines - Tea tree
- Potential foods
 - Kangaroo
 - Quandong
 - Wattle seed
 - Pepper bush

1.9 ASC Label

- The Aquaculture Stewardship Council (ASC) is an NGO acting as international standard setting and labelling body for responsible aquaculture.
- "informed consumers can improve the management of aquaculture by selecting products that are linked to high environmental and social production standards"
- Prevents misleading from self-claimed labels
- Established in 2010 by IDH (a Dutch sustainable trade initiative) and WWF Netherlands
 - Introduced in Australia in 2017 with two part time staff ⁷
- Although Australia is a major producer of aquaculture, it usually exports high value seafoods (lobsters, abalone, tunas, scallops, prawns) but also imports lower value products (bulk fish, prawns)
- Greenwashing (untruthfully marketing as environmentally friendly, sustainable, or ethical) can occur in the aquaculture industry and is a concern for the ASC
- Self-created labels can be created cheaply and easily, therefore the ASC aims to provide as much information about goods, especially for imported products

1.10 Holiday Homework

1.10.1 The EPBC Act

iiiiiii HEAD

1. Explain how the EPBC Act protects threatened species in Australia? =====
2. Explain how the EPBC Act protects threatened species in Australia? [iiiiiii cf81edad4e0473ec9bca6c1bfa03dacb39d6807](#)
 - When planning projects that impact natural environment/heritage (eg. mining, land clearing, property development, farming intensification), approval from Aust. govt and/or state+local govt.
 - Mitigation strategies need to be accounted for
 - Refer project to the department if there is significant impact

iiiiiii HEAD

The EPBC enables the government to manage development projects that would impact the environment, as well as managing nationally and internationally imported plants, animals, habitats, and places. =====

The EPBC enables the government to manage development projects that would impact the environment, as well as managing nationally and internationally imported plants, animals, habitats, and places. [iiiiiii cf81edad4e0473ec9bca6c1bfa03dacb39d68074](#)

The Act protects certain nationally significant animals, plants, habitats, or places (protected matters). A referral and assessment may be required if a project potentially impacts matters protected under the EPBC Act.

The Act protects nationally threatened species and ecological communities by:

- identifying high risk species and ecological communities
- developing conservation advice
- maintaining a register of critical habitats
- recognising key threats

⁷yay we have a grand total of 2 part time staff in Australia :)

3. Explain how the EPBC Act would apply to the salmon industry in Macquarie Harbour.

The EPBC Act regulates and monitors the processes of salmon farms in Macquarie Harbour to minimise environmental impact. When building the farms, a referral and assessment would need to be provided to the Australian and Tasmanian Governments, as well as the West Coast Council. The assessment of the farm would then be analysed, with appropriate amendments. Requirements could include:

- limiting the density of fish
- designing and implementing appropriate technologies that mitigate fish escape
- limiting the use of chemicals such as vaccines, as well as mitigating the amount of lost feed

These processes may reduce the profitability of salmon farming in the harbour, however would minimise harm to the local ecosystem.

- 4.

1.10.2 Our World in Data - Urbanisation

1. Describe how urban areas are defined.

Although there is no internationally standardised definition of an urban area, country-based statistics are still useful in demonstrating population changes. Although varying, countries often categorised an urban area based on the number of inhabitants, as well as other metrics such as infrastructure development or designated cities.

2. Describe the change in urban populations since 2000.

Global urban populations have experienced a constant growth since 2000 of 0.13% per year. In 2007, the distribution of rural and urban residents equalised.

1.10.3 Urbanisation and the Future of Cities - TedEd

1. Outline the major challenges for urban residents?

With the consistent increase of urbanisation, demand for resources will become an increasingly large issue. Food, sanitation resources, and education will need to be properly provided for. This increase in demand will also require environmentally sustainable processes for food production and infrastructure development to allow for large-scale production.

1.10.4 World Cities Report 2024

1. Explain how cities can best mitigate climate change today.

Climate change mitigation strategies in cities should incorporate diverse urban groups, and are more likely to produce inclusive solutions. For example, input from people in high climate risk areas is more likely to produce effective plans. Community-led programs should therefore be supported by higher governance levels, benefiting from community knowledge and targeted approaches, while fostering general community engagement.

2. Outline which cities and city residents are considered climate vulnerable.

Coastal cities are at high risk to the effects of climate change due to sea-level rise and exposure to more severe weather systems. Low socioeconomic residents often reside in the most climate-prone areas of cities, further disadvantaging them. As well as this, marginalised groups are more often impacted by climate change due to existing issues.

1.10.5 Cities and Climate Change: Making the Links - Tedx

1. Outline the best things cities can do to mitigate climate change.

Good data and monitoring to create effective, effective budgeting, community support

2. Explain how cities are leading climate action.

Implementing local laws to incentivise large building owners to reduce total energy use. Reducing consumption of energy has a vital role in reducing associated carbon emissions, and may facilitate the transition to less efficient sustainable methods while technology continues to develop. Investing in sustainable energy sources where appropriate can also decrease carbon emissions that drive climate change. For example, solar panels are especially useful in cities exposed to long periods of bright sun, such as Sydney. Using environment specific sustainable energy production methods can improve efficiency of such systems and reduce overall emissions. Developing new methods of energy production that decreases the amount of current waste.

1.10.6 How will the next generation of cities address the challenges of climate change?

1. Explain what this video suggests is the best way for cities to mitigate climate change.

The video identifies transport as a major contributor to greenhouse gas emissions that affect climate change. Use of power from car manufactures resulted in cities designed for cars, such as large distances between designated residential and commercial land. The primary method of mitigating this is through the adaptation of urban areas to facilitate access to public transportation and active transit would decrease the use of private cars, as well as encourage city development to focus on accessibility without cars.

2. Explain how climate mitigation also fosters high liveability in cities?

As mentioned, reduction in fossil fuel powered transportation systems can help mitigate released carbon emissions. Building highly walkable cities increases their liveability and build environments where public infrastructure is capable of accommodating all inhabitants to minimise reliance on privately owned transport such as cars.

1.10.7 AT Kearney Global Cities Report

1. Outline what is being measured by the global cities report

The global cities report aims to measure and analyse the connectivity of globally influential urban areas. Data is used to generate a Global Cities Index (GCI) that assesses the current state of connectivity for 156 cities.

Contents

Chapter 2

Global Sustainability Aquaculture

2.1 Syllabus

Sustainability in the contemporary world

- Sustainability and sustainable development, including pillars of sustainability - social, economic, environmental and cultural
- Principles of ecologically sustainable development - precautionary principle, intergenerational equity, conservation of biological diversity and ecological integrity
- Opportunities and challenges in planning for and achieving global sustainability
Including:
 - the role of global forums, agreements and cooperation
 - levels of action at a range of scales, from the United Nations Sustainable Development Goals to practices in local communities, including actions by governments, intergovernmental organisations (IGOs), non-government organisations (NGOs), corporations, community organisations and individuals
 - Indigenous Peoples' practices and benefit sharing
 - political, economic, technological, social, cultural and environmental influences

Evaluating sustainability

- The reasons for evaluating and monitoring global sustainability
- A range of criteria for evaluating the sustainability of economic activities

Investigation of a global economic activity

Students study ONE global economic activity, for example:

- agriculture
- energy production
- fishing
- forestry
- manufacturing
- mining

- tourism.

For the global economic activity studied, students:

- evaluate the sustainability of the activity, using one or more criteria
- examine a range of strategies for sustainability
- critically analyse ONE strategy.

Students investigate:

- The nature and spatial patterns of the global economic activity
- Influences on the global economic activity
Including:
 - biophysical
 - economic
 - technological
 - political/organisational
- Current trends and future directions

2.2 Relevant Statistics

2.2.1 Nature

- Total aquaculture production in 2022 was 130.9 million tonnes
- 2022 was the first time that global aquaculture surpassed capture production
- 59.1 million tonnes of production from inland water aquaculture
- Technological advancements in pond-based aquaculture have been adopted, increasing efficiency and reducing environmental impact. Eg. the in-pond raceway system (↑production, ↓waste accumulation) is being increasingly adopted in China
- The 564 farmed species are taxonomically recognised

2.2.2 Spatial Patterns

- Concentrated in Asia due to abundance of coastlines
- China's share in aquaculture reached 80.3% in 2022

TABLE 3 WORLD AQUACULTURE PRODUCTION OF AQUATIC ANIMALS BY REGION AND SELECTED MAJOR PRODUCERS

	2000	2005	2010	2015	2020	2021	2022	Share in regional total, 2022 (%)	2020/2022 variation
	(thousand tonnes, live weight equivalent)								
Africa	400	646	1 289	1 788	2 266	2 328	2 317	100	↗
Egypt	340	540	920	1 175	1 592	1 576	1 552	67.0	↘
Nigeria	26	56	201	317	262	276	259	11.2	↘
Ghana	5	1	10	45	64	89	133	5.7	↗
Uganda	1	11	95	118	124	139	101	4.4	↘
Others	28	38	64	134	225	249	271	11.7	↗
Americas	1 423	2 177	2 515	3 280	4 443	4 494	4 958	100	↗
Chile	392	724	701	1 046	1 486	1 427	1 509	30.4	↗
Ecuador	61	139	273	427	775	904	1 123	22.6	↗
Brazil	172	258	411	578	630	649	738	14.9	↗
United States of America	457	514	497	426	448	461	478	9.6	↗
Others	341	543	633	804	1 105	1 053	1 111	22.4	↗
Asia	28 422	39 190	51 233	64 682	77 513	80 485	83 399	100	↗
China	21 522	28 121	35 513	43 748	49 620	51 221	52 884	63.4	↗
India	1 943	2 967	3 786	5 341	8 636	9 403	10 230	12.3	↗
Indonesia	789	1 197	2 305	4 342	5 227	5 536	5 414	6.5	↗
Viet Nam	499	1 437	2 683	3 462	4 668	4 736	5 160	6.2	↗
Bangladesh	657	882	1 309	2 060	2 584	2 639	2 731	3.3	↗
Myanmar	99	485	851	997	1 145	1 167	1 197	1.4	↗
Thailand	738	1 304	1 286	921	1 012	991	1 001	1.2	↘
Others	2 177	2 796	3 500	3 810	4 623	4 792	4 783	5.7	↗
Europe	2 053	2 144	2 533	2 956	3 271	3 570	3 503	100	↗
Norway	491	662	1 020	1 381	1 490	1 665	1 648	47.0	↗
Russian Federation	74	115	120	152	270	295	320	9.1	↗
Spain	311	225	257	297	277	280	276	7.9	↘
United Kingdom of Great Britain and Northern Ireland	152	173	201	212	220	239	203	5.8	↘
France	267	245	203	163	191	193	200	5.7	↗
Greece	95	106	121	107	132	144	142	4.1	↗
Italy	214	182	153	149	126	146	133	3.8	↗
Others	448	436	457	496	566	608	582	16.6	↗
Oceania	122	154	190	178	225	250	235	100	↗
Australia	32	45	76	83	103	129	125	53.2	↗
New Zealand	86	105	111	91	119	117	106	45.1	↘
Papua New Guinea	0	0	2	2	2	2	2	0.8	↗
New Caledonia	2	3	1	1	1	1	1	0.6	↗
Others	2	0	1	0	1	1	1	0.2	↗

NOTE: Data on aquatic animals exclude crocodiles, alligators, caimans, aquatic products (corals, pearls, shells and sponges) and algae.

SOURCE: FAO. 2024. FishStat: Global aquaculture production 1950–2022. [Accessed on 29 March 2024]. In: FishStatJ.

Available at: www.fao.org/fishery/en/statistics/software/fishstatj. Licence: CC-BY-4.0.

2.2.3 Environmental

2.2.4 Economic

- Global trade had value of USD 312.8 billion in 2022

2.2.5 Social

- In 2022, an estimated 61.8 million workers were employed in commercial fisheries and aquaculture
 - Predominantly from Asia 85%
- Aquaculture provided employment for around 22 million people

2.2.6 Political

2.2.7 SDGs

SDG 2: Zero Hunger - Aquaculture provides for 50% of global seafood production. Sustainable aquaculture can reduce hunger and malnutrition, especially in developing countries due to their significant source of protein and micronutrients.

SDG 8: Decent Work and Economic Growth - The aquaculture industry provides jobs for millions of people worldwide, from hatcheries to processing facilities.

SDG 12: Responsible Consumption and Production - Aquaculture systems must be managed sustainably to avoid overuse of natural resources, reduce waste, and ensure efficient production. Promoting environmentally responsible practices like *integrated multi-trophic aquaculture (IMTA)* minimizes negative ecological impacts while maximising yield.

2.3 Introduction to Aquaculture

"Farming of aquatic species in controlled or semi-controlled conditions" Eg. Salmon, barramundi, lobsters (can be semi-controlled), crabs, prawns, oysters, scallops, seaweed Non food: pearl scallops, coral (people keeping pets), crocodile skin Pets: goldfish

In situ → In the environment

Ex situ → Isolated to the environment

Eg. Oyster farms in situ may be affected by external factors like a sewage spill

2.3.1 History

Although the Brewarrina fish traps are one of the oldest human constructions, they aren't real farms Roman oyster farm Chinese carp farm

Aquaculture is practised across a wide variety of locations and species. Can be:

- Marine (mariculture), estuary or freshwater (in-land)
Mariculture is currently underutilised, vast ocean space that isn't being used
- In-situ or ex-situ
- Fin-fish, crustacean, molluscs, or plants (usually algae)
Carp (trash fish)
- For human consumption, fishmeal, or fish oil
- For local consumption or for export earning
Norway and Chile grow the majority of the world's salmon, and is exports
Changes the nature that the fish grows

Aquaculture is **NOT** fishing

In 2018, aquaculture produced 114.5 million tonnes in live weight, with a total farm-gate sale value of US\$263.6 billion Aquaculture accounted for 46% of the total seafood production and 52% of fish for human consumption China produces and consumes the largest amount of aquaculture, but also more broadly Asian countries

There aren't that many inland waters, so inland fisheries do not have a significant amount of production ¹

Types of Economic Activity

- Primary - Farming
- Secondary - Manufacturing, producing
- Tertiary - Distribution of goods, using produced goods
- Quaternary - Researcher of salmon
- Quaternary - Researcher of salmon

¹Carp and tilapia are not nice - David Latimer

2.3.2 Distribution of Aquaculture

Aquaculture is mainly centred around Asia, with China representing around 60% of global aquaculture. Fish is common in South-east Asia, especially with river fish eg. Vietnam. Other countries just catch their fish.

African countries do not have the development or GDP to farm fish. Culturally also doesn't eat fish.²

Developing countries are increasing their share of international fish trade. Countries with large fishing catches often have larger aquaculture production.

Various places have cultural preferences and natural advantages for the production of particular species.

- Predominantly carp³
- Seaweeds
- Tilapia
- Oysters
- Clams
- Catfish
- Prawns - Warm species
- Salmons, trout, smelts - Salmon is expensive
- Freshwater fishes

As China gets richer and richer, they will seek to eat more expensive fish, therefore increasing the demand.

2.4 Draft Nature and Spatial Patterns Text

The text below is a reasonable, band 4-5 response to the stimulus prompt **“Examine the nature and spatial patterns of ONE global economic activity”**. Use the FAO report below to help you edit the text into a strong Band 6 response, complete with a clear thesis, detailed information and vocabulary, and well structured paragraphs. Your finished text should be around 300-500 words in length.

Draft Text

Aquaculture is global economic activity whereby people grow fish for food and trade. Aquaculture takes places around the globe, giving people both food and money.

Aquaculture is really old, having been practised for years and years. However, people grow lots of different species today. It's important to state that aquaculture and fishing are different activities.

The economic activity of aquaculture can be carried out in both rich and poor countries. However, different countries tend to practise aquaculture differently and for different reasons. Aquaculture is mostly practised in rich countries.

Aquaculture is also practised in different environments. Moreover, these different types of aquaculture are not growing at the same speed. Some types of aquaculture are growing much more rapidly than others.

Comments

- Use stats
- In an "examine the nature and spatial distribution" question, evenly allocate writing to each part
- Specify location; Asia is very broad but aquaculture is focused around only 5

²"I don't like river fish, it's gross" - David Latimer

³"River fish have a bland, muddy flavour" - David Latimer, D1 river fish hater

2.5 Influences on the global economic activity

"How do different things affect the activity of aquaculture"

Nature, spatial patterns, future changes, sustainability

Biophysical	How the biophysical environment and ecosystems influence aquaculture
Economic	Demand and supply factors
Technological	New developments that increase sustainability
Political/Organisational	How is it controlled

2.5.1 Biophysical Factors

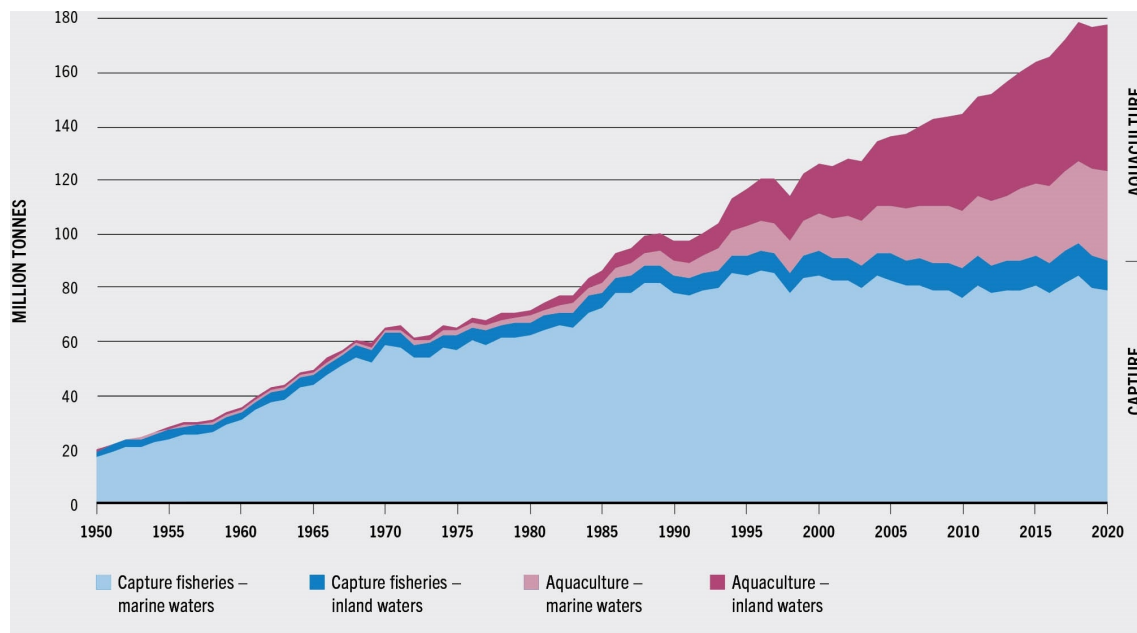
There are 622 species recognised by the FAO as being produced by aquaculture with each species requiring its own specific biophysical requirements

Local water conditions can impart "**merroir**" to seafood → the flavour it has

Local conditions flavour specialisation and give places competitive advantages

- Atlantic Salmon production is dominated by cold deep waters found in Norway and Chile
- Salmonids have become the largest single fish commodity by value
- Shrimp production benefits from brackish, warm tropical waters

Ex situ aquaculture attempts to separate aquaculture from the biophysical environment by controlling for temperature and chemistry. However, it is difficult to reproduce the conditions cheaply



Water Chemistry

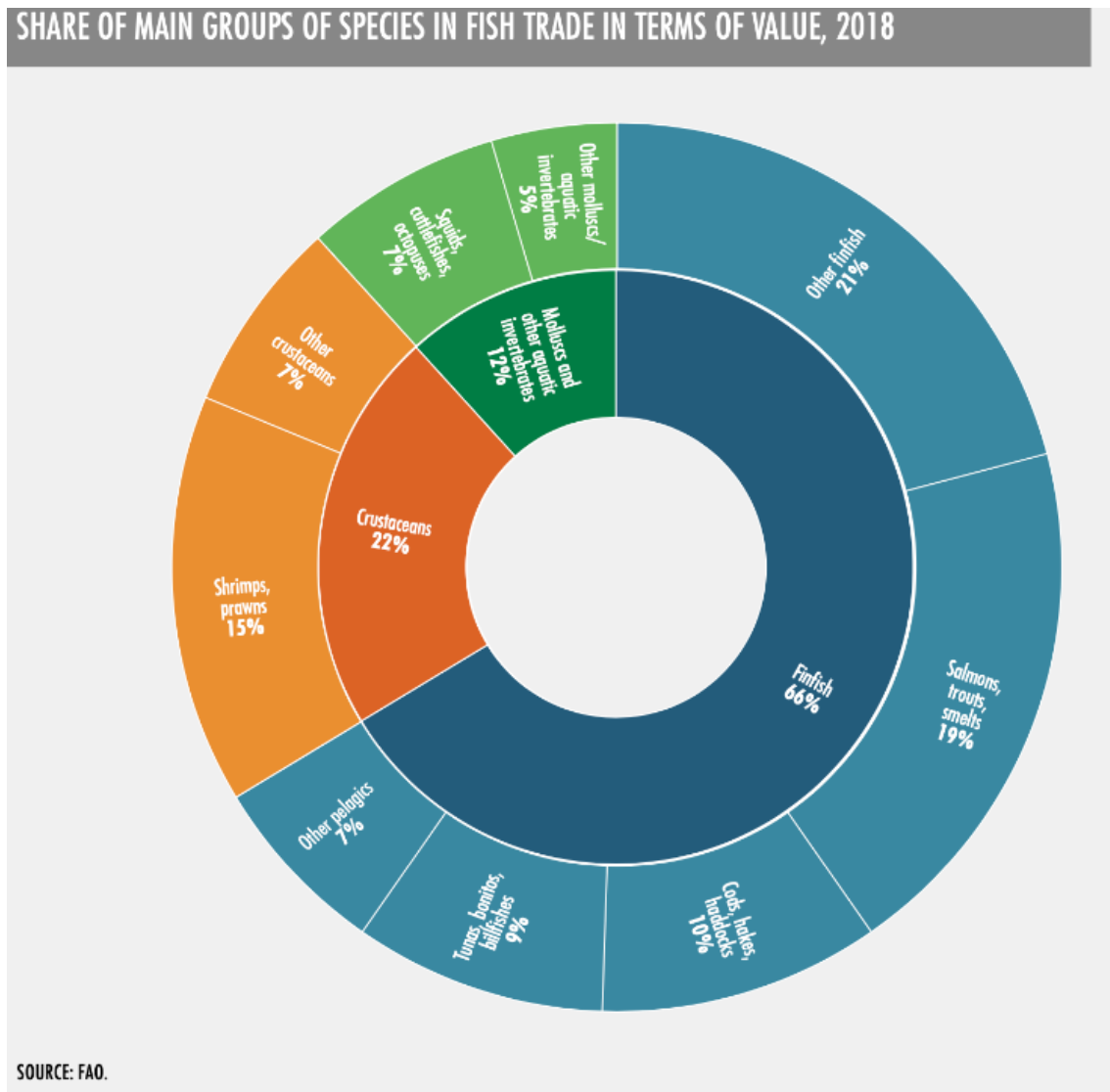
The local bedrock and substrates will impact various chemical characteristics to the water, such as nitrates, phosphates, heavy metals. Heavy metals are present due to mining operations that

Salinity is one of the most important characteristics of the water used in aquaculture

- Briny - High salinity
- Saline - Seawater, salt lakes
- Brackish - Estuaries, mangrove swamps
- Fresh - Ponds, lakes, river, streams

Eg. Oyster farmers will move their oysters up and down stream to control the way they grow

Salmon farms need high flow of water to account for the waste produced by the high concentration of salmon
Water plants can generally be grown anywhere



Climate

Atlantic Salmon require deep water with temperatures below 10°C giving Norway and Chile an advantage

Vannamei Shrimp require brackish, estuarine water that does not fall below 20 °C giving South-East Asian nations an advantage

Ecological

Aquaculture can have a highly detrimental interaction with local and global ecologies. For example:

- Carbon emissions from feed catch trawling
- By-catch from trawling
- Land clearing of mangroves

Aquaculture ventures often have to work with nearby human settlements. Some communities use this to produce multi-trophic production systems

Disease outbreaks are increasing in aquaculture due to **monoculture**

Eg. An in situ production system:

- Food pellets aren't completely consumed, increasing the concentration of food in an area
- The introduction of non-native species that are highly competitive
Bad weather can increase the likelihood of escapes
- Predators like birds can attack fish, increasing the overall level of fish stress
- Bulk antibiotics applied to fish farms can impact resistance in future
This can extend to humans consuming the fish
- Fat salmon are better to eat, however to become this way they are overfed and lazy. If salmon escape, they can breed lazy salmon in the natural environment ^{4 5}

To mitigate the greater environmental impacts:

- Make the farm ex situ
- Lower the density of the farm (However this lowers profit)
- Environmental Laws → Developing nations are also able to use lax environmental laws to develop coastal land for aquaculture

Positive Ecological Impacts

Oyster farming industries can filter estuaries and apply pressure to keep waterways clean - encourages community to reduce pollution

2.5.2 Economic Factors

Commodity Prices

Variable exchange rates and market prices for export commodities will modify production, including access to feed meal.

In recent years, other major producing countries have reported low market prices of staple species, reflecting market saturation at least seasonally and locally for these mass-produced species.

Salmon and avocado sushi was invented by Norwegians to encourage Japanese to purchase it. Before introduction, Japan was not a major salmon consumer but was wealthy and Norwegians had an excess.

The **commodification** of aquaculture produce also placed demand to exceed environmental capacity. Commodification drives the production of more goods.

⁴"How do you get a fat salmon" - Latimer

⁵"You want a fat, lazy salmon" - Latimer

Differences in HIC and LIC aquaculture

In some LICs, low labour costs can be a competitive advantage for production.

However, capital can be difficult to source in LICs - Greater degree of risk, less willingness for investors

HICs will use the high value of their markets to demand higher quality produce.

China has been accused of devaluing its yuan to promote exports. If their exchange rate is lower, their exports are cheaper, people will buy more, better for the Chinese market. (Denied by China ofc)

Urbanisation

People are increasingly living in cities with higher incomes and better infrastructure to facilitate fish purchases

Labour Specialisation

In HICs, changes in life expectations have made it difficult to find adequate labour - It is difficult to get people to work in far away aquaculture farms. Is promoted in Australia by using Tongan migrants as labour.

In LICs, small scale farms account for much greater rates of production

The International Labour Organisation (ILO) has identified that aquaculture utilises child and slave labour, but notes there is limited availability of evidence.

People from Myanmar run to Thailand to escape the government. However questionable law enforcement in Thailand promotes illegal labour. One solution to this is international agreements and tariffs, however this is unlikely because people want their shrimp cheap. It is then a responsibility of the consumer to check the source of produce

2.5.3 Technological Factors

Selective breeding and GMO (genetically modified organism) technologies are common in aquaculture.

Used to:

- Improve market appeal
- Address disease
- Promote growth

Often used in the salmon industry because salmon is more expensive

Development in technologies for production are also important:

- Four stroke engine replacements → are less polluting than two stroke engines that release exhaust into the water, increasing pollution
- Optical scanner → can be used to replace human labour, ie. capital
- Improved cage netting → stronger materials for netting, double walled netting, overhead enclosure. Reducing escapees

Transport and Retail Technologies

Improvements in refrigerated transport have boosted trade and consumption of aquaculture products.

Internet sales and marketing have increased people's access to farm gate sales and reduced the cost and control of market sales. People are now able to purchase directly from the supplier, cutting out the middle man in trade.

Geospatial technologies allow for tracking and more efficient trade.

2.5.4 Organisational Factors

International governance:

- Food and Agriculture Organisation (FAO) UN organisation that provides advice
- World Trade Organisation (WTO) polices trade
- International Labour Organisation (ILO) monitor conditions of labour

National scale:

- NSW Department of Primary Industries (DPI) peak controlling organisation, gives permits, permission
- NSW Food Authority eg. tells oyster farmers what they can and can't sell

The size of the Chinese market. Supply due to demand factors allows major traders to influence what is produced

Ownership

A wide variety of farm owners are responsible for global aquaculture production.

Increasingly, large companies are looking to undertake **vertical and horizontal integration**

As well as producers, in Australia, supermarkets are also able to control prices Large aquaculture companies are able to use **economies of scale** to gain control over large market shares

Vertical integration: Company aims to own the entire production process, however all the liabilities are placed on the company

Horizontal integration: Company purchases competing companies in the same industry, eg. Cermaq is a major salmon and trout producer owned by Mitsubishi. For some companies, aquaculture is not their main goal, rather food in general

Control

Supermarket chains exert significant power over consumers ⁶

Most people buy their food from supermarkets

Labelling and Decision Making

Sea food labelling rules change consumer preference and may require government intervention

Australian made labels don't provide that much information about the product. If it is produced in many countries, the label will not say every country it has been in.

Manufactured products are considered to be from that country. Eg. Malaysian prawns are labelled as Malaysian if raw, but if sauce is put on them in Australia, then they are manufactured in Australia

⁶The power of companies has always been extreme and have power in politics through funding

2.5.5 Political Factors

International Trade

Tariffs are a tax on an imported good. Governments impose tariffs so the local businesses can compete with cheaper imports

Subsidies are similar, but work in reverse. The government pays local farmers so that they can continue production. Protects domestic employment

Eg. Sugarcane farmers in Queensland are given money to maintain employment. Queensland is a swing state, so governments are always going to provide funding

A quota is a limit of number of items imported into a country.

Import and export barriers to free trade are used to protect local industries.

However, trade wars have also affected aquaculture products and commodity prices - particularly soybeans. Countries are likely to apply tariffs on each other, elevating economic tensions

Diplomatic relationships and the WTO are important in resolving disputes

The WTO also regulates Trade Related Intellectual Property Rights (TRIPS) which affects trademarks, geographic indications, patents and industrial designs

A particular barramundi species can be patented, allowing you to market the quality of the barramundi

Asia-Pacific Trade

Australia participates in a range of bilateral and multilateral agreements which facilitate greater trade with the Asia-Pacific region. Trade relationships are often overlapping

However, trade can also place environments at risk from exotic species and pathogens. It can cause confusion whether it is imposed as a biosecurity risk or as a trade restriction.

Legislation

Growth of aquaculture has outpaced the development of legislation and legal frameworks to govern the industry

Land clearing has been unchecked in some places

Development of a valuable industry has been given precedence over environmental concerns.

Research, monitoring and lobbying by NGOs like Greenpeace and WWF provides political pressure on nation-states.

International Geopolitics

UNCLOS (1982) - Defines the 200 nautical mile boundaries for Exclusive Economic Zones (EEZ)

Ramsar - Defines a number of internationally significant wetlands.

CITES - Prevents trade of endangered species. For example the trade of illegally fished caviar from the sturgeon fish which is now mostly farmed.

COP negotiations - Pressure on nations to change agriculture practices and prevent land clearing

Nine dash line defined by China is still hotly contested due to fishing resources. China is a large country with large food demand

Niger river catchment is the only source of water for some countries. Climate change means water is very

important in the catchment. Conflict and destabilisation means that water resources are very valuable. The pollution of water resources due to aquaculture or the use of water in general could contribute to the conflict.

2.6 Practice Question

Explain three influences that will likely determine the future directions of aquaculture globally. (6 marks)

Aquaculture is a rapidly developing global industry that has many opportunities for future growth. There are a variety of economic, technological and political influences that will likely determine the industry's future.

Economic influences control how much the aquaculture industry can expand, with demand playing a vital role in the production of aquaculture products. Demand factors directly influence the funding resources that businesses have to continue and expand. If there is a lack in consumer demand for aquaculture products, there will be a decrease in production, and hence a contraction in the industry overall. Currently, the consumption of aquaculture products is generally similar the world, except for the highly concentrated popularity in East and South-East Asian countries, especially China. In 2024, China consumed 57,474 tons of fish, over four times higher than the second largest consumer, Indonesia. With the recent economic prosperity of the Asian region, the aquaculture industry has the ability to grow significantly to match the needs of its demand.

Technological influences including emerging developments can also drive the growth of the aquaculture industry across the world. Developments in aquaculture often allow for more time and resource efficient production processes that maximise the affordability and viability of aquaculture. New technologies including the automation of processes such as feeding systems or water quality monitoring reduce impacts of human error, and can be cheaper to operate than using labour. This facilitates a more efficient operation, attracting potential investors and entrepreneurs. Emerging developments can also improve the environmental sustainability of aquaculture. For example, the transition from two-stroke to four-stroke boat engines increases fuel efficiency and can significantly reduce exhaust emitted into the water. Although four-stroke engines are not compatible in all situations, future technologies may further reduce waste generated from the aquaculture process. Technology hence has the ability to further expand the efficiency and sustainability of the aquaculture industry.

The changing nature of the aquaculture industry requires new political legislations to maintain a sustainable and fair economic environment. Like other production industries, aquaculture requires land and other resources that can have external impacts to the wider ecosystem and community. Hence, some government organisations and NGOs advise and enforce rules upon businesses and nation states to maintain the sustainable growth of aquaculture. Currently, there are limited regulations surrounding the operation of aquaculture despite it being estimated to have reduced mangrove forests in countries such as Indonesia and Thailand by over 30%. As well as this, it also increases the competition between countries for ocean areas. The South China Sea is a highly valuable area for potential aquaculture however is contested by its surrounding countries, with China extending its control over the region. With the increasing demand for food resources, areas such as this will need to be regulated to maintain equitable outcomes while still being available as a global commons.

2.7 Sustainability

33% of species are overfished, 60% are fished at maximum capacity

2.7.1 Challenges to Sustainability

- Capitalism drives over consumption and exploitation, caused and leading to commodification of aquaculture products
- Corporate control lacks respect for local values, ie. businesses are only interested in profit maximisation
- Ecological impacts can be externalised very easily, ie. negative externalities → social and environmental cost
- Lack of information and hence less consumer awareness limiting responsible purchasing decisions

2.7.2 Issues with Aquaculture

- Food chain bias with low conversion rates
 - People mostly consume apex predators, ie. the top of the food chain eg. salmon
 - Conversion rate is the efficiency of input to output of resources needed to produce a food → barramundi has high conversion rate, cows have low conversion rate
- Monocultures lead to high disease mortalities

2.7.3 Benefits of Aquaculture

- Seaweed farms filter pollutants from the water, as well as absorb CO₂ from the air and water
- Aquaculture supports secondary and tertiary industries such as transport. This diversifies the economy, making it more resilient

2.7.4 Economic Sustainability

Aquaculture has high export returns for national economies, especially prevalent in South and South-East Asian countries

Developing countries have growing fish industries, increasing more rapidly than developed nations. Although this allows developing countries to reach developed status faster, its heightened growth may also be attributed to the lack of regulations regarding labour and land clearing.

Aquaculture can create economic diversity through tertiary services such as:

- Consultation
- Resource management
- Infrastructure

This economic diversity provides more resilience and stability.

2.8 Indigenous People's Practices and Benefit Sharing

- Philosophical approaches
 - Scientific knowledge
 - Holistic approaches
- Australian land management knowledge
 - TUMRA
- Potential medicines - Tea tree
- Potential foods
 - Kangaroo
 - Quandong
 - Wattle seed
 - Pepper bush

2.9 ASC Label

- The Aquaculture Stewardship Council (ASC) is an NGO acting as international standard setting and labelling body for responsible aquaculture.
- "informed consumers can improve the management of aquaculture by selecting products that are linked to high environmental and social production standards"
- Prevents misleading from self-claimed labels
- Established in 2010 by IDH (a Dutch sustainable trade initiative) and WWF Netherlands
 - Introduced in Australia in 2017 with two part time staff ⁷
- Although Australia is a major producer of aquaculture, it usually exports high value seafoods (lobsters, abalone, tunas, scallops, prawns) but also imports lower value products (bulk fish, prawns)
- Greenwashing (untruthfully marketing as environmentally friendly, sustainable, or ethical) can occur in the aquaculture industry and is a concern for the ASC
- Self-created labels can be created cheaply and easily, therefore the ASC aims to provide as much information about goods, especially for imported products

2.10 Holiday Homework

2.10.1 The EPBC Act

iiiiiii HEAD

1. Explain how the EPBC Act protects threatened species in Australia? =====
2. Explain how the EPBC Act protects threatened species in Australia? *iiiiiii*
cf81edad4e0473ec9bca6c1bfa03dacb39d68074
 - When planning projects that impact natural environment/heritage (eg. mining, land clearing, property development, farming intensification), approval from Aust. govt and/or state+local govt.
 - Mitigation strategies need to be accounted for
 - Refer project to the department if there is significant impact

iiiiiii HEAD

The EPBC enables the government to manage development projects that would impact the environment, as well as managing nationally and internationally imported plants, animals, habitats, and places. =====

The EPBC enables the government to manage development projects that would impact the environment, as well as managing nationally and internationally imported plants, animals, habitats, and places. *iiiiiii* cf81edad4e0473ec9bca6c1bfa03dacb39d68074

The Act protects certain nationally significant animals, plants, habitats, or places (protected matters). A referral and assessment may be required if a project potentially impacts matters protected under the EPBC Act.

The Act protects nationally threatened species and ecological communities by:

- identifying high risk species and ecological communities
- developing conservation advice
- maintaining a register of critical habitats

⁷yay we have a grand total of 2 part time staff in Australia :)

- recognising key threats
3. Explain how the EPBC Act would apply to the salmon industry in Macquarie Harbour.

The EPBC Act regulates and monitors the processes of salmon farms in Macquarie Harbour to minimise environmental impact. When building the farms, a referral and assessment would need to be provided to the Australian and Tasmanian Governments, as well as the West Coast Council. The assessment of the farm would then be analysed, with appropriate amendments. Requirements could include:

- limiting the density of fish
- designing and implementing appropriate technologies that mitigate fish escape
- limiting the use of chemicals such as vaccines, as well as mitigating the amount of lost feed

These processes may reduce the profitability of salmon farming in the harbour, however would minimise harm to the local ecosystem.

4.

2.10.2 Our World in Data - Urbanisation

1. Describe how urban areas are defined.

Although there is no internationally standardised definition of an urban area, country-based statistics are still useful in demonstrating population changes. Although varying, countries often categorised an urban area based on the number of inhabitants, as well as other metrics such as infrastructure development or designated cities.

2. Describe the change in urban populations since 2000.

Global urban populations have experienced a constant growth since 2000 of 0.13% per year. In 2007, the distribution of rural and urban residents equalised.

2.10.3 Urbanisation and the Future of Cities - TedEd

1. Outline the major challenges for urban residents?

With the consistent increase of urbanisation, demand for resources will become an increasingly large issue. Food, sanitation resources, and education will need to be properly provided for. This increase in demand will also require environmentally sustainable processes for food production and infrastructure development to allow for large-scale production.

2.10.4 World Cities Report 2024

1. Explain how cities can best mitigate climate change today.

Climate change mitigation strategies in cities should incorporate diverse urban groups, and are more likely to produce inclusive solutions. For example, input from people in high climate risk areas is more likely to produce effective plans. Community-led programs should therefore be supported by higher governance levels, benefiting from community knowledge and targeted approaches, while fostering general community engagement.

2. Outline which cities and city residents are considered climate vulnerable.

Coastal cities are at high risk to the effects of climate change due to sea-level rise and exposure to more severe weather systems. Low socioeconomic residents often reside in the most climate-prone areas of cities, further disadvantaging them. As well as this, marginalised groups are more often impacted by climate change due to existing issues.

2.10.5 Cities and Climate Change: Making the Links - Tedx

1. Outline the best things cities can do to mitigate climate change.

Good data and monitoring to create effective, effective budgeting, community support

2. Explain how cities are leading climate action.

Implementing local laws to incentivise large building owners to reduce total energy use. Reducing consumption of energy has a vital role in reducing associated carbon emissions, and may facilitate the transition to less efficient sustainable methods while technology continues to develop. Investing in sustainable energy sources where appropriate can also decrease carbon emissions that drive climate change. For example, solar panels are especially useful in cities exposed to long periods of bright sun, such as Sydney. Using environment specific sustainable energy production methods can improve efficiency of such systems and reduce overall emissions. Developing new methods of energy production that decreases the amount of current waste.

2.10.6 How will the next generation of cities address the challenges of climate change?

1. Explain what this video suggests is the best way for cities to mitigate climate change.

The video identifies transport as a major contributor to greenhouse gas emissions that affect climate change. Use of power from car manufactures resulted in cities designed for cars, such as large distances between designated residential and commercial land. The primary method of mitigating this is through the adaptation of urban areas to facilitate access to public transportation and active transit would decrease the use of private cars, as well as encourage city development to focus on accessibility without cars.

2. Explain how climate mitigation also fosters high liveability in cities?

As mentioned, reduction in fossil fuel powered transportation systems can help mitigate released carbon emissions. Building highly walkable cities increases their liveability and build environments where public infrastructure is capable of accommodating all inhabitants to minimise reliance on privately owned transport such as cars.

2.10.7 AT Kearney Global Cities Report

1. Outline what is being measured by the global cities report

The global cities report aims to measure and analyse the connectivity of globally influential urban areas. Data is used to generate a Global Cities Index (GCI) that assesses the current state of connectivity for 156 cities.

Chapter 3

Urban and Rural Places

3.1 Urbanisation

3.1.1 Definition of a Slum

- Lack of tenure ie. lack of ownership of the land
- Sanitation
- Durability
- Employment
 - Governments prefer formal employment because it can be taxed
 - Informal employment prevents the government from gaining funds to invest in infrastructure and public services
 - Informal employment lacks safety measures, eg. trash picking job common to developing countries is likely to have poor sanitation, and is not regulated
 - However, it is more flexible, decreases barriers to employment (paperwork, certification) (also reduces capital and initial investment)
 - Work outside regulation is not illegal
 - Can be a source of:
 - * Child labour
 - * Unsafe working conditions
 - * Environmental concerns
- Energy supply
 - Power is needed for manufacturing and is necessary to attract foreign investment
 - People in LICs will buy their own power
 - * Don't need excessive amounts
 - * Charge a car battery with a solar panel
 - * Known as "leap frogging" technology
- Water supply
 - Large populations need substantial water supply
 - Groundwater usage destabilises the soil and causes sinking
 - Groundwater is also exposed to arsenic and other heavy metals

- Water supplies are frequently privatised by city leading to inequality - mismatch of interests from business perspective
- Sanitation
 - It is hard to use a toilet in a slum
 - Faecal matter is exposed to the environment
- Traffic congestion
 - Cycle rickshaws (3 wheeled bike) increase congestion and prevent cars from utilising their speed, causing high inefficiency that also impacts air pollution

3.1.2 Statistics

- Housing
 - Global urban population surpassed rural population in 2007 and is currently at 55%
 - 24.2 % of the urban population lives in slums
 - By 2030, 1 in 4 people will live in slums, currently, 1 in 7 people live in slums
- Pollution
 - 99% of the global population lives in places where air pollution exceeds WHO guidelines
 - Air pollution is the largest contributor to global disease burden (measured by Disability-Adjusted Life Years (DALYs), where one DALY = one year of good health lost)
 - 8.1 million premature deaths annually due to air pollution
 - Traffic congestion costs people in Rio de Janeiro 190 hours per year
- Sanitation
 - Dharavi has one toilet per 1500 people
- Informal economies
 - More than 60% of employed people globally are in informal employment arrangements UNSD-SDG Goals
 - Up to 92% of women are in informal employment compared to 87% for men

Case Studies

- Shanghai
 - Increase of over 13 million people from 1987 - 2015
 - Population density from 1785 - 3809 /km²

3.2 Challenges in Rural Places

A clear rural-urban divide exists in most countries

1. Rural areas face challenges in providing adequate and equal healthcare, services, education, and infrastructure
2. Diminishing economic and social well-being outcomes concentrate poverty and disadvantage in rural places

Remoteness is measured as a location's proximity to a city.

Remoteness patterns place Indigenous communities in these areas and further their disadvantage

3.2.1 Provision of Goods and Services

- Rural places often lack a **population threshold** high enough to provide anything other than low order goods and services (eg. bread, milk)
- Larger towns extend their **sphere of influence** as transport infrastructure and communications technologies improve, as regional centres extend their influence, it makes it harder for smaller towns to support themselves
- Automation and economic rationalisation have resulted in job losses in small towns
- Population ageing and outward migration exacerbate this decline
 - Remote areas have smaller working age populations and more aged people in comparison to major cities
 - Less people are working, and have smaller taxation revenue
 - However, old people are hard to keep alive

3.2.2 Provision of Healthcare and Education

- Long distances to hospitals and higher numbers of people per medically trained personnel lead to lower health outcomes
 - Regular check-ups are hard to do
 - People will need to travel long distances to these services
- Higher rates of poverty and age result in lower health outcomes
- Long distances and isolation result in higher rates of accidents and suicide
 - Longer distances to drive increase risks

3.2.3 Provision of Infrastructure

- Lack of communications infrastructure
- Fluctuations in economic activity in regional industries make it difficult for infrastructure to efficiently and sustainably underpin long term growth and development (eg. sugarcane is not economically viable in Australia due to overseas competition. Therefore will not be funded by Australian government)
- Infrastructure is more expensive per capita in lower density populations

3.2.4 Example Questions

1. **Describe the reasons for a decline in regional, rural, and remote area populations (approx. 200 words)**

Variations in population in a particular location occur due to a variety of reasons, predominantly the ability of available services to provide for the population, and the distance of which unprovided resources can be accessed. The accessibility of necessary services such as

2. **Compare and contrast the challenges for regional, rural, and remote area populations in Australia with those globally (approx. 500 words)**

3.3 Mr Ritchie's Lesson

- Urban centres serve the population around them
- Towns grow to support their populations
- Town growth relies on the success on farmers and the townspeople that service these farmers
- Farms are now more expensive to run due to technology, ie. less accessible
- Horizontal expansion occurs because some farmers cannot compete
- Populations to support towns is decreasing
- Rural-to-urban migration occurs due to decreasing populations
- Christaller's central place theory
- Small towns need to support some kind of industry, such as tourism

3.4 Understanding Mossman

3.4.1 Conceptual Map

3.4.2 Timeline

- **1875** - Dan Hart becomes the first non-indigenous settler in the Mossman district although at that time he did not have tenure

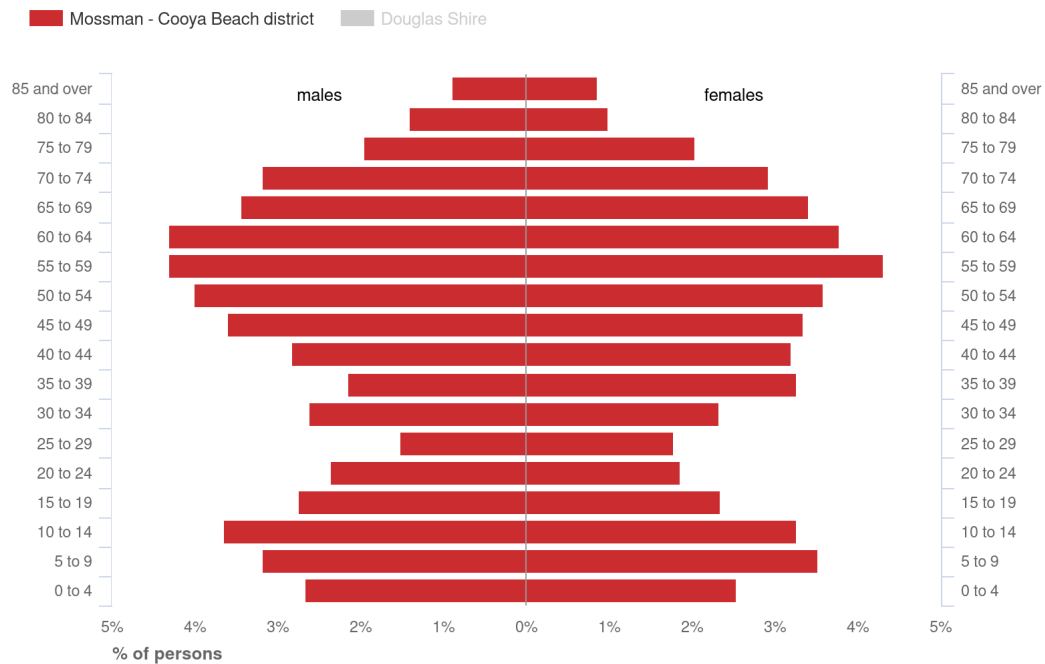
Mossman Gorge Wet tropical area - Luscious green undergrowth Buildings with undercover walkways due to rainfall Low-rise infrastructure

3.5 Nature of Social, Economic, and Environmental Changes in Mossman

Social Changes

- First nation recognition
 - Native title established in 2007
 - Kuku Yalanji bi-lingual signs
 - Mossman Gorge Cultural Facility
- Ageing population
 - emigration (18-25)
 - immigration (55-65)

Age-sex pyramid, 2021

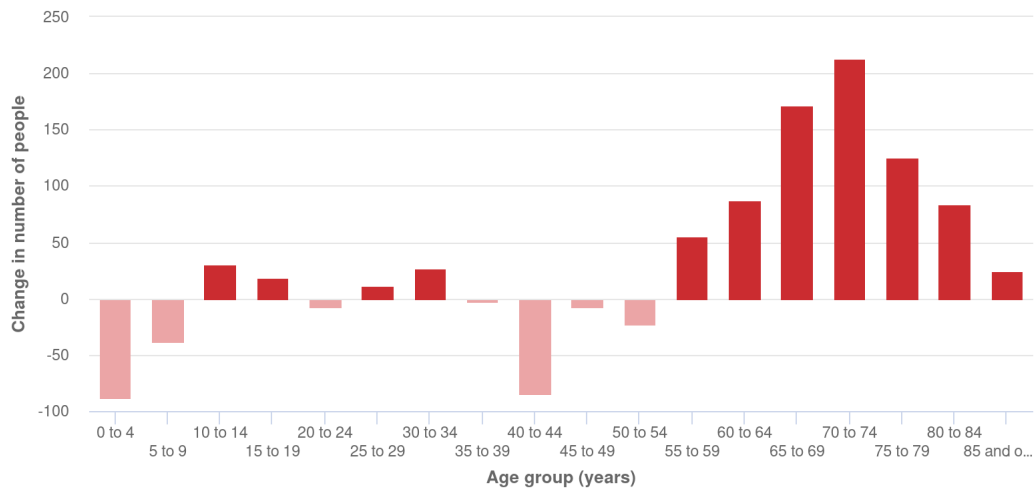


Source: Australian Bureau of Statistics, Census of Population and Housing, selected years between 1991-2021 (Enumerated data). Compiled and presented in profile.id by .id (informed decisions).

.id informed decisions

Change in age structure - five year age groups, 2016 to 2021

Douglas Shire - Total persons



Source: Australian Bureau of Statistics, Census of Population and Housing, 2016 and 2021 (Usual residence data). Compiled and presented in profile.id by .id (informed decisions).

.id informed decisions

Economic Changes

• Sugar industry

– https://www.abc.net.au/news/rural/2024-05-07/mossman-cane-growers-harvest-decision-mill-closure/103806792?utm_campaign=abc_news_web&utm_content=link&utm_medium=content_share&utm_source=abc_news_web

- The Mossman Mill entered voluntary administration in November 2023, and liquidation in February 2024
- The closure of the mill is expected to 188 million loss in total economic output and the loss of 575 local jobs
- Labour shortage
 - Mossman LFPR is at 52.1%, vs. the national average of 67.3%
- As the sugar industry becomes less sustainable, tourism must grow to compensate
- Growth in tourism, tourism development

Environmental Changes

- Climate change
- Prospectus mentions the Daintree Bio Region concept to diversify products and tap into green industry (eg. biofuels), however hasn't been mentioned

3.6 Responses

- Promotion and diversification of tourism
 - Ferry upgrade
 - Botanic Garden - preservation of local flora
 - Aquariums can also be used to preserve the reef
 - Road/cycleway - increase liveability
- Promotion and diversification of agriculture
 - Diversity in crop
 - up skilling → Daintree Bio Region
- Adaptation and mitigation to climate change
 - Adaptation
 - * Microgrids using sugarcane biofuels - this increases the resilience of Mossman
 - * Cooling urban spaces - higher temperatures in a high humidity environment
 - * Biodiversity preservation
 - Mitigation
 - * Reef 2050

3.7 Practice Essay

Analyse the challenges facing rural and urban places.

Rural and urban places are both complex systems that face numerous challenges as their populations and purposes change. Rural places generally suffer from their remote locations and consequently small populations. This limits their ability to support internal economy and must therefore rely on external economic sources to sustain themselves. This effect is compounded by rural to urban migration that further decreases their populations. Urban places face starkly different issues as high order centres with high density populations. The infrastructure and resources needed to support this is significantly higher, requiring intense planning to manage access to basic services and control waste production.

Rural places are remote centres that exist outside of cities and towns, often positioned as rest points on major connecting highways. The remoteness of these locations often decreases accessibility, in turn decreasing overall liveability. The small populations that inhabit these places do not meet the population threshold required to viably sustain some services. This lack of services such as schools is often a major push factor for young people in pursuit of education and dynamic social, cultural, and professional environments. Young populations are necessary in maintaining a working population and this rural to urban migration of young people further decreases internal economy and creates a negative feedback loop that perpetuates this decline.

In Australia, rural places are important in utilising the abundance of land for agricultural purposes. Mossman is a remote town located in Northern Queensland with a small sugarcane industry. Its economy primarily relies on ecotourism, providing access to the Daintree rainforest and Great Barrier Reef, accounting for 81% of the GRP of Douglas Shire.

3.8 Another Essay

Explain the national and global urban hierarchies of settlements.

Settlements are created as hubs for human connection and interaction to satisfy a particular purpose within the national context, and can extend to serve populations globally. The overall liveability and lifestyles of a settlement has a unique consideration of push and pull factors that directly control its inhabiting population. This variation in population determines the scale at which a settlement can economically and socially operate, forming a dynamic hierarchy of { settlements synonym } across the world.

High-order alpha cities provide connection hubs on a global scale and are the highest urban settlements. These cities, such as the alpha++ London and New York City, are economically interconnected with the world and support the largest stock exchanges in the world, with the NYSE representing appropriately 27.3% of the global equity market. This connection allows these cities to assert large spheres of influence globally, which further promotes development in these areas. Significant investment programs from public and private sectors create occupational opportunities that promote rural-to-urban migration, creating a positive feedback loop continues to increase population growth. Cities with many inhabitants often suffer from efficiency issues that inhibit their long-term growth. Many developed cities are experiencing declining or negative population growth such as Tokyo's 0.21% decrease between 2021-2022.

Cities within nations can also grow to similar sizes, however lack the economic interconnectedness of alpha+ and alpha++ cities. This restricts the economic sphere of influence with country, however these cities still have significant on other settlements. Like global cities, national centres serve as economic hubs whilst also providing a broad range of services for surrounding populations.

3.9

Primate cities - singular large city in a country, eg. Paris

hub and core arrangement - central city for large area eg. NYC for NA, London for Europe

how does nyc exert control - hub for transnational corporations

global cities vs. dominant cities

Role: Economic influence

- Command and control function

Cities that control and command centres - Tokyo exerts significant control based on revenues of corporations to headquarter cities

- Specialised services
- Market for goods
- Full range of goods and services

Role: Social influence

- Social infrastructure eg. ICC, global interconnectedness, NYC has 3 major airports
- Cultural facilities
- Range of events
- Distinctive and prestigious lifestyles

3.10

3.10.1 Ecological Footprint

Takes into account:

- Fisheries
- Built up land
- Pasture
- Cropland
- Carbon footprint
- Forest products

Good measure of space required to sustain a person's lifestyle. For much of the developed world, the capacity of production is less than the consumption of people

Hence, a linear relationship between the sustainable development index and HDI forms. Pretty much no countries have managed to couple high sustainability with high development. **The richer you get, the larger the ecological footprint.** Some countries like Cuba and Vietnam have relatively low footprints with larger HDI's however, they lack political freedoms that aren't accounted for in the given indices.

3.10.2 Arcadis Sustainable Cities Index

- Planet
 - Air pollution
 - Waste management

- Sustainable mobility
- City resilience
- Profit
- People
 - Personal well-being
 - Working life
 - Urban living (including access and reliability of public transport)
- Progress

3.10.3 Activities

1. Outline the measurements that specifically address environmental impacts for settlements. (4 Marks)

There are a variety of measurements that can be used to evaluate the environmental impact to settlements. Carbon footprint is a relevant measurement that accounts for air quality and carbon emissions. The increasing effects of climate change necessitate means of comparing the effectiveness of climate change solutions implemented by cities. Natural disaster resilience is important in identifying high risk cities that is furthered by the effects of climate change. Renewable energies are also important.

2. Assess the criteria used by Arcadis for evaluating sustainability. (6 Marks)

The Arcadis Sustainable Cities Index attempts to compare the environmental, social, and economic sustainability of cities around the world. It is a { insert evaluation } index that accounts for various aspects of sustainability

3.11 Sustainable Settlements

Important aspects of sustainable settlements

- Waste → Burning waste vs. stockpiling it. Burning can be used as energy, however there is community pushback
- Transport
- Energy → Renewable vs. natural resources
- Food → Food miles (ie. energy)
- Work
- Culture → Eg. attitudes to refugees + immigration
- Resilience → Economic resilience, eg. adapting for the shock of COVID, however it is increasingly due to the effects of climate change
 - In Mossman, a microgrid reduces reliance on other locations
 - As well as this, NBN can be used to reduce dependence
- Biodiversity
- Safety
- Equality → Housing affordability

Strategy 1 (Paris) - The leverage of cycling infrastructure to make Paris a 15 minute city

1. What has Paris done to promote active transport? (bikes)

- Over 1,000 km of bike lanes + 60 km for Olympic Games
- 2001 footpath widening
- Non-radial design targeted for cyclists
- In 2021, bicycle theft was the biggest reason that first time cyclists gave it up
- Paris Region Institute, April 2024, 11.2% of transportation within the city interior is done by bicycle, compared to the 4.3% done by car
- Introduction of green spaces
- Removing power away from cars, non-conformist, don't adhere to car roads or pedestrian paths. Also don't adhere to red lights
- E-bikes can go fast
- Addressing bike parking

2. How has this been supported?

- USD\$270 million from 2021-26 to build 180 km of new secure cycling lanes from French government

3. What effects has this had?

- La Convergence, a festive event that unites cyclists by encouraging people to ride to Invalides in Paris
- 45% increase in bike usage