

Human impact on the environment

- Syllabus :** Human Population - the exponential growth of the human population and its control.
 - the impact of human population explosion on the environment.
- Resource exploitation - the variety of resources exploited by humans : renewable (e.g. timber and fish) and non-renewable resource (e.g. fossil fuel).
 - that human exploitation of natural resources has modified the environment.
 - the risk of renewable resources (e.g. timber) becoming a limiting resource.
- The effects of agriculture - deforestation as a means to clear land for agriculture and animal grazing.
 - soil erosion as a consequences of inappropriate agricultural practices.
 - the undesirable effects of chemical control of pests and weeds, and the excessive use of chemical fertilisers.
- The effects of urbanisation and industrialisation :
- Land clearance and reclamation = the impact of land clearance and reclamation (for residential and urban infrastructure development) on the environment.
 - Pollution = some major atmospheric pollutants (e.g. sulphur dioxide and particulates) and their effects.
 - = global issues : ozone depletion, global warming and acid rain.
 - = how inadequate treatment of sewage may lead to the deterioration of water quality and microbial hazards.
 - = eutrophication and algal bloom.
 - = some water pollutants (e.g. oil and detergent).
 - = the use of organisms as pollution indicators.

Human Population

Human population density and the rate of growth for an area depending on the number of individuals entering the population (birth and immigration) and the number leaving (death and emigration).

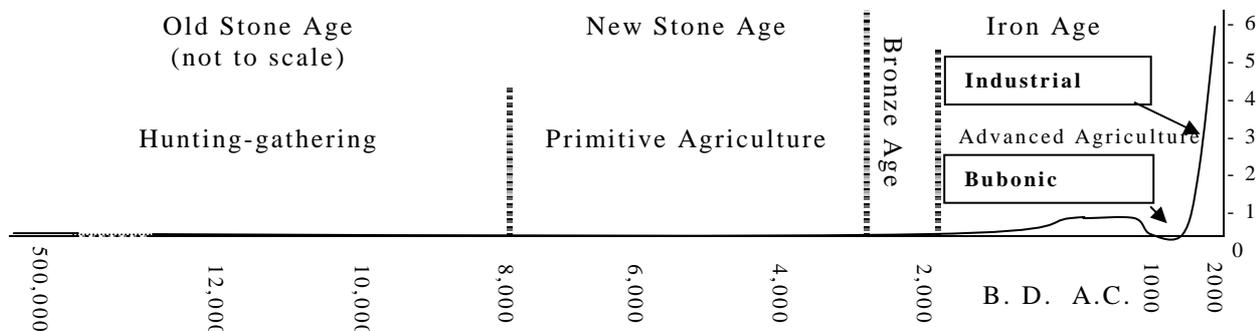
$$\text{natural growth rate} = \frac{\text{number of births} - \text{number of death}}{\text{mid-year population}} \times 100\%$$

$$\text{growth rate} = \frac{\text{number of birth} - \text{number of death} + \text{balance of migration}}{\text{mid-year population}} \times 100\%$$

migration = immigration - emigration

Doubling time = the time for the population to double in size, the shorter the doubling time, the higher the rate of population growth

A. Development of human population :-



I. The early man (before 8000 B.C.)

- they lived in small, wandering groups with a simple hunting and food gathering way of life
- the population density of the hunting and gathering tribes is approximately 5 sq. km per man, and this is the maximum carrying capacity of the environment for this way of life
- they were confined to tropical regions, i.e. Africa
- this population was characterized with high natality and also high mortality, because
 - a. Shortage of food : wild animals and plants might be scared at times, so many people would be starved to death
 - b. Disease : the absence of sanitation, people hygiene and medical care were the major reasons of the people deaths
 - c. Predation by other animals : e.g. tiger and lion during hunting
 - d. Poor quality of life : the constant exposure to sun, wind, cold, hunger and other physical stress would lower the life span
 - e. Warfare : territorial dispute of the competition for food often lead to warfare
- but the mortality was slightly lower than the birth rate because most couples had many children

II. Since 1650 (scientific-industrial age) to present

- it is the age of industrialization
- population explosion was brought about by the advances in agriculture and transportation, which lowered the prospects of crop failure and improved distribution system, reduced incidence of local famine
- medical advances conquered a number of fatal disease, reduced infant mortality, and increased longevity
- the abrupt increase of the population is due to a sharp decline of death rate, especially the children, this decline of death rate can be explained by the following reasons
 - a. Adequate supply of food : improved farming techniques, better storage and distribution facilities can support the livelihood of more people
 - b. Green revolution : the improved technologies also reduce the chance of crop failure and famine
 - c. Well medical care : improved sanitation and control of infectious diseases lower the mortality sharply, especially in the children
 - d. Good quality of life : struggle under the wildness of the environment is no longer necessary after urbanization, the life expectancy of the people is longer

B. Factors affecting the rate of human population growth :-

1. food supply
2. available of natural resources
3. disease
4. medical care
5. warfare
6. natural disasters i.e. earthquake, drought and flood
7. quality of life i.e. living condition
8. job opportunities and economic development
9. birth control
10. migration

C. Malthusian theory :-

Robert T. Malthus (1798) noted that population, when unchecked, grew at a geometric rate (GP) of increase, while the resources, food and fuels, for the human

D. The impact of human population explosion on the environment :-

In the last two centuries especially, widespread industrialization has led to potentially damaging environmental pollution and global deforestation i.e. upset the balance of the ecosystem.

Resources exploitation :

Natural resources can broadly be divided into two groups : renewable and non-renewable.

A. Renewable resources :

- They are living resources which have the reproductive property so that they can replace for the loss and increase in amount.
- For examples food and raw materials such as timber, cotton and leather derived from plants and animals are renewable resources.
- If their harvests is well controlled within the compensatory power of their natural cycle of renewal, there will be a continuous yield of those resources

B. Non-renewable resources :

- They are non-living materials, e.g. minerals such as iron, copper and aluminium, and fossil fuels such as petroleum, coal and natural gas.
- Once they have been used, they cannot be regenerated.
- Their supply is limited, sooner or later they will run out.

Over-exploitation of natural resources, particularly the non-renewable ones, will quicken the exhaustion of these resources. This problem is aggravated by two factors :

- (1) The rapid growth of human population uses the available resources at a faster rate.
- (2) The high living standard makes people of the developed countries consume much more resources than that should be used.

The environmental effect by exploitation of natural resources :

- (1) Timber : soil erosion, flooding and extinction of wildlife
- (2) Fossil fuel : air pollution, energy crisis

To prevent the loss of renewable resources :

- (1) Timber : the cleared area must be planted with seedlings so that in future a new forest can grow up again and thus such resource can be maintained
 - : planned trees cutting (e.g. cutting trees in pieces of small areas in sequence)
 - : prevent forest fires by planting fire-resistant trees like Acacia, pines etc., education, laws to prohibit barbecue at conserved areas and by setting up fire lines (gaps), etc.
- (2) Fish : restrict the amount of fishing would give time for young fish to grow up to adult stage to replace those caught.

Exercise : (94 I 6a)

Explain what you understand by non-renewable resources

[2 marks]

The effects of agriculture :

I. Soil properties in relation to crop growth :

Soil is a fundamental requirement for virtually all agricultural system. Soil provides support for the plants, acts as a reservoir for water and minerals, and contains numerous organisms which may be beneficial or harmful to crops.

- (1) Fertility : the soil fertility is often determined by the amount of humus present, for humus improves soil texture, yield plant food and assists in retaining moisture
 - : crops require varying amount of the different mineral nutrients in the soil
 - : it is necessary to replace the worn-out soil nutrients from time to time if a high level of productivity is to be maintained, add fertilizers, crop rotation and fallowing are some of the methods used by farmers to keep their soil fertile
- (2) Texture : the physical of soil, depending on the size of the soil particles, may be coarse, medium or fine, the soil texture governs such vital aspects of agriculture as ease of plough, root penetration, aeration
- (3) Aeration : mainly determined by the soil texture (sand, silt and clay ratio), the large sand particles fit together loosely so that large air spaces are present between them, thus sandy soil has good aeration
 - : the small clay particles pack together closely so that small air spaces are present, these small air spaces are easily flooded with water (waterlogged) that drives air out, thus clay soil has poor aeration
- (4) Water retentivity : the amount of soil water retained is affected by size of soil particles, rainfall and location of soil
 - : small soil particles have relatively large surface area to bind with water thus the retentivity is higher
- (5) Temperature : soil temperature affects the plant growth, microbial activities and thus the soil fertility
 - : it is determined by the physical location of the soil (tropical or temperate area), microbial activities which liberate heat energy and amount of humus in the soil (humus absorb more solar radiation due to the dark coloration)
- (6) Drainage : drainage is the ability of soil to allow water flowing through it, large soil particles have bigger air spaces (higher porosity) between them that allow more water to flow through them (higher drainage)
- (7) Capillarity : capillarity of soil is the rise of water from the damper regions (underground water table) to the dry regions (top soil)
 - : it is due to the force of attraction between the water molecules and the surface of the soil particles (i.e. surface tension), the smaller the soil particles the bigger is the total surface area available for producing a stronger attraction in drawing water to greater height

Exercise : (95 II 3a)

How do the physical properties of soil affect plant growth ?

[7 marks]

II. Man's technology in relation to the balance of ecosystem :

Since man is part of the ecosystem, his activities will either directly or indirectly affect the balance of the ecosystem.

A. Selection of species :-

- plant and animal breeding are able to alter genotypes to produce varieties of plants and animals suited to specific conditions and incorporating various desirable characteristics

B. Pests and weeds control :-

- to eliminate non-human consumers by

i/ physical methods : elimination of pests from the crops directly by

- hands
 - installation of an ultra-sonic expeller
 - setting up of insect attractant lamp
- : keeping away of the pest from the crops by
- net house or green house, or covering with a plastic cover
 - sterilization (burning) of the soil before cultivation
 - setting up of man-or-straw or other expeller

advantages : cause no environmental pollution,

: not induce the mutant strains of pests

: low cost

disadvantages : labour consuming

: low efficiency

ii/ chemical methods : pesticides which are based on synthetic hydrocarbons and organophosphorus are often used to eliminate a broad spectrum of pests, they are long lasting, but have side effects

: hormonal stimulants such as juvenile hormone that prevent insects from moulting and completing their life cycle

: the release of chemical or radiation sterilized males which can slow down the breeding cycle of the wild pests

advantages : high efficiency to eliminate broad spectrum pests in a short time, easy to apply the pesticide on the field

disadvantages : cause pollution, some non-biodegradable pesticides (DDT) may be accumulated through the food chain, and eventually harms man

: non-selective, may also eliminate the beneficial animals

: pesticides resistant strain of pest man be evolved

: more expensive

iii/ biological methods : introduce of natural enemies - predators

: introduce of parasites, such as calcid wasps

: introduce of pathogens, such as bacteria and virus

: cultivate low-value crops to attract pests away from high value crops

: crop rotation to block the life-cycle of pests

: artificial selection for pest resistance varieties

: incorporate a pest resistance feature to the crops by biotechnology

advantages : cause no environmental pollution

: selective and more specific

: high efficiency, low cost

disadvantages : it is hard to find the most suitable biological methods to eradicate the pest, only a specialised pest would be eradicated by one method, and unable to act on other pest at the same time

C. Use of fertilizers :-

- aims of use of fertilizers

- to increase soil fertility, as well as the crop yield
- to supply and replace specific nutrients to the crops
- to change the poor soil, to agrarian land and to increase land for agriculture
- to improve soil texture and reduce the risk of soil erosion

- two types of fertilizers

i/ natural fertilizer : they are manure or humus - organic

: manure is any substance from the excretion of living organisms which is added to soil to increase its fertility as well as the soil texture

advantages : improve the soil texture, as the natural fertilizers contain humus, they also aid in soil flocculation, this can help to improve the physical properties of soil, e.g. retentivity of sandy soil and the drainage of clay soil

: insoluble before broken down by the microbes, thus avoid leeching and reduce the risk of water pollution to the nearby water bodies

: improve soil fertility, the organic compounds of the manure are acted on by the living micro-organisms(bacteria and fungi) in soil to useful mineral salts for plant growth

: low cost and long lasting

disadvantages : slow in action and dirty

ii/ artificial fertilizer : they are mainly in the form of nitrogenous and phosphorus compound i.e. inorganic chemicals, e.g. ammonium nitrate, ammonium phosphate

: they increase the mineral content of the soil directly and precisely

advantages : they are soluble, so immediately be absorbed by plants

: clean

disadvantages : they have no humus, so not improve the physical properties of the soil

: easily leached after heavy rain, this may cause eutrophication to the waterbodies

: more expensive and short lasting

- excessive use of chemical fertilizers may lead to pollution

- the excess fertilizers may enter streams by surface run-off or via underground water
- this may lead to algal bloom, so disturb the biological balance of the water
- after death and decay of the algae, even greater contamination problems may be resulted

D. Soil erosion :-

- it is the removal of the top soil by the wearing action of rain and wind, soil erosion is enhanced by human activities in the following ways

i/ deforestation : the removal of trees from the steep slope exposes the top-soil which is no longer protected by the leafy canopy of the forest

- : this thin layer of top-soil is easily washed away by heavy rain or blown away by strong wind
- : the root system of the crops (when forest removed, crops may be planted) are usually more shallow to hold the soil particles tightly, so also result in soil erosion
- ii/ over-grazing : too large a population of animals rearing on a piece of grassland will quickly turn it into a barren land because of over-grazing
 - : the trampling of a large population of animals on soil rapidly compact the soil into a hard layer that can hardly absorb any rain, eventually the soil becomes dry and is easily blown away
 - : this is a major cause of desertification (沙漠化) in Mongolia (内蒙古) and many parts of China
- iii/ harvesting : after harvesting several crops, the soil fertility and humus content of the soil decreased, the soil may deplete of certain minerals
 - : the reduce in soil fertility also reduce the retentivity of soil so that the soil will dry up and will blown away easily
- iv/ monoculture : this requires the removal of all other vegetation and eliminates interspecific competition, it allows many plants of the same kind to be grown in a small area at the same time and at the same stage of growth, this simplifies cultivation and harvest
 - : this is an ecologically unstable situation with the possibility of raid spread of pests and diseases, and may deplete certain kinds of mineral

The effect of urbanization and industrialization

Land clearance and reclamation :

The effect of human activities on the environment is proportional to the size of the human population. As growth of population, they need land for agriculture and live, so deforestation and reclamation may be the only way to get more land to use.

The impact :-

- lost of natural habitat for the wild animals to live, this may cause extinction
- missing parts of the food web may upset the balance of ecosystem
- decrease the total photosynthetic rate may upset the balance of the gas composition of the atmosphere, this may worsen the green house effect
- changing the soil texture and the geographical environment, cause soil erosion, landslide and flooding

Pollution :

Pollution can best be defined as ‘the unfavourable alteration of the environment wholly or largely as a by-product of man’s activities, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundance of organisms. These changes may affect man directly (health hazards) or indirectly through his supplies of water, agricultural and other biological products, his physical objects and possessions, or his opportunities of recreation and the appreciation of nature.’

I. Pollutants :

- a pollutant is a substance or pattern of energy in the wrong amount, at the wrong place or at the wrong time
- this substance or pattern of energy is introduced into the environment by man and is harmful or potentially harmful to man

- however, not all are wastes, some can be reused again
- they can be divided into two groups
 - (1) Biodegradable pollutants : mainly organic substances
 - : can rapidly be decomposed by natural processes (putrefaction by bacteria) into harmless substances
 - : but when there are too many raw organic pollutants discharged, this natural purification process will be useless
 - (2) Non-biodegradable pollutants : mainly inorganic substances such as heavy metals (mercury, lead etc.), aluminium cans and glass bottles and organic substances such as plastic products and some insecticide(DDT) which cannot be decomposed naturally by microorganisms

II. Cause of pollution :

- i/ over population : when population increase, the wastes produced will also increased
- ii/ modern technology : factories need energy which is supplied mostly by combustion of fossil fuels that releases harmful substances into the air
 - : over use of plastic products, chemical synthetic materials also deteriorate the situation, since most of the plastic products are non-biodegradable
- iii/ higher living standard : increase in consumption of goods per head of population, the goods themselves often are discarded after use and become wastes
- iv/ poor city planning : the anti-pollution measures cannot catch up with the rapid urbanization and industrialization
- v/ lack of social conscience : many citizens or factories ignore the importance of public health and the cleanliness of environment, they dispose the wastes in improper ways

III. Types of pollution :

A. Air pollution :-

(1) Major air pollutants and their effects :-

i/ Particulate (dust and smoke) :-

- sources : the dust is usually deposited near to its source and results in filthy, dark and choking conditions
 - : smoke particles remain longer in the air due to smaller size
 - : mainly produced from combustion of fossil fuels and construction sites
 - : to reduce this type of pollution electrostatic precipitator were constructed in the main pollution sources e.g. electric power plants and incinerators
- effects : aggravation of chronic lung disease and asthma
 - : aggravation of cardiorespiratory disease symptoms in elderly patients
 - : increase cough, chest discomfort
 - : reduce incoming solar radiation and visibility
 - : increase the amount of rainfall (more condensation nuclei)

- : reduce the light intensity that in turn decrease the rate of photosynthesis
 - : block the stomata and thus reduce photosynthesis
- ii/ Sulphur dioxide :-
 - sources : this is the other major pollutant from combustion of fossil fuel e.g. power station, automobiles and incinerators
 - : however nearly 70% of the global production of sulphur dioxide comes from natural source (volcanic activities)
 - effects : aggravate the respiratory disease such as bronchitis
 - : they dissolves in rain water to produce sulphuric acid (acid rain), this increases the acidity of soil and lake, damage organisms and reducing crop yields, erodes the metal bridges and the lime stone buildings
 - : destroy the chlorophyll of plants
 - : lichens are sensitive to sulphur dioxide, concentration of 200 μgm^{-3} prevent all lichen growth and produce a 'lichen desert' such as the most urban area in H. K.
- iii/ Carbon monoxide :-
 - sources : it is produced from incomplete combustion of fossil fuel
 - : the main pollution source is automobiles
 - : when its level over 9 mgm^{-3} is harmful to the body, such concentration is often found in the poorly ventilated car parks and tunnels
 - effects : it is poisonous because it greatly reduce the oxygen-carrying capacity of blood by readily combining with haemoglobin
 - : the resulting shortage of oxygen causes dizziness, headache, fainting or even death
- iv/ Carbon dioxide :
 - sources : from combustion, volcanic activities and respiratory activities of living organisms
 - : predictions are that the carbon dioxide content of the atmosphere will change from 640 mgm^{-3} in 1970 to 800 mgm^{-3} in 2000.
 - effects : upset the carbon cycle in nature
 - : reduce the outgoing long wave radiation from the earth and retain the heat in the atmosphere, this warming is called the 'greenhouse effect'
 - : some scientists estimate that the carbon dioxide concentration will increase enough in the future to warm the earth significantly and the icebergs will melt and cause flooding to the coastal cities
- v/ Nitrogen oxides (nitrogen monoxide and dioxide)
 - source : combustion of fossil fuels
 - effects : dissolve in rainwater to form, acid rain
 - : irritates the eyes, nose and lungs and high concentration can prove fatal
 - : produce photochemical smog --- nitrogen oxides combine with hydrocarbons under UV (intense sunlight) to form peroxyacyl nitrate (PAN) and ozone which are serious pollutants cause irritation to respiratory tract

vi/ Lead :-

- sources : from coal combustion, pesticide spraying and
: from the use of leaded petrol --- in order to prevent engine knock, tetraethyl lead compound is added to petrol, almost 2/3 of the lead added is emitted in the exhaust fumes and dispersed throughout the environment
- effects : it is non-biodegradable
: will accumulate along food chains and reach toxic level for man
: the accumulation in body may impair the nervous system, especially in children

(2) Global issues :-

i/ Ozone depletion :-

- the atmosphere provides a thermal blanket and radiation shield to the Earth
- in the upper atmosphere (stratosphere), oxygen and ozone absorb much of the incoming short-wave radiation (ultra-violet, X-ray and gamma rays) which are harmful to living organisms by damaging their genetic material
- in the USA it has been estimated that a 5% reduction in stratospheric ozone would lead to a 7.5-15 % increase in ground-level UV radiation which might increase the incidence of skin cancer by tens or hundreds of thousands of cases a year
- radiation absorption by stratospheric ozone warms the stratosphere creating a deep temperature inversion layer, this limits convective motion in the atmosphere
- any change or weakening of this temperature inversion layer may alter global weather patterns and hence Earth surface climates
- high in the atmosphere oxygen molecules are dissociated by radiation into oxygen atom which combine with oxygen molecules to make ozone (O_3)
- the reaction is reversible by sunlight : $O_3 + O \leftrightarrow 2O_2$
- ozone exists at an equilibrium level in the 'ozone layer' at a concentration of 1ppm
- chlorofluorocarbons (CFCs) are group of chemicals including carbon tetrachloride and chloroform, these are commonly used as solvents, aerosol propellants and refrigerator coolants
- they are not readily broken down, they rise eventually into the stratosphere, CFCs are broken down by sunlight, releasing chlorine and fluorine, these react with ozone, one atom of chlorine or fluorine destroying 10^5 molecules of ozone, breaks it down into oxygen faster than it can be reformed from oxygen into ozone
- CFC pollution shifts the oxygen-ozone equilibrium
- at the present levels of CFC pollution a 10 % depletion of ozone may occur over the next 20 years, and it has been suggested that as much as 2/3 of the ozone could be destroyed in half a century
- in 1987 a seasonal but completion of the ozone layer occurred above Antarctica for the first time

ii/ Global warming (Greenhouse effect) :-

- the additional human-induced turnover of carbon in the form of carbon dioxide to the carbon cycle is estimated at 5×10^{12} kg yr⁻¹ released by human use fossil fuels

- some scientists think that deforestation is an equally important source of additional atmospheric carbon dioxide and that the total annual rate of human-induced release to the atmosphere may be nearer $10 \times 10^{12} \text{ kg yr}^{-1}$
- carbon dioxide is normally present in the lower atmosphere, the troposphere, in very small amounts, about 300ppm or 0.03% by volume
- carbon dioxide is transparent to incoming short-wave radiation from the sun, but absorbs strongly the long-wave radiation which the earth typically re-radiates into the space
- it therefore 'traps' outgoing radiation radiates energy back to the surface
- carbon dioxide levels (and those of other greenhouse gases, notably carbon monoxide, methane and CFCs) are rising very quickly and their increase will logically favour an increasingly warmer surface environment
- this may in turn lead to increased evaporation and a greater atmospheric water vapour content, since water vapour also act as a powerful long-wave absorber, this may further increase surface temperature
- the resulting rise in surface temperatures will cause changes in the distribution pattern and intensity of the major planetary weather systems which may profoundly affect human activities
- carbon dioxide is removed from the atmosphere by photosynthesis, by exchange with the ocean, and by deposition as carbonates
- the surface 75m of the ocean is a well mixed layer, heated by the sun and agitated by wind, exchange with the deep water in most areas a slow process due to the oceanic thermocline (lower temperature and higher density for the deep water), so although the oceans have the potential for absorbing the human induced excess atmospheric carbon dioxide, it is also possible that as the surface oceanic waters become saturated with carbon dioxide, the proportion of atmospheric carbon dioxide that the oceans can absorb may be reduced, making the carbon dioxide problem even worse
- atmospheric carbon dioxide will rise to 600ppm by the mid-twenty-first century, more than double the level for the late nineteenth century
- climatic consequences are also hard to predict due to the large number of possible feedback effects, most models predict an overall global warming by the mid-twenty-first century of $3 \pm 1.5 \text{ }^{\circ}\text{C}$
- possible environmental consequences range from extensive flooding of coastal lowlands, this may reduce food production

Exercise : (95 I 4c)

Distinguish between the causes of the greenhouse effect and the causes of ozone depletion. [2 marks]

iii/ Acid rain :-

- acid gases SO_2 and oxides of nitrogen are produced by burning fossil fuel
- incomplete combustion of fossil fuels also releases hydrocarbons that may have effects as dry gases or they may be washed out of the atmosphere to produce acid precipitation in rain and snow
- the most industrial areas of the world, such as the western Europe, north-east China have all experienced rainfall with a pH well below 4.0

(pH 5 is the conventionally accepted lower limit for natural rainfall acidity)

- acid rainfall (pH < 5) is often accompanied by major changes in ecosystems and damage to buildings
- the soil on which precipitation falls not neutralize the acid but the fauna of lakes and rivers suffers, young fish fry and spawn are particularly susceptible
- Mg and Ca are leached from soils and from humus to lower fertility
- disease induced by mineral deficiencies becomes common, eventually aluminium, manganese and heavy metals come into solution and may reach toxic concentration, causing damage to tree roots
- the dry deposition of acid pollutants even at levels where they are individually harmless, ozone, SO₂, nitrogen oxides, and other pollutants may together produce severe and damaging reductions of plant growth
- adding lime to lakes and forests can be viewed as temporary stop-gaps
- the remedy lies in reducing the release of pollutant gases
- attention has been focussed on reducing sulphur dioxide emissions since these have significant and clearly identifiable industrial sources, most notably coal-fired electricity generators
- the desulphurization technology is available and effective, though costly, , it may be equally important to reduce hydrocarbon and nitrogen oxides emissions

(3) Control of air pollution in H. K. :-

- in 1974 an Advisory committee on Environmental Pollution (EPCOM) was established whose duties are to keep a constant watch on the state of the environment with particular respect to pollution, and to advise the Secretary for the Environment on the position
- the Environment Branch of the Government Secretariat is the policy making body on pollution control whose task is to set up comprehensive environmental legislation and work out the best means to provide effective controls, and also regulations have been enacted under the Clean Air Ordinance to control smoke emission from factories
- the Environmental Protection Unit, staffed with Environmental Protection Officers is also operating to work on all aspects of environmental pollution and its control, including investigation, research, monitoring and formulation policy
- the Air Pollution Control Unit of the Labour Department which continuously monitors and inspects air at a number of sites also gives advice and technical assistance to industry and commerce so that fuels can be used more efficiently and smoke and pollutant emissions can be lessened

(4) Air Pollution Index (API) :

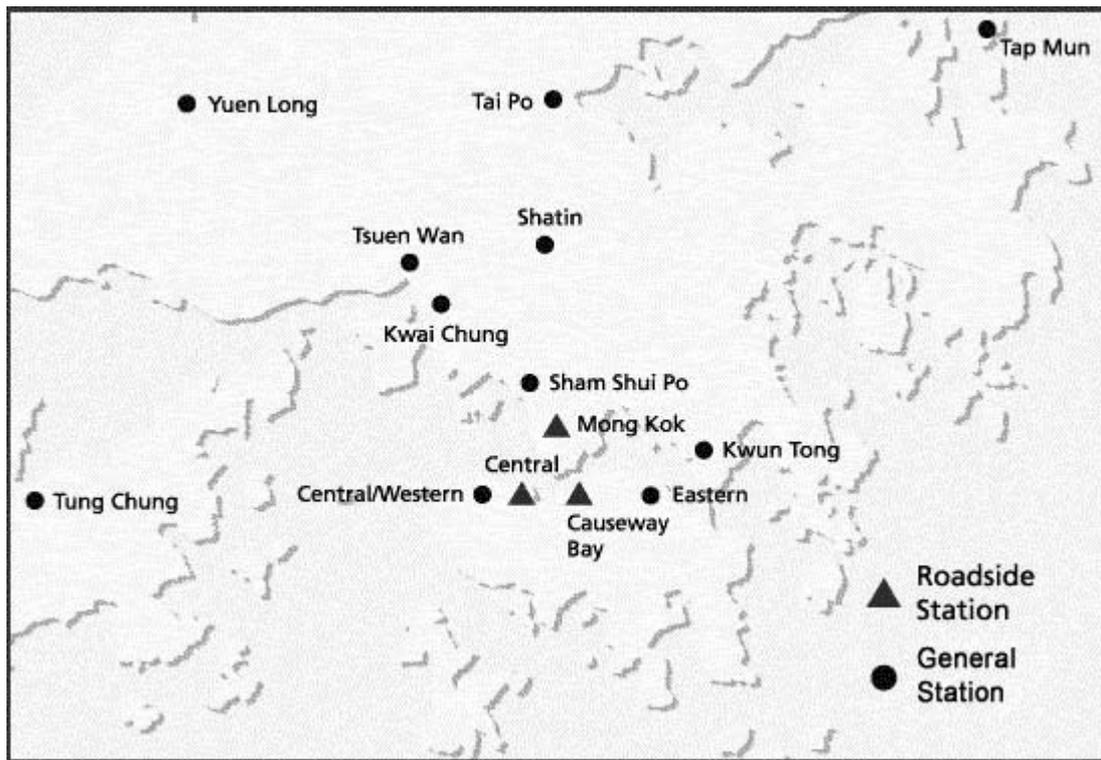
- Since June 1995, the Environmental Protection Department (EPD) has been reporting the API and making a forecast for the following day.
- API is a simple way of describing air pollution levels
- In Hong Kong the API converts air pollution data from several types of pollutants into a value ranging from 0 to 500. Similar systems are widely used in many other places such as the United States, Singapore, Malaysia, Taiwan and the Philippines.

- The potential health effects and suggested precautionary actions for different ranges of API values are as follows:

Air Pollution Level	API	Advice to Public	Health Implications
Severe	201 to 500	The general public are advised to reduce physical exertion and outdoor activities	People with existing heart or respiratory illnesses may experience significant aggravation of their symptoms and there may be also widespread symptoms in the healthy population. These include eye irritation, wheezing, coughing, phlegm and sore
Very High	101 to 200	Persons with existing heart or respiratory illnesses (such as coronary heart and cardiovascular diseases, asthma, chronic bronchitis and chronic obstructive airways diseases) are advised to reduce physical exertion and outdoor activities	People with existing heart or respiratory illnesses may notice mild aggravation of their health conditions. Generally healthy individuals may also notice some discomfort.
High	51 to 100	No immediate response action is suggested -- Long-term effects may, however, be observed if exposed at this level persistently for months or years	Very few people, if any, may notice immediate health effects. Long-term effects may, however, be observed if you are exposed to such levels for a long time.
Medium	26 to 50	No response action is required.	None expected for the general population.
Low	0 to 25	No response action is required.	None expected.

- These indices are calculated by comparing the measured concentrations of the major air pollutants with their respective health related Air Quality Objectives (AQOs) established under the Air Pollution Control Ordinance.
- These pollutants are nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and respirable suspended particulates. APIs for each of these five pollutants are calculated and the highest API number is reported as the API of that hour.

Fig. 1 The map below shows the locations of air quality monitoring stations.



- for more details, you may refer to the web site of Environmental Protection Department: http://www.epd-asg.gov.hk/api_you/eng/api_youf.html

B. Water pollution :-

It is the addition of undesirable matter into water that deteriorates the quality of water and makes it unsuitable for man's uses in respect to drinking, washing, irrigation, industry, recreation and support aquatic life.

(1) Organic pollutants :-

- source : domestic = human sewage, detergent and refuse
- agricultural = animal manure, pesticides and excessive fertilizers
- industrial = wastes from slaughter houses, tanneries, dairies, breweries, paper mill, textile factories and power station

- effects :

i/ oxygen depletion

- when organic waste added into stream, microorganisms break down the organic matter and oxygen is rapidly depleted and the dissolved oxygen (D.O.) of water decrease and finally become anaerobic
- the anaerobic microorganisms become active and begin to partially break down the organic matter to release toxic gases such as methane, ammonia and hydrogen sulphide
- the combination of low oxygen content, anaerobic deposits and poisonous gases make the water septic and dangerous and result in rapid death of most aquatic organisms

ii/ algal blooming

- in low concentration, organic material added to water can have a beneficial fertilizing effect

- through the process of self-purification, microorganisms break down the organic matter and release nutrients for the growth of phytoplanktons in water (eutrophication)
 - iii/ unpleasant smell
 - the bad smell come from the activities of anaerobic microorganisms when the water become anaerobic
 - they include the hydrogen sulphide, ammonia and methane
 - iv/ transmission of pathogens
 - parasites, pathogens and their eggs are easily be transmitted by the animal excreta, e.g. dysentery
 - measurement of the organic pollution :
 - i/ biochemical oxygen demand (BOD)
 - BOD defined as the amount of dissolved oxygen (in mgdm^{-3}) absorbed by the microorganisms to decompose the organic matter present in the water sample when stored in darkness for 5 days at 20°C
 - the higher BOD represents the higher level of organic pollution, typically water for drinking should have a BOD less than 1 mgdm^{-3}
 - ii/ dissolved oxygen (D.O.)
 - a direct on site reading of the amount of dissolved oxygen is obtained when a D.O. meter is available
 - higher the D.O. represents the lower level of organic pollution
- (2) Eutrophication and red tide
- eutrophication is a process whereby a water body becomes enriched with nutrients (inorganic and organic materials) at rates which cannot be assimilated
 - this causes an increase in the growth of phytoplankton and cause algal bloom or red tides which may toxic to marine organisms
 - makes the water not suitable for industrial, commercial, recreational and drinking purpose
 - cause :
 - i/ a lot of sewage and other organic substance are discharged in the water, after their decomposition by micro-organisms, the inorganic minerals in the water will increase greatly
 - ii/ eutrophication is more obvious at early summer (warm water), at the previous winter, most of the organic wastes are accumulated at the bottom of sea and not decomposed by the bacteria as the temperature is too low and hinder the activities of the microorganisms; at the early summer, warm water stimulates the activities of micro-organism, so the mineral content of the water will be sharply increased in the early summer; early summer is the growing season of crops and rainy season in H.K., excess fertilizer will be added and leached from the field into the water, warm water ($25 - 30^{\circ}\text{C}$) is suitable for the rapid growth of phytoplankton
 - iii/ heavy use of fertilizers on agricultural land and increased discharge of nitrate and phosphates into the water by leaching
 - iv/ additional nutrients favours an increase in the more rapidly growing competitive planktonic species (red tide species e.g. *Gyrodinium*) and an overall reduction in phytoplankton diversity,

- effect of red tide :
 - i/ dissolved oxygen
 - the greatly growing of red tide will deplete dissolved oxygen in water, especially at night
 - their dead bodies will also enhance the microbial activities, this makes the condition more worse
 - ii/ filter feeders
 - since some red algae are toxic species, then most filter feeders i.e. clams bivalves and oysters may be contaminated
 - iii/ fishes
 - since the marine culture at near coast is densely culture of fishes, then the decreasing of dissolved oxygen causes the death of the fishes and a great economic loss to the fishermen
 - iv/ man
 - some red algae is irritant to man' skin when he swims in the affected area, this will cause the loss of some recreational resources
 - eating the affected seafood will cause food poisoning to man
- methods to minimize the harmful effects of red tide :
 - i/ avoid the accumulation of organic substances or minerals in the sea by
 - not dumping untreated sewage and animal wastes in the sea water
 - digging out the accumulated wastes from the sea bottom
 - use organic fertilizer instead of chemical fertilizer to avoid leaching from the field
 - ii/ to avoid the depletion of oxygen in sea water by
 - aeration
 - culture the fishes not so densely
 - iii/ do not swim in the water where red tide occurs
 - iv/ do not eat the seafood which is contaminated by the red tide

Exercise : (94 I 6b)

Explain what you understand by eutrophication

[2 marks]

(3) Detergent as a pollutant :-

i/ foaming effect :

- this floating mass reduces the penetration of light to the submerged plants and impedes the movement of surface dwellers
- also affect the sewage plant to function properly
- in the mid-1960s the biodegradable and foamless detergents were introduced and the foaming effect is reduced

ii/ oxygen depletion :

- even the detergent as low as 0.1ppm, it reduces the rate of oxygen dissolving in water by 50%

iii/ eutrophication :

- the high phosphate content of detergents cause eutrophication and support excessive growth of algae (algal bloom)

(4) Oil as a pollutant :-

- oil is a very obvious pollutant of the sea
- it is caused by wreck of oil tankers, cleaning of the tanks and seeping from shipping and shipyards

- effects :

- i/ the spilled oil covered the seashores kill seaweed, molluscs and crustaceans
- ii/ the spilled oil also kill sea birds because
 - they cannot fly when their feathers become soaked with the oil
 - when they clean the feathers, they ingest the oil to poison themselves
 - the feather lost the insulation function so that they easily die of cold or pneumonia
- iii/ the oil contaminates beaches and thus spoils a valuable recreational resources
- iv/ cover the surface of the gill of fishes cause suffocation and death of fishes
- v/ cover the water surface that prevent oxygen to dissolve and the D.O. of the water decreased
- vi/ the early methods to clean the spilled oil were by spraying detergents to disperse the oil, but such practice caused greater ecological damage because the detergents are more toxic than the oil and the oil sunken to the sea bottom may kill the bottom dwellers

(5) Hot water as a pollutant :

- the major source is from power stations and desalination plant
- at the point where it is discharged into the sea, the high temperature of the water may kill most of the organisms there
- some distance away from that point, the water temperature decrease to a temperature, say about 37 °C, that is the optimum temperature for most of the organisms to grow, i.e. metabolism of the aquatic organisms are raised that may upset the balance of the normal ecosystem
- higher the water temperature, lower the ability of the water to hold oxygen, i.e. high temperature decrease the oxygen content of sea water

C. Land pollution :-

Addition of materials to the land which destroy and damage the flora and fauna, reduce the usefulness of the land for recreational, agricultural or other pursuits, or which pose health hazards to man can be considered as land pollution. In addition removal of materials from the land can also reduce the usefulness of the land to man and so these all can be considered as land pollution.

(1) Solid wastes :-

- include litter dropped by picnickers, domestic, industrial and agricultural wastes
- if the wastes are toxic then all life may cease to exist where they are dumped
- large areas of productive land or recreationally useful land may become totally useless as the result of the dumping of such products
- the heap of such wastes may destroy the view of that area
- in excess the soil micrflora and fauna are unable to cope with the large amounts of organic build-up and land spoilage and soil souring result

(2) Pesticides :-

- the excess pesticides may be toxic to other useful organisms, e.g. earthworms
- the pesticides may also accumulate in the food chain, finally poison human beings when we eat those 'infected' plant or animal

(3) Erosion of soil :-

- due to poor management practices in agriculture, mining, forestry, etc.
- soil erosion removes the surface soil and vegetation of the land, this reduce the area of land that is suitable for agricultural use

(4) Fire :-

- when properly use, fire can be an ecological tool to enhance the productivity, e.g. area can be burned and ploughed-in to make the soil more fertile
- effect of bush fire :
 - destruction of the standing vegetation and the associated animal communities
 - the blackened soil surface will heat up more rapidly than unburnt soil, and as the vegetation cover is removed, the sun's ray fall directly on the bare soil surface, causing the soil temperature to fluctuate greatly
 - a fire also burns the organic matter of the upper humus layer, the burnt humus layer has lower water-holding capacity and is less efficient in hindering the evaporation of water from the mineral soil layers below

IV. The use of organisms as pollution indicators:

1. For air pollution : e.g. lichens

- lichens are association between algae and fungi
- they are commonly encrusted on exposed rocks and trunks of trees, also hang from trees in wet forests
- they are sensitive to the air pollutants, poor the air quality, less amount and diversity of lichen can be found.

2. For water pollution :examples

- (i) stonefly nymph - can only grow in the water with high D.O., however, water pollution with organic matter may lower oxygen content.
- (ii) faecal coliform bacteria - faecal coliform bacteria are found in the large intestine of human and other mammals which will exist in their excreta
 - although coliform bacteria (e.g. *E. coli*) themselves are not pathogenic bacteria, their presence can indicate the level of faecal pollution
 - typically, a sample with a count of less than 100 per 100 ml water is considered safe to drink