DP IB Geography: SL

Your notes

Impacts of Changing Trends in Resource Consumption

Contents

Resource Security

Your notes

The Water-Food-Energy Nexus

- Proposed at the Bonn Nexus Conference in 2011, the **water, food and energy (WFE) nexus** refers to the connections or links between the consumption and supply of natural resources
- Changes in any of the three resource areas will impact the **security** of the others
- If resources are to be sustainably managed, then an understanding of the links and interactions is essential
  - The WFE nexus helps stakeholders such as governments, international organisations, TNCs and research establishments achieve this

What are water, food and energy security?

- **Resource security** refers to the ability of a country to maintain a **reliable** and **sustainable flow** of **resources** to maintain the **living standards** of its population
  - **Water security** is sufficient water of high enough **quality** to meet the population's needs
  - **Food security** is access to a diet of sufficient quantity and quality to meet daily health needs and allow people to lead an active life
  - **Energy security** is an available, affordable energy supply which is uninterrupted

Water security

- By 2050, global water demand is predicted to increase by 20–25%
- In 2023, almost 50% of the world's population faced **high water stress** for at least one month
- There are different levels of water shortage - these are **water stress** and **water scarcity:**
  - Water stress occurs when the supply of water is **below 1700m^3** a year per person
  - Water scarcity is when the supply is **below 1000m^3** a year per person
- According to the World Resources Institute, **25** countries faced extremely **high** levels of **water stress** in 2023
  - This affects over **25%** of the world's population
  - More than **80%** of the water **available** to agricultural, domestic and industrial users is **withdrawn** annually
  - Leaves businesses, farms and communities **vulnerable** to scarcity

Food security

- Large **spatial variations** exist in food security
  - North America, Europe, Japan and Australasia are the regions considered **most** food secure
  - The **greatest risk** of food insecurity is in sub-Saharan Africa, Afghanistan and Haiti
- **Climate change** and **growing population** are increasing the risk to food security in many regions of the world
- The UN estimates that the number of people in 'hunger emergencies' has increased from 135 million in 2019 to 345 million in 2022
  - Global food prices are rising; 23% higher in 2023 than in 2021
  - **World grain reserves** are lower than they have been for 14 years
  - Women and girls account for 70% of the people suffering hunger
  - Globally, approximately 783 million people are suffering from severe hunger
- In more developed countries, there is often a **food surplus** and large amounts of **food waste**

Energy security

- An **energy gap** is when a country cannot meet the demand for energy using its resources
- When countries have an energy gap, they have to import energy to meet the demand
- Having an energy gap means that a country is not **energy-secure**
- Fossil fuels still supply over 80% of the world's energy and account for 75% of global greenhouse gas emissions
- According to the International Energy Agency, 775 million people do not have access to electricity
  - The majority of these people live in Sub-Saharan Africa

The WFE nexus


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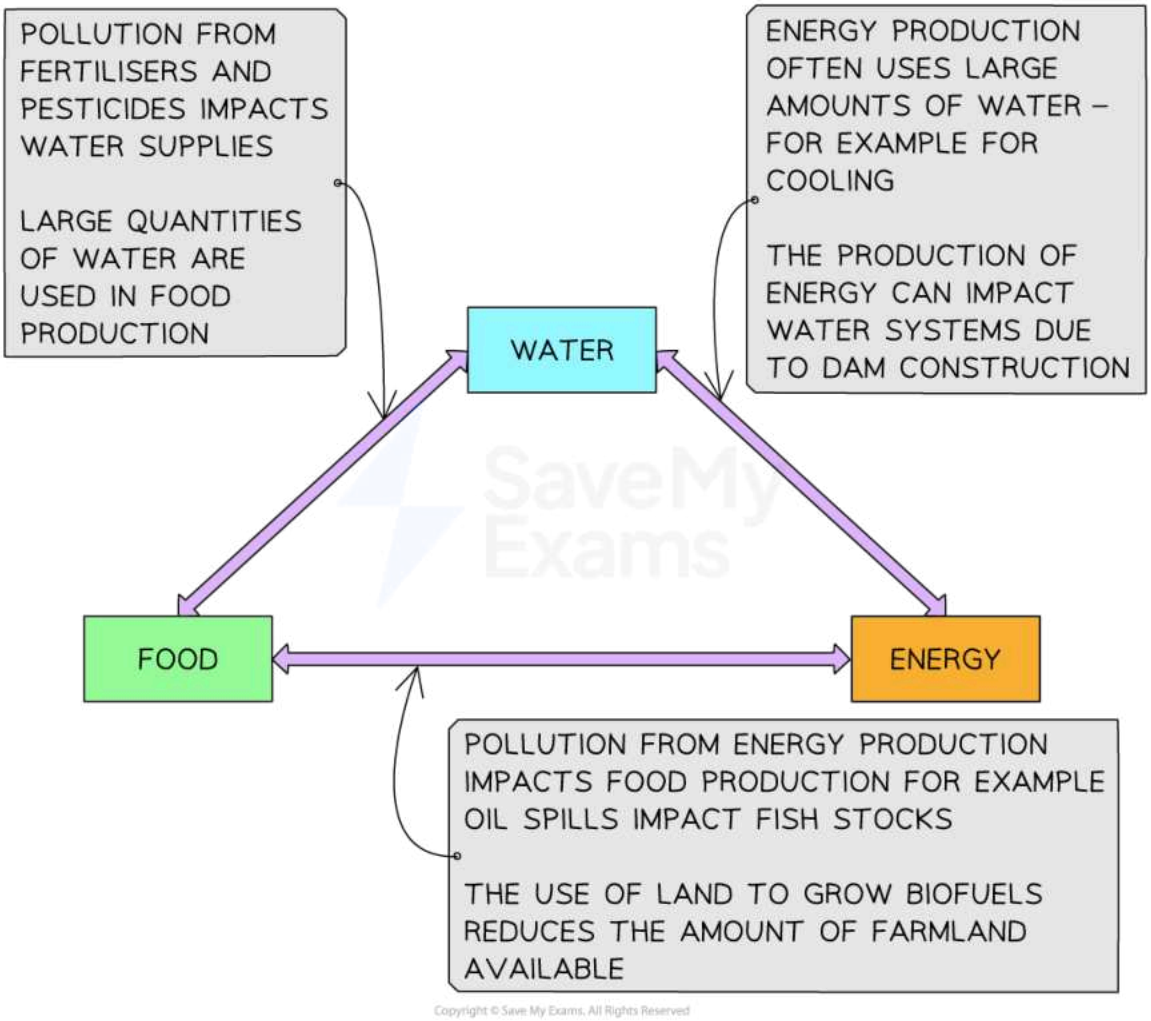

Examples of the interactions in the WFE nexus

- The interactions between food, energy and water may contribute to food, energy and water insecurity because they reduce the amount of the resource which is available
- This may be due to:
  - Increased use of the resource
  - Pollution of the resource

Global examples of interactions in the WFE nexus

- A lack of available water to cool power plants in India led to the loss of 8.2 terawatt hours (TWh) of energy because the power plants could not function

- In Europe the land used to grow biofuels could be used to produce for an estimated 120 million people


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Interactions of Food, Energy and Water Resources

Resource	Food	Energy	Water
Food production and its impact on energy and water security		Energy is used to grow, transport and process food; this accounts for 30% of global energy use *(FAO, 2011)*. Most of this is used in food processing and transport Increased demand for food increases the use of energy. New technology, such as hydroponics, uses more energy for light and heat	Over 70% of freshwater withdrawals are for use in agriculture *(FAO, 2023)* Pollution from livestock, fertilisers and pesticides enters water sources, reducing freshwater availability Food processing uses large quantities of water
Energy and its impact on food and water security	Growth of biofuels and solar farms uses land which could be used for growing crops Mining and drilling for fossil fuels creates waste, which can pollute farmland		Use of water for energy production and cooling Fracking uses large quantities of water combined with chemicals The construction of dams for HEP reduces discharge downstream but can improve water security in some areas
Water and its impact on food and energy security	Increased urbanisation increases the demand for water, reducing the amount available for food growth	High energy consumption from desalination Energy is used for treating waste water and abstraction of groundwater Water shortages will impact energy generation due to a lack of water for cooling	

Value of the nexus concept

- Resources and resource security do not exist in isolation, they are all linked
  - The nexus concept acknowledges these connections and interactions
- It views energy, food and water security as of equal importance
- The WFE nexus provides a framework, enabling integrated solutions to be developed

Challenges for the nexus concept

- Resource management crosses international boundaries, making stakeholder cooperation essential to the success of resource management
- The participation of stakeholders is not equal, governments and TNCs have more power than local communities
- The balance between food, energy and water security is not always achieved when the main focus of projects is on one particular issue


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Case Study: Resource Security in Bangladesh

WFE resource insecurity in Bangladesh

- Bangladesh already faces the impact of climate change
  - Rising sea levels
  - Changing **monsoon** rainfall patterns
  - Coastal flooding
  - Increased frequency and severity of **tropical cyclones**
- The population of Bangladesh is almost 170 million people
  - Although the rate of natural increase has fallen it is still 12 per 1 000
  - **Population density** is 1 329 people per Km^2
- This increases the pressure on water, food and energy

Water insecurity in Bangladesh

- Bangladesh has 238 major rivers and should have a plentiful water supply
- However, **water security** is poor
  - An estimated 40% of the population lacks access to safe water
  - Almost 70% have no access to **improved sanitation**
  - Over 40% of northwestern Bangladesh experiences **groundwater scarcity,** particularly in summer
- River and groundwater pollution levels are high
  - It is estimated that 50% of the population drinks water which is polluted with arsenic
- **Over-abstraction** of groundwater in the area surrounding Dhaka has led to:
  - Increased risk of [popover id="Uqny5Im4N4F4azVj" label="salt intrusion"]
  - A decrease in groundwater levels by 2–3 m a year
- Agriculture accounts for 80% of water withdrawal
- **Water demand** exceeds **water supply,** a situation which is likely to worsen as the population increases and development continues

- The reduction in the size of the **ice stores** in the Himalayas will decrease the supply further


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Food insecurity in Bangladesh

- An estimated 25% of the population suffers from **food insecurity**
- Over 11 million people suffer acute hunger
- Approximately 36% of children under five suffer from stunting, which indicates chronic **malnutrition**
- Increased coastal flooding has led to **salinisation** which affects crop yields
  - Over the past 35 years, soil salinity has increased by approximately 26%
- Increasing areas of land are lost to:
  - Erosion on the banks of rivers or at the coast
  - Building of settlements and industries
    - Each year, an estimated 69 000 hectares of farmland is lost (a rate of 1% per year)
- An increase in the frequency and severity of tropical cyclones will impact crops and livestock
  - Cyclone Sidr damaged over 1.5 million hectares and killed almost 500 000 livestock

Energy insecurity in Bangladesh

- The availability of electricity to the population of Bangladesh has increased from 20% (2000) to 85% (2023)
- Bangladesh relies heavily on imports of energy resources to generate electricity
- The energy mix for Bangladesh is
  - Gas - 54%
  - Oil - 22%
  - Coal - 7%
  - Biofuels and waste - 16%
  - Renewables -1.2%
- Bangladesh aims to reach 15% renewable energy by 2030
- Increasing use of solar power is contributing to the use of renewables
  - To avoid the use of agricultural land, the focus has shifted to rooftop systems

Case Study: Resource Security in Denmark

WFE resource security in Denmark


Your notes

- Denmark is not as vulnerable to climate change as Bangladesh but there are still challenges which may impact its **WFE security**
  - Rising sea levels
  - Increased precipitation
- Denmark has a population of almost 6 million people
  - The rate of **natural increase** is 1 per 1 000
  - **Population density** is 139 people per Km^2

Water security in Denmark

- Denmark has a **water surplus**
  - The available water resource is an estimated 1,800 million m^3 per year
  - Water demand is 1,000 million m^3 per year
- The whole population (100%) have access to safe drinking water
- Almost 90% are connected to the main sewage network
- Most of the water supply is obtained from **groundwater sources**
- Use of water is split equally between agriculture, domestic and industrial use (approximately 33% each)

Threats to water security

- **Salt intrusion** may begin to affect the quality of groundwater due to rising sea levels and coastal flooding
- **salinisation** due to increased demand on the groundwater

Food security in Denmark

- Food security is high in Denmark, with only 1.8% of the population experiencing severe food insecurity
- Denmark only imports just over 13% of the population's food

Threats to food security

- Rising temperatures have led to a **longer growing season** in Denmark
- However, they have also increased the need for:

- Greater pest and disease protection
- More **fertiliser** use, which leads to increased water pollution
- **Increased Irrigation**, which places more pressure on the water supply

- Increased precipitation in winter and rising sea levels are increasing the risk of flooding and crop loss
- Water temperature increase has impacted the populations of traditional species such as salmon and trout
  - New species are increasingly found in the waters around Denmark, such as hake
  - There has also been an increase in toxic **algae**, which threatens fish populations


Your notes

Energy security in Denmark

- Denmark imports about 12% of its energy
- It has a high energy security
- The energy mix for Denmark is
  - Oil - 38%
  - Biofuels - 33.6%
  - Other renewables - 12.4%
  - Gas - 9.4%
  - Coal - 7.0%
- Denmark has closed all its oil-fired power stations and is in the process of closing its coal-fired power stations
  - This has significantly reduced its reliance on fossil fuels
- The entire population (100%) has access to electricity

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Climate Change & the Water, Energy & Food Nexus

What impact will climate change have on water supplies?

- There are a number of ways that water supplies are affected by climate change, these include:
  - Unpredictable rainfall
  - Floods
  - Droughts
  - Rising sea levels
  - Melting ice sheets/glaciers
- Climate change is impacting on the amount of available **freshwater**
- The UN predicts that by 2050, up to **5 billion people** worldwide will face freshwater shortages
- The melting of glaciers and ice sheets has led to an estimated **3% reduction** in freshwater storage since 1971
- **Salinisation** of groundwater is increasing annually at a rate of 10% due to **salt intrusion** caused by sea level rise
  - This decreases the amount of freshwater available in coastal areas
- Higher water temperatures, droughts and floods decrease water quality
- More frequent droughts may lead to increased **soil degradation** and **desertification** in areas such as the **Sahel**
  - This will impact on food production due to a lack of water for irrigation
  - Fewer trees and vegetation will mean less biomass for energy production, particularly in areas where people rely on fuelwood for heat and cooking
- High-income countries such as the USA and Australia also face water shortages but this is less likely to impact food and energy security because they can afford to import

What impact will climate change have on food supply?

Crops and livestock

- Increased temperatures and changes in rainfall patterns affect crop yields

- Decreasing freshwater supplies have an impact on:
  - The availability of irrigation
  - Water for livestock
- Increased floods, which destroy crops
- Crop yields are impacted through:
  - Declining water quality
  - Soil degradation and desertification
- Climate change is also affecting the areas affected by **pests and diseases**, expanding their geographic range
  - Tar spot is a fungal disease affecting maize
    - It was native to Latin America
    - It can lead to a 50% reduction in yields
    - In 2015, it was detected for the first time in the US
- The spread of **invasive, non-native species** due to higher temperatures can impact food systems


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Fish stocks

- Increased sea and river temperatures may affect:
  - Fish breeding patterns
  - Fish populations
  - Increased algae growth, which contaminates seafood
- Decreases in water quality impacts fish and seafood

What impact will climate change have on energy supply?

- **Changing weather patterns** may impact renewable energy supplies
  - Reduced cloud cover may lead to increased solar power
  - Changing wind patterns may impact the use of wind energy
- **Reduced precipitation** may lead to challenges in growing biofuels
  - Increased water scarcity will reduce the amount of water available for irrigation
- As the amount of water stored in glaciers reduces, the spring snowmelt will result in lower discharge

- This will affect the amount of energy generated by hydropower
- Tajikistan is reliant on hydropower and is already experiencing changes in river flow

- **Sea ice melt** in the Arctic may improve access to gas and oil reserves
  - Increasing the availability of fossil fuels
  - Reducing the cost of extraction


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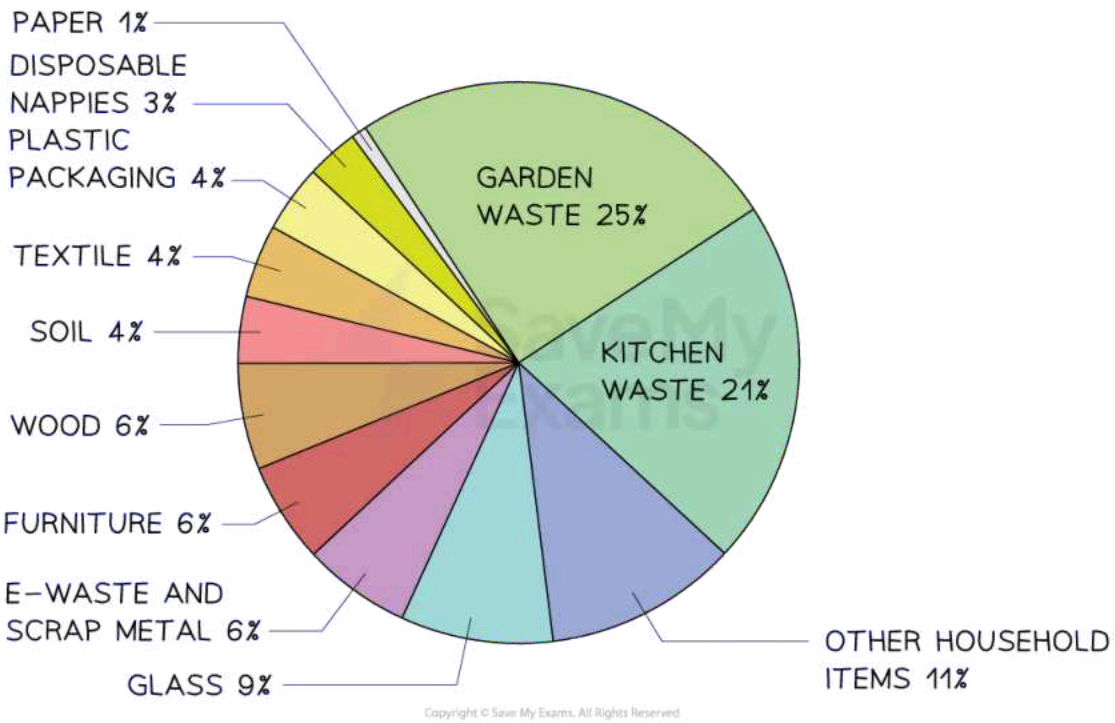
Disposal & Recycling of Consumer Waste

Your notes

Solid Domestic Waste

- As well as the consumption of resources, ecological footprints include the waste created
- The increases in consumption have led to an increase in the waste created
- The **World Bank** estimates that there will be a **70% increase** in the production of waste by 2050
  - Most of this increase is predicted to be in low-income and emerging economies

Types of Solid Domestic Waste



Estimate of the proportions of solid domestic waste in the UK in 2020

- Solid domestic waste (SDW), also known as household waste, refers to the waste generated by **households** and small-scale commercial establishments
  - It consists of various materials discarded by **individuals** and **families**
- The **volume** and **composition** of solid domestic waste can **vary over time** due to several factors, including:

- Consumption patterns
- Technological advancements
- Waste management practices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Organic Waste

- This includes food waste, garden waste, and other **biodegradable** materials
- The volume of organic waste tends to be **significant**
  - It varies due to cultural practices, dietary habits, and seasonal factors
- Over time, the composition of organic waste may change due to:
  - Shifts in food preferences
  - Increased consumption of processed foods
  - Advancements in waste management technologies that promote **composting**

Paper and Cardboard

- These materials are commonly found in solid domestic waste and are derived from packaging, newspapers, magazines, and other paper-based products
- The volume of paper and cardboard waste may fluctuate depending on factors such as:
  - **Digitalisation trends**: the increasing trend for people to read the news on phones and tablets rather than by reading a physical newspaper
  - Efforts to **promote recycling** and reduce paper consumption

Plastics

- Plastics are a major component of solid domestic waste and can include packaging materials, containers, and various single-use items
- The volume and composition of plastic waste have experienced a **significant increase** in **recent decades** due to the widespread use of plastics in various sectors
- The composition and management of plastic waste vary due to:
  - **Changes** in consumer **behaviour**
  - Government **regulations**
  - **Recycling initiatives**

Glass and Metals

- Glass and metal waste, such as bottles, cans, and other packaging materials, contribute to solid domestic waste
- The volume of glass and metal waste can be influenced by factors like **beverage consumption** patterns, **recycling rates**, and the availability of alternative packaging materials
- Changes in packaging preferences, recycling infrastructure, and resource conservation efforts can impact the composition and volume of glass and metal waste

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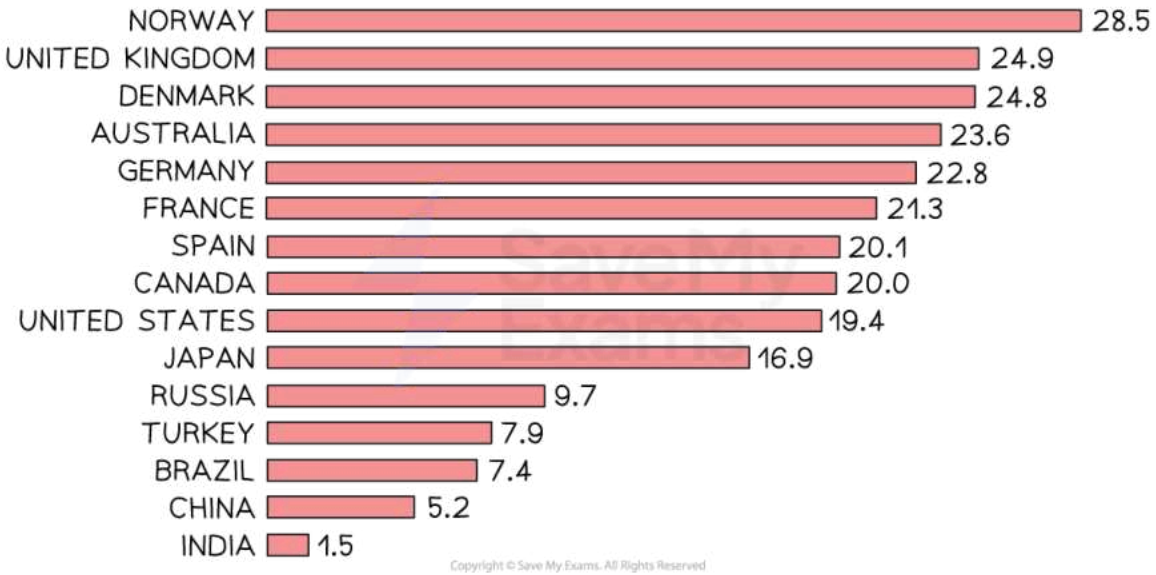
Electronic Waste

- With the **rapid advancement of technology**, electronic waste, or **e-waste**, has become a growing issue
- It includes discarded electronic devices such as computers, mobile phones, televisions, and appliances
- The volume and composition of e-waste may change over time due to the introduction of new devices, upgrades, and the speed at which older electronics become **obsolete** (i.e. out-of-date)
- Increasing awareness of e-waste management and the implementation of **regulations** influence the handling and disposal practices of electronic waste



Kilograms of electronic waste (e-waste) produced per capita for a selection of countries in 2016

Waste Disposal & International Flows of Waste

Waste disposal

- Waste disposal is critical in managing and minimising the environmental impact of waste
- Various methods are available, each offers distinct approaches to handling waste materials
- In the past, **landfill** were the most popular form of waste disposal but this is not sustainable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Landfills

- Landfill involves **burying waste** in designated areas, often lined with protective plastic barriers
- They provide a centralised and controlled disposal method for a wide range of waste types

Advantages and Disadvantages of Landfills

Advantages	Disadvantages
Provides centralised waste management	Generates methane, a potent greenhouse gas
Can accommodate a wide range of waste types	Requires suitable land availability and careful site selection
Relatively low operational costs compared to other options	Potential risk of groundwater and soil contamination
Can be engineered with liners and **leachate** collection systems to minimise environmental impact	Long-term management and monitoring required after closure

Incineration

- Incineration involves the **controlled burning** of waste materials at high temperatures
- It reduces the volume of waste and can sometimes be used to generate energy through the combustion process

Advantages and Disadvantages of Incineration

Advantages	Disadvantages
Reduces the volume of waste and minimises space requirements	Releases air pollutants, including greenhouse gases and toxic emissions (public concerns over health and environmental impacts)

Potential to generate energy through the combustion process (provides waste-to-energy potential)	Requires careful management of air emissions and ash disposal
Reduces the reliance on landfills	Potential for the release of hazardous substances during incineration
Can handle various types of waste, including hazardous waste	High operating costs


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Recycling

- Recycling focuses on **converting waste** materials into **reusable** materials
- It conserves natural resources, reduces energy consumption, and minimises greenhouse gas emissions associated with the production of new materials

Advantages and Disadvantages of Recycling

Advantages	Disadvantages
Conserves natural resources and reduces the need for raw materials	Requires energy and resources for collection, sorting, and processing
Reduces the amount of waste sent to landfills or incinerators	Limited availability and accessibility of recycling facilities
Saves energy and reduces greenhouse gas emissions	Contamination of recyclables can hinder the recycling process
Prevents pollution caused by extracting and processing raw materials	Some materials are difficult or costly to recycle
Creates job opportunities in the recycling industry	Market demand and prices for recycled materials can fluctuate

Reusing

- Reusing involves using products or materials **multiple times** instead of discarding or recycling them
- It extends the lifespan of products, reduces waste generation, and decreases resource consumption

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Advantages and Disadvantages of Reusing

Advantages	Disadvantages
Reduces the need for new products and resource extraction	Limited availability of reusable items in certain areas
Saves energy and resources required for manufacturing	Requires proper cleaning and maintenance of reusable items
Minimises waste generation and landfill usage	May not be suitable for all types of products or materials
Can be cost-effective, saving money for individuals or businesses	There is a limited market for used or second-hand items in some cases
Promotes a **circular economy** and sustainable consumption	Requires a change in consumer behaviour and mindset

Composting

- Composting involves the **decomposition** of **organic waste** materials into nutrient-rich soil
- Successful composting relies on the proper balance of organic materials, moisture, and aeration to facilitate the decomposition process
- It diverts organic waste from landfills, reduces methane emissions, and produces high-quality compost for use in agriculture and landscaping

Advantages and Disadvantages of Composting

Advantages	Disadvantages
Diverts organic waste from landfills, reducing methane emissions	Requires space and proper management for composting process
Produces nutrient-rich compost for soil enrichment	It takes time for organic waste to decompose and turn into compost
Reduces the need for chemical fertilisers	Some materials may not be suitable for composting (e.g., meat, dairy)

It helps retain soil moisture and reduce erosion	Potential for odour and pest issues if not properly managed
Promotes healthier plant growth and biodiversity	Requires knowledge and education to ensure proper composting practices


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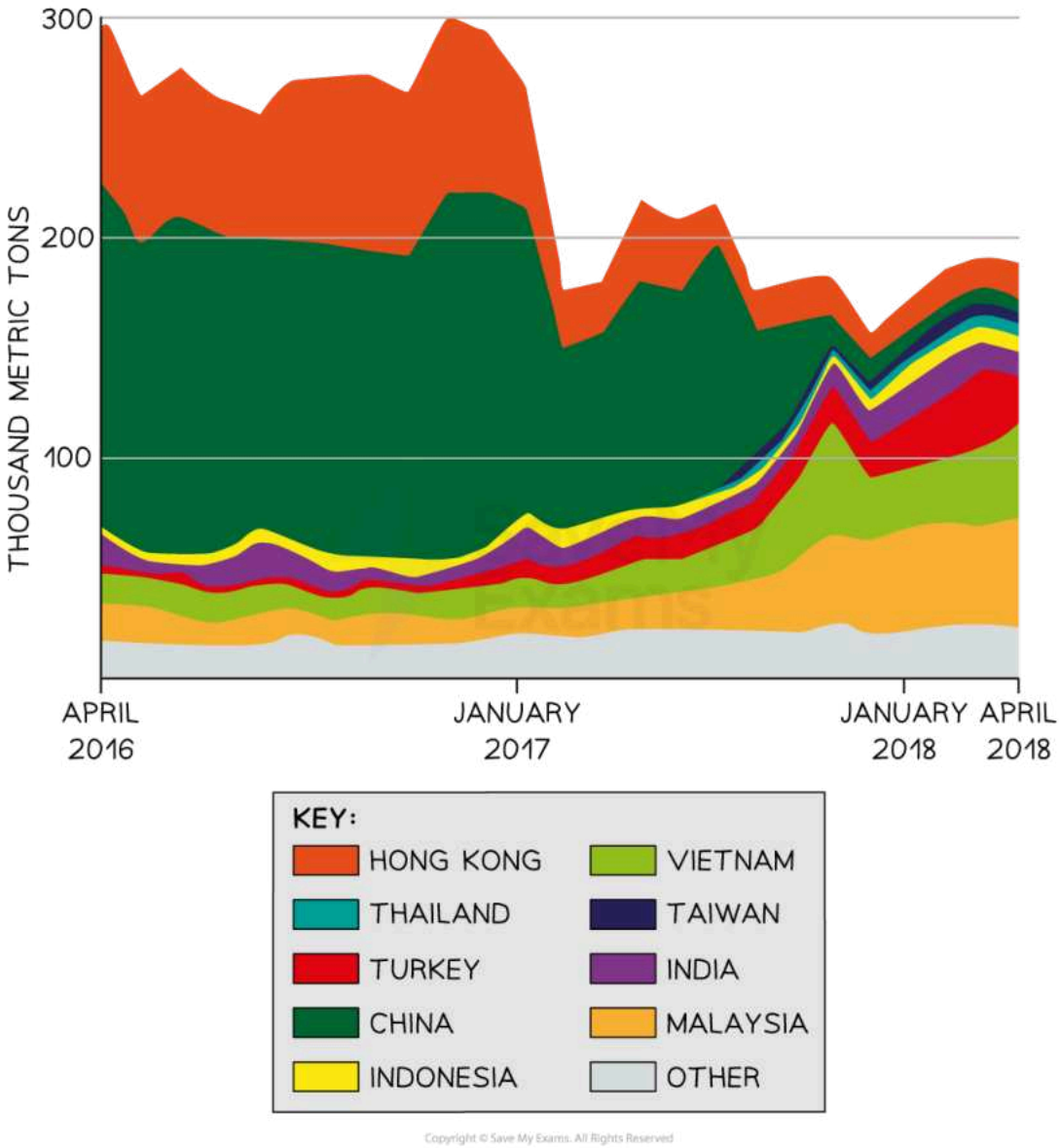
- These waste disposal options offer a **range of strategies** for managing waste materials effectively
- The choice of method depends on various factors, including the type of waste, available infrastructure, environmental considerations, and societal preferences
- Implementing a **combination** of these options can contribute to sustainable waste management and **resource conservation**

International waste flow

- In an attempt to reduce the use of landfills in developed countries, large amounts of waste are transported to emerging economies and low-income countries for disposal and recycling
  - The EU directive states that less than 10% of waste should be sent to landfill by 2035
  - The UK has a target of reducing biodegradable waste going to landfill to almost zero by 2028 and recyclable waste by 2042
- Until 2017, China had been disposing of:
  - Over 55% of the world's plastic waste
  - Almost 60% of the USA's paper waste and 70% of Europe's paper waste
- China announced in 2017 that it would be significantly reducing the amount of waste it accepted
- Waste flows then increased to Southeast Asia, in countries like Malaysia, Thailand, Vietnam, Indonesia and India
- Up to 90% of the waste in these countries is burned rather than recycled
  - This impacts on people's health and the environment
- In 2019, Malaysia, Indonesia and Thailand all announced restrictions on the amount of imported waste they would accept
- Between 2019 and 2021, Malaysia sent back over 340 containers of waste that had been shipped there by countries including the USA, UK and France

Your notes



The destination of Europe's plastic waste between 2016–2018

- Increasingly, waste is sent to countries such as Ghana and Nigeria for disposal
- Türkiye is now receiving the most waste from the EU
  - In 2021, the amount of waste received was 14.7 million tonnes, three times the amount they received in 2004

- India (2.4 million tonnes) and Egypt (1.9 million tonnes) are the second and third-highest recipients of EU waste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