TYCHR

Friend, Philosopher, Guide

Foundations of Environmental Systems & Societies

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1.1 ENVIRONMENTAL VALUE SYSTEM

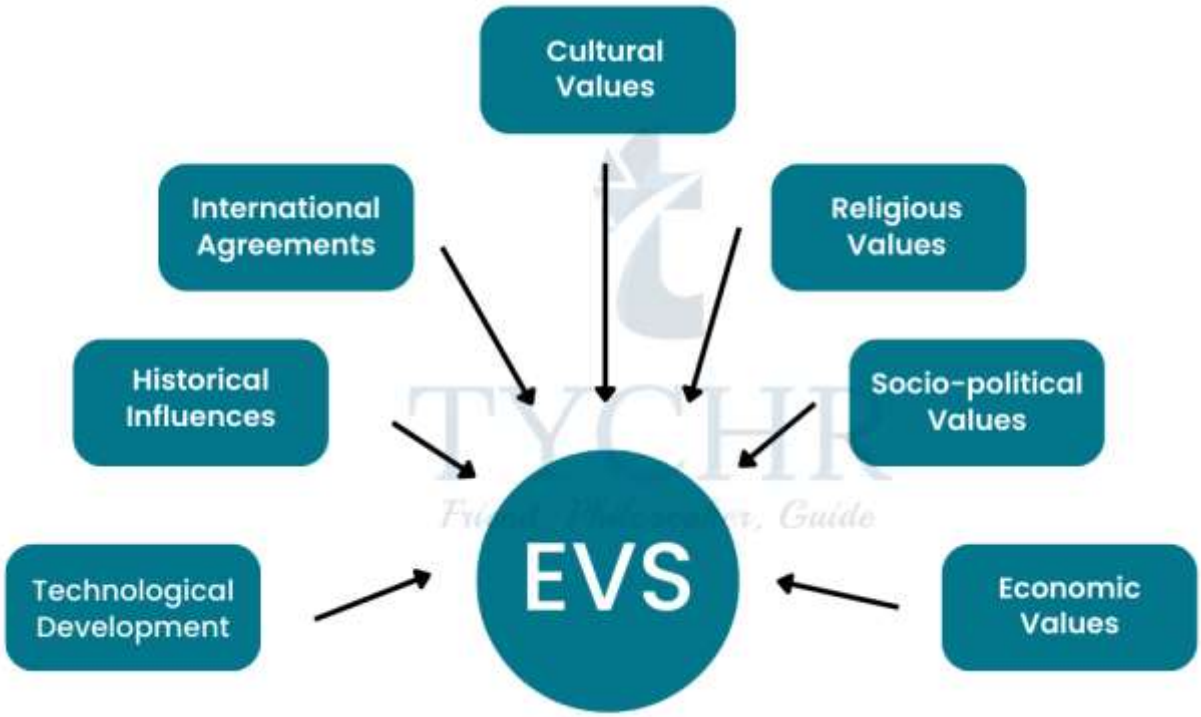


Figure 1 Different factors that affect the way individuals and society perceive and evaluate environmental problems.

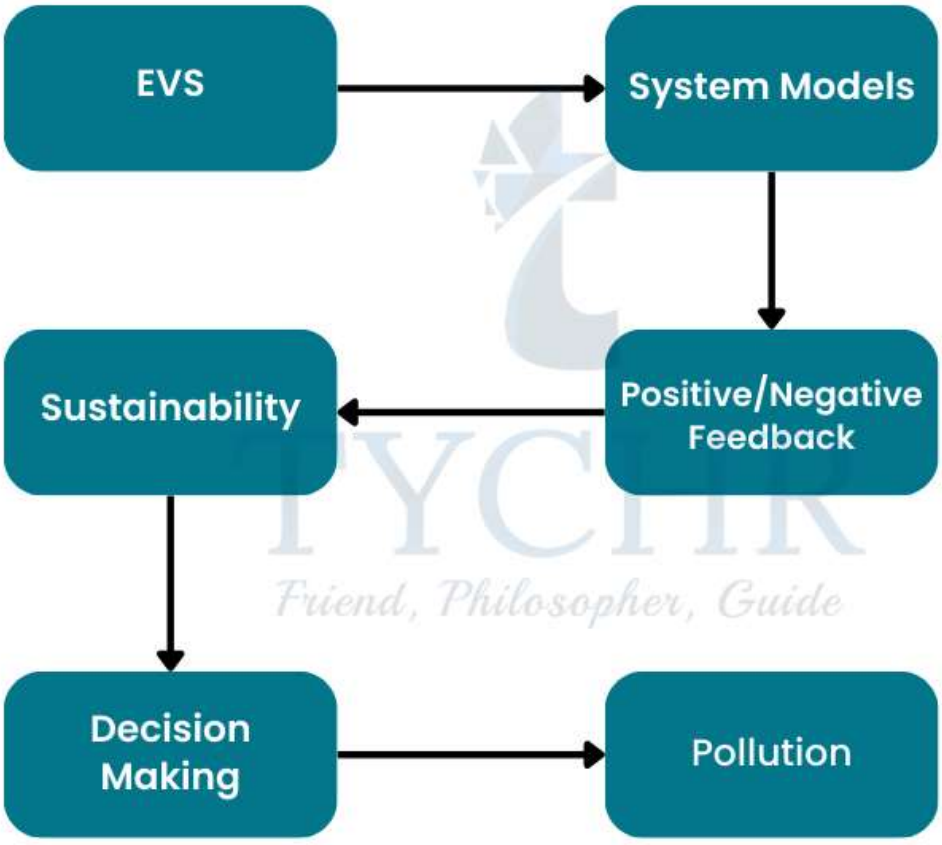


Figure 2 System models are crafted to capture our environment systems which help explain

positive and negative feedback processes in the environment. This in turn impacts how we assess and practice sustainable development. This leads to key decision making around how we solve the problems of pollution.

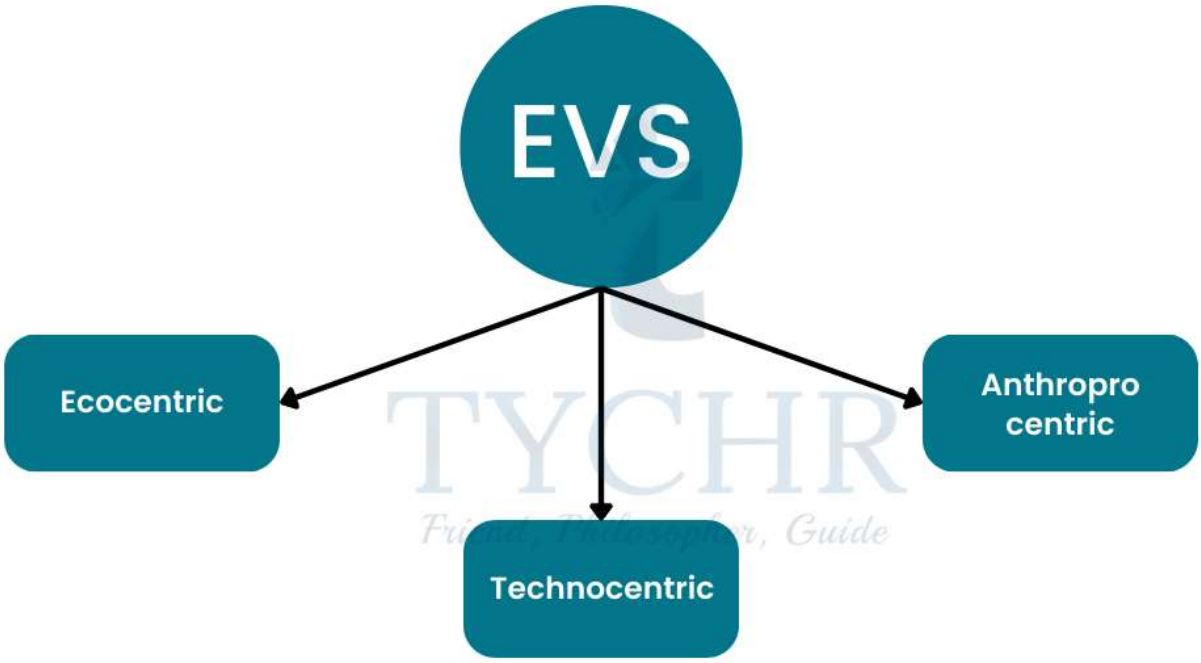
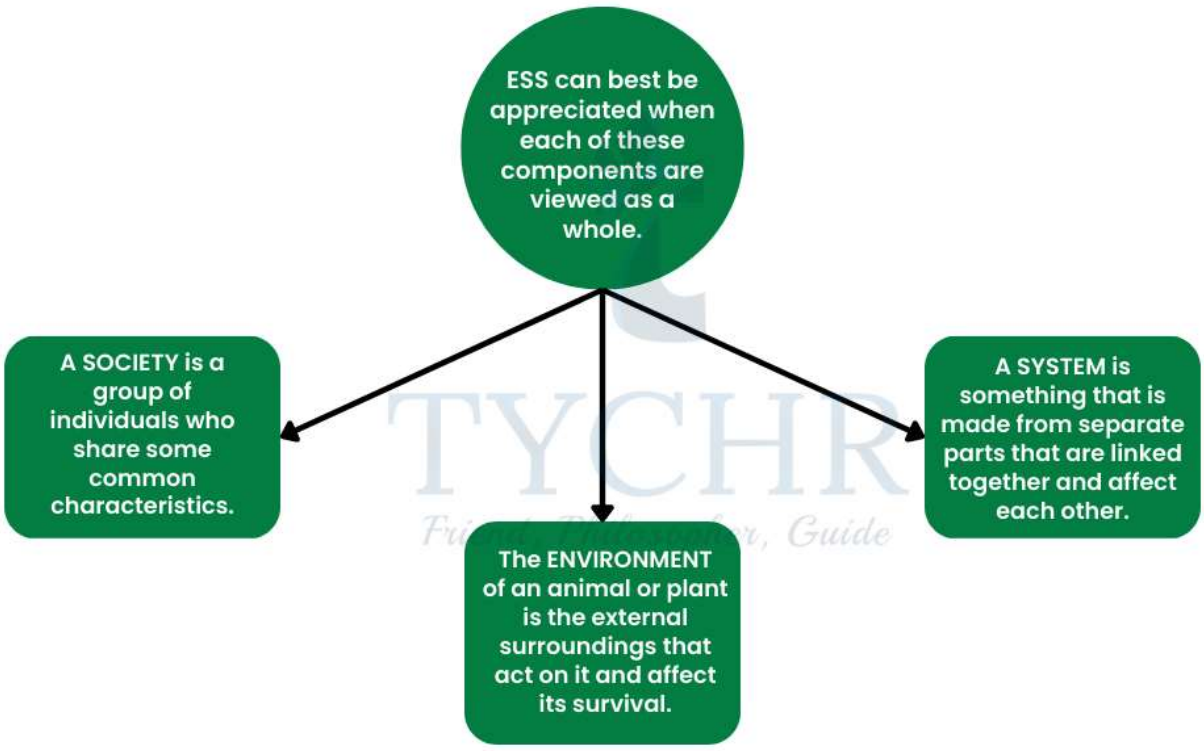


Figure 3 Categories of EVSs and what values they operate on to solve environment problems.

1.1.1 What Is ESS?



1.1.2 Development Of Environmental Movement

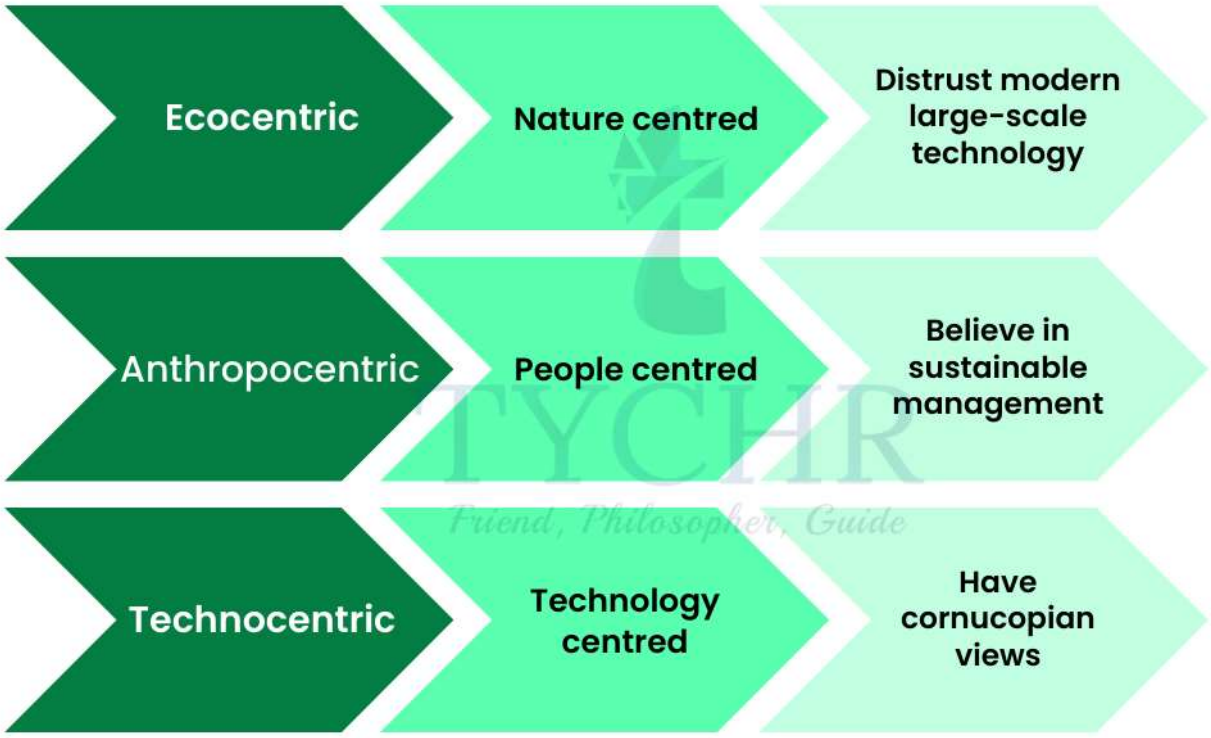
Environmental Disasters	Literature	Media	International Agreements	Technological Innovation
• Minamata Disease in Japan • Bhopal Gas Tragedy • Chernobyl Disaster • Fukushima Nuclear Plant	• Rachel Carson's book Silent Spring about food chains. • The Limits to Growth by Club of Rome – a global think tank. Examined consequences of a rapidly growing world population. • James Lovelock's book Gaia which proposed the hypothesis that the Earth is a living organism.	• Local & International pressure groups have resulted in increased public awareness. • The 2006 film, An Inconvenient Truth, examined the issues surrounding climate change. • Earth Day is marked each year on 22 April, coordinated globally via the internet and other media.	• UN Conference on the Human Environment 1972- produced Agenda 21 and Rio Declaration. • A 1987 report by the UN World Commission on Environment and Development (WCED) was published. • UN Earth Summit, Rio, 1992. • UN conference in Kyoto, 1997. • Johannesburg World Summit on Sustainable Development, 2002. • UN Conference on Sustainable Development, 2012.	• The Green Revolution led to increased agricultural productivity worldwide. • Other technological innovations have resulted in alternatives to fossil fuels.

1.1.3 Environmental Value Systems

A particular worldview or set of paradigms is known as an environmental value system (EVS), and it influences how an individual or group of people perceive and evaluate environmental issues.

EVS Inputs	EVS Outputs
• Education • Cultural influences • Economic factors • Socio-political factors • Religious texts and doctrine • Media	• Perspectives • Decisions on how to act regarding environmental issues • Courses of action

1.1.4 Range Of EVS



Ecocentric	Anthropocentric	Technocentric
Ecocentrists are nature-centered and prefer to work with natural environmental systems to solve problems, and to do this before problems get out of control.	An anthropocentrist believes humans must sustainably manage the global system: this might be through taxes, environmental regulation, and legislation.	Technocentrists accept that innovation will stay up with and give answers for ecological issues.

1.1.5 Decision Making And EVSs

EVSs influence our decision-making processes in the following ways:

Environmental Challenges Posed By	Approaches Of Resource Managers	Methods For Reducing Acid Rain:

The Extensive Use Of Fossil Fuels:	To Increasing Demand For Water Resources:	
Ecocentrists– Would call for the reduction of greenhouse gases through curtailing the existing gas-emitting industry, even if this restricts economic growth. **Technocentrists–** Would consider this to be a good illustration of the replacement of resources—an alternative industry can take the place of one that is harmful to the environment. They would try to develop technology that would lower the amount of carbon dioxide produced by burning fuel.	**Ecocentrists–** Would highlight the overuse and misuse of water. They would encourage the conservation of water and greater recycling, and say that water use should be within sustainable levels. **Technocentrists-** Would support iceberg capture and transport, wastewater purification, synthetic water production, cloud seeding and extracting water from deep aquifers. They would also look at innovative ways to reduce the use of water, both in industry and at a domestic level.	**Ecocentrists-** Would argue for a change in lifestyle that reduces the need for either the energy produced by coal, or the products that are made with that energy. Eg: dressing warmly or changes in transport. They also encourage the 'reuse, reduce, recycle' philosophy. **Technocentrists-** Would again argue for the use of alternative technology and the promotion of continued economic growth regardless of the impact of emissions of greenhouse gases because they believe that humanity is capable of controlling the issue whenever it is necessary.

1.1.6 Intrinsic Value

This means that the natural world has integral worth independent of its value. intrinsic value is one that has an inherent worth, irrespective of economic considerations- such as the belief that all life on Earth has a right to exist. Intrinsic values include those based on cultural and aesthetic values. Intrinsic values may vary between different EVSs.

1.2 Systems And Models

1.2.1 Systems

- Reductionist approach vs Holistic approach
- Use of diagrams in a Systems approach
- Emphasises similarities in the ways in which matter, energy and information link together in a variety of different disciplines
- Allows links to be made between subjects
  Systems have inputs, outputs, and storages.

1.2.2 Characteristics Of Systems

A system consists of:

- Storages- which are places where matter or energy is kept in a system.
- Flows- which serve as energy and matter inputs and outputs. The processes that make up the flows can be either:
  - Transfers (a change in location) or
  - Transformations (a change in the chemical nature, a change in state or a change in energy).

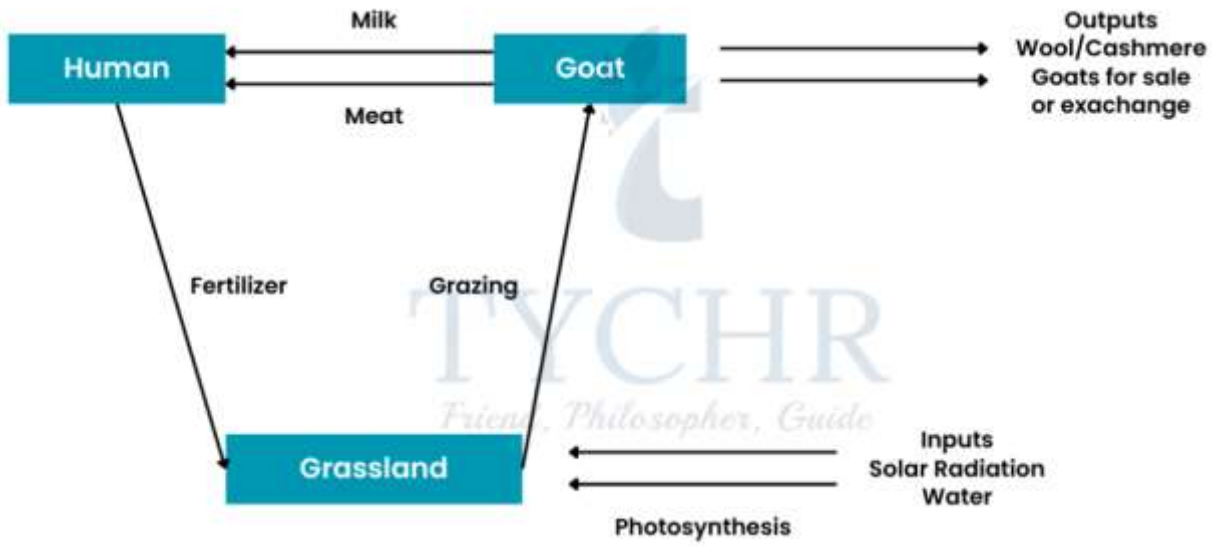


Figure 4 Diagram of a farming system.

1.2.3 Types

- Open systems – Both matter and energy are exchanged across the boundaries of the system. Open systems are organic and so must interact with their environment to take in energy and new matter, and to remove wastes.
- Closed systems – Energy but not matter is exchanged across the boundaries of the system. Strictly, closed systems do not occur naturally on Earth except all the global cycles of matter (e.g. the water and nitrogeno Isolated systems – Neither energy nor matter is exchanged across the boundary of the system. These systems do not exist naturally, although it is possible to think of the entire universe as an isolated system.

1.2.4 Models

A simplified version of reality is called a model. Systems can be understood through the use of models, which can also be used to predict how they will react to change.

Strengths Of Models	Limitations Of Using Models
• Allow scientists to simplify complex systems and predict them. • Make it possible to modify inputs and examine outcomes without having to wait a long time, as would be the case if real events were the subject of the study.	• Different models may show different effects using the same data. • Systems may be complex; they may become less accurate due to oversimplification. • Climate models may not be accurate due to different assumptions that have to be made.

- Allow results to be shown to other scientists and to the public, and are easier to understand than detailed information about the whole system.

- The quality of the data used in a model is the only thing that matters. Additionally, the model's input data may not be reliable.
- Inaccuracies can result from the fact that models are based on the expertise of the people who make them.
- They are subject to interpretation.

1.3 Energy And Equilibria

1.3.1 Laws Of Thermodynamics And Environmental Systems

- First Law of Thermodynamics (law of conservation of energy)- states that energy cannot be created or destroyed: it can only be changed from one form into another. This indicates that the total amount of energy in any system is constant and can only change form.
- Second Law of Thermodynamics- states that the transfer of energy through a system is inefficient and that energy is transformed into heat. This means that less energy is available to do work and the system becomes increasingly disordered. In an isolated system, entropy increases spontaneously.

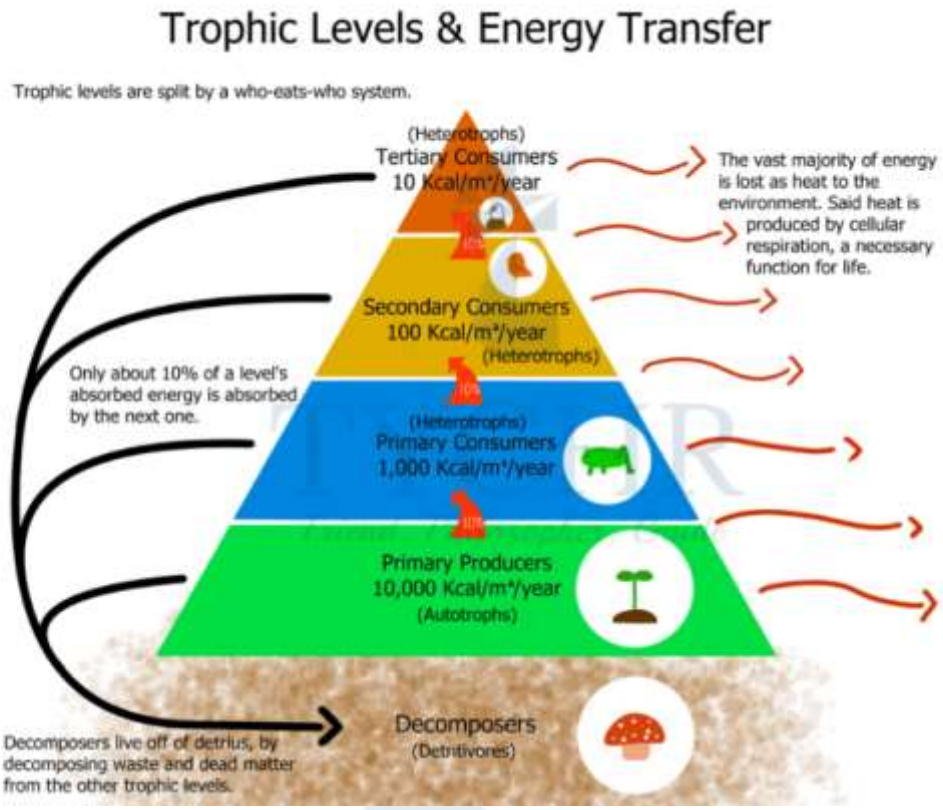


Figure 5 Energy flow through a food chain. One-way energy enters an ecosystem as sunlight energy. This sunlight energy is then changed into biomass by photosynthesis. Chemical energy in producers is passed along food chains as biomass, or transformed into heat during respiration. Transfer and transformation of energy is inefficient with all energy ultimately being lost into the environment as heat. This is why food chains tend to be short.

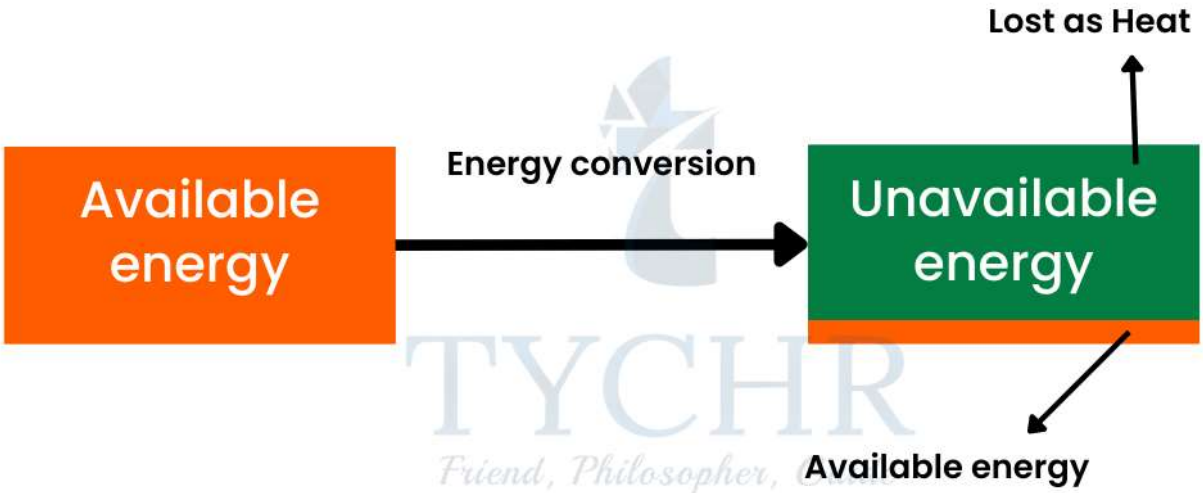


Figure 7 Energy cannot be created or destroyed: it can only be changed from one form into another. The total energy in any system is constant, only the form can change.

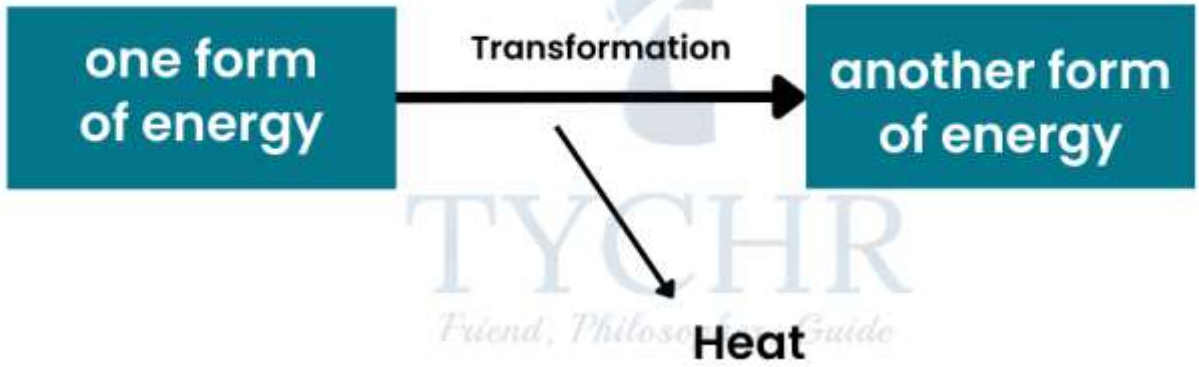


Figure 6 The second law of thermodynamics states that energy is converted into heat when energy is transformed from one form to another.

1.3.2 Nature Of Equilibria

Let's Revise

Feedback- When part of the output from a system returns as an input, so as to affect subsequent outputs.
Equilibrium- A state of balance among the components of a system.
Tipping Point- The minimum amount of change within a system that will destabilize it, causing it to reach a new equilibrium or stable state.

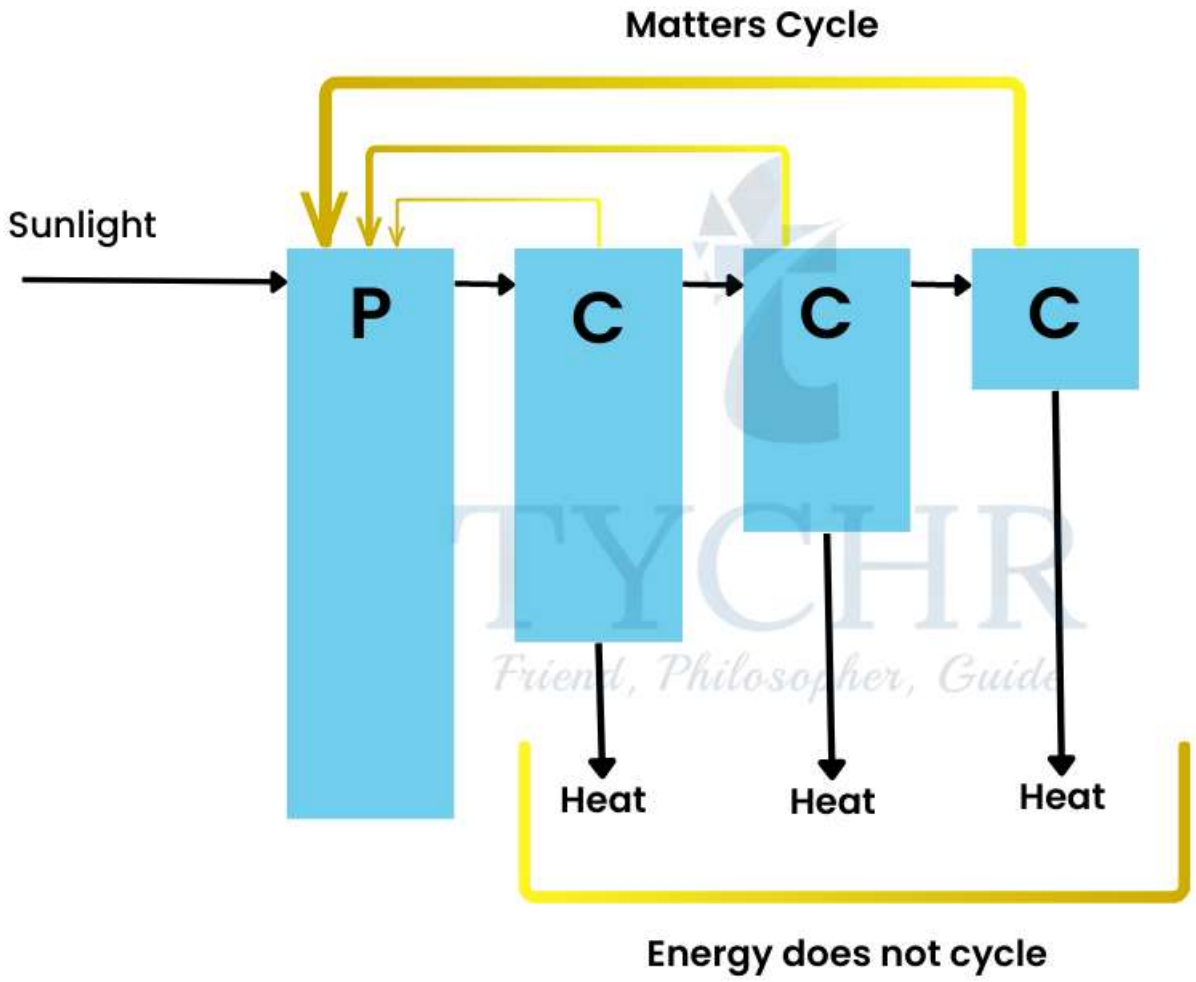


Figure 12 Energy Energy flow through a food chain; P = producers, C = consumers. The boxes show energy available to do work at each feeding level. Energy decreases through the food chain as some is converted to heat. The '10 per cent rule' indicates that on average only around 10 per cent of the available energy is passed on to the next trophic level.

1.3.3 Positive & Negative Feedback

Positive Feedback	Negative Feedback
• When a change in a system's state leads to more and more change, this is positive feedback. • They move the system further away from equilibrium.	• Negative feedback can be defined as feedback that counteracts any change away from equilibrium, contributing to stability. • They return the system to its original equilibrium.

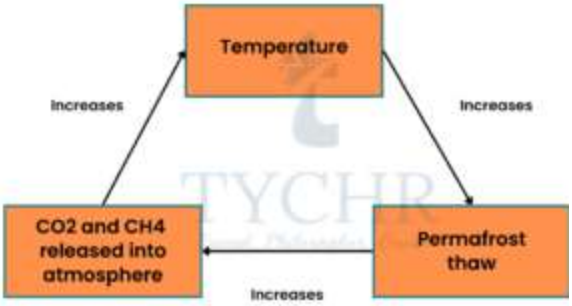


Figure 13 Positive Feedback.

Negative feedback is a method of control that regulates itself.

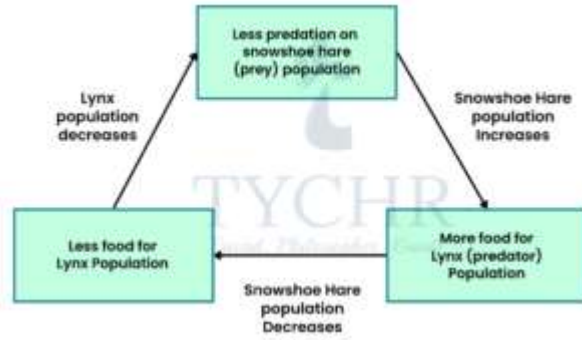


Figure 14 Negative Feedback.

1.3.4 Tipping Point

A tipping point is a critical threshold when even a small change can have dramatic effects and cause a disproportionately large response in the overall system. Positive feedback loops tend to drive a system towards a tipping point where a new equilibrium is adopted. Systems at a threat from tipping points include:

- El Niño Southern Oscillation
- West African monsoon
- Amazon rainforest
- Boreal forest

1.3.5 Resilience & Diversity In Systems

Resilience- refers to tendency of ecological or social systems to avoid tipping points, and maintain stability through steady-state equilibrium. Diversity is a large number and proportions of species present in an ecosystem. Large storages/ high diversity, will mean that a system is less likely to reach a tipping point and move to a new equilibrium.

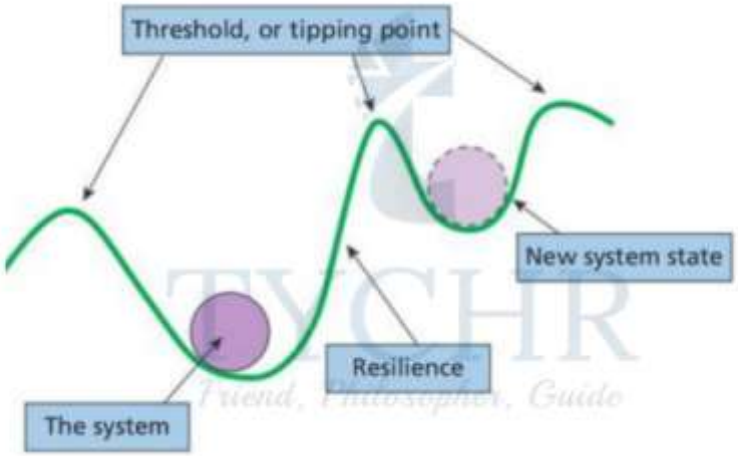


Figure 15 The role of resilience in avoiding tipping points.

1.4 Sustainability

1.4.1 Sustainability

Sustainability means using resources from around the world at a rate that allows for natural regeneration and minimises environmental damage. It involves the use of renewable resources and the sustainable use of natural capital.

- Natural Capital- Are resources that can be utilised to produce a sustainable natural income. Natural ecosystems consist of goods and services. Goods are tangible products, such as timber. Services include water replenishment, flood and erosion protection, and climate regulation, which are life-supporting but often difficult to value economically.
- Natural Income- is the annual yield from natural capital sources like timber, ores, fish, plants, and so on.

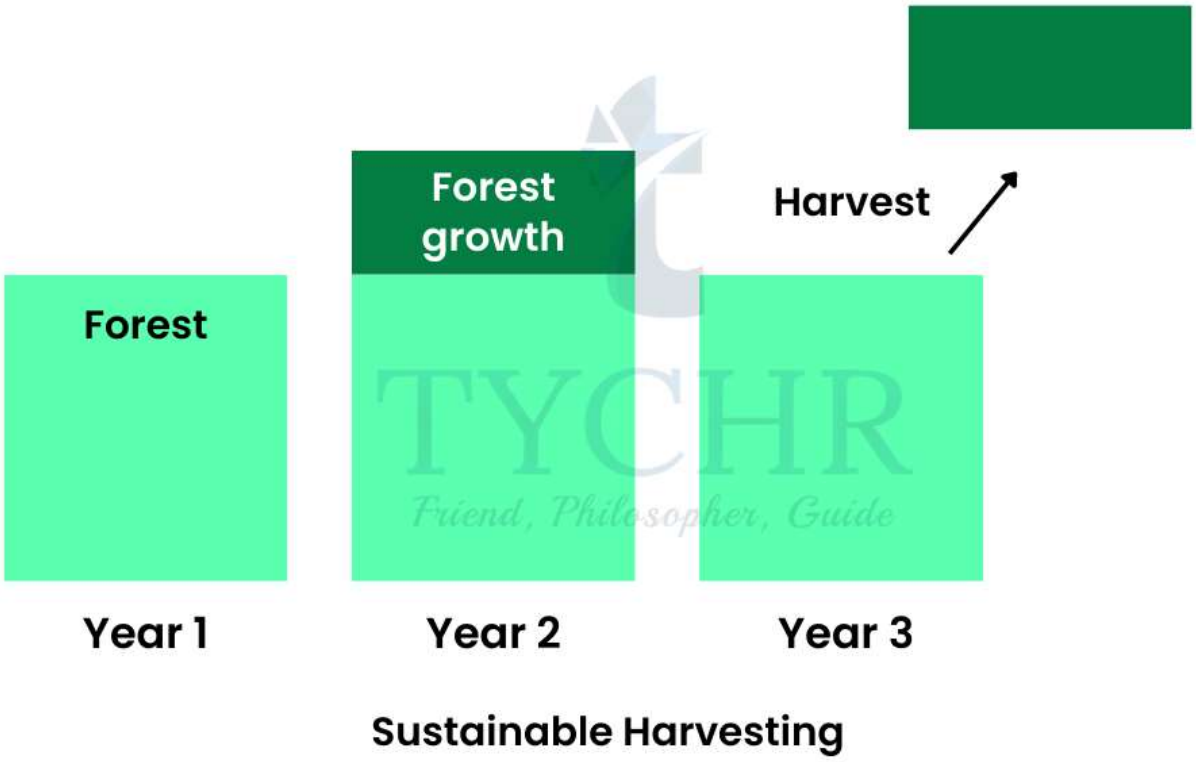


Figure 17 (a) The sustainable use of a forest ecosystem to provide natural income (i.e. timber). (b) Unsustainable harvesting

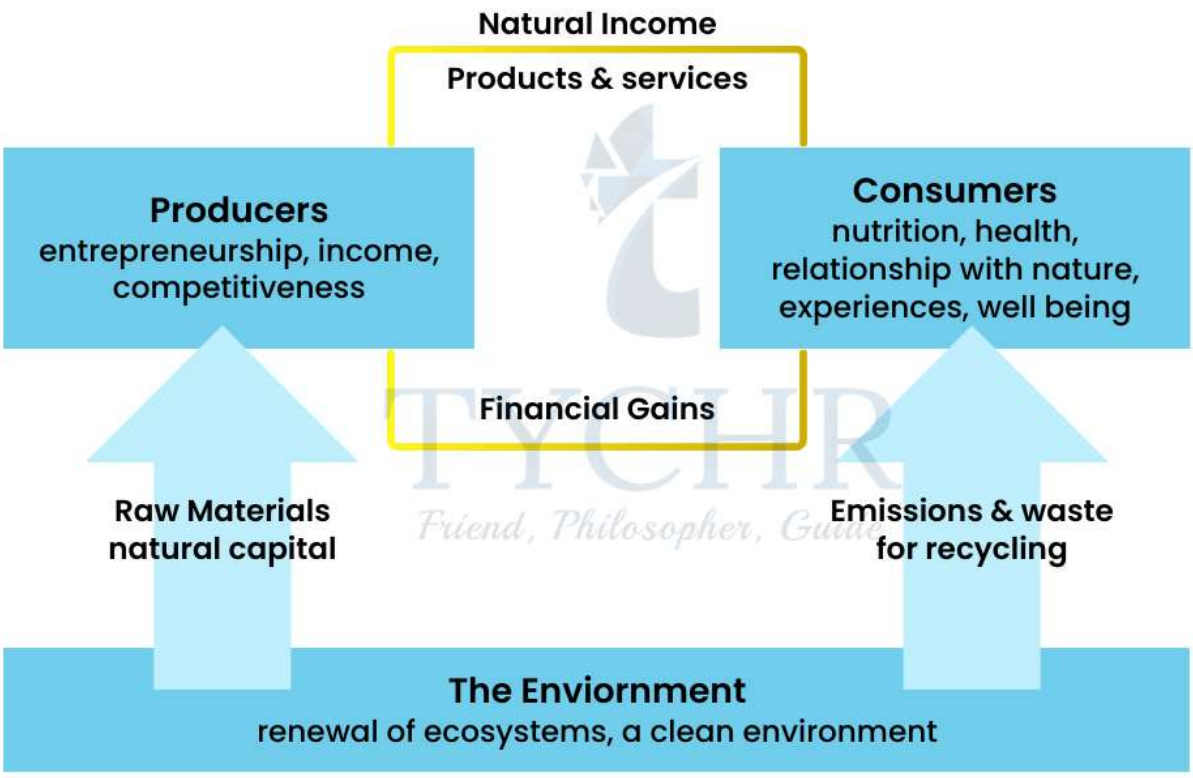


Figure 16 Natural capital and natural income.

1.4.2 Sustainable Development

The definition of sustainable development is “meeting the needs of the present without compromising the ability of future generations to meet their own needs.”

1.4.3 Indicators Of Sustainability

- Environmental Impact Assessment
  An Environmental Impact Assessment (EIA) is carried out before any major development project. An EIA is an evaluation of the current ecosystem and the impacts from the development. An EIA estimates change to the environment that occurs as a result of a project, and helps to weigh the pros and cons.
- Ecological Footprints
  An ecological footprint is the area of land water needed to support a defined population at a given standard of living. Ecological footprints greater than the biocapacity of a country (i.e. the ability of a biologically productive area to generate sustainable supply of resources) indicate unsustainability.
- The Millennium Ecosystem Assessment
  In 2000 the UN initiated a consultation exercise that ultimately led to the launch of the Millennium Ecosystem Assessment (MA) in 2001. It was a large study to assess knowledge in this area and to reach agreement, involving both social and natural scientists. The aims of the MA were to improve the decision- making process relating to ecosystem management, with a view to improving human well-being. The MA was also developed to inform and improve future scientific assessments of this kind.

1.5 Humans & Pollution

1.5.1 Pollution

Pollution is the addition of a harmful substance to an environment at a rate greater than that at which it can be removed, and which has a noticeable effect on the organisms within the environment. It

may be used quantitatively as an environmental indicator of sustainability.

Types of Pollution:

- Non-point Source Pollution- Is the release of pollutants from numerous, widely dispersed origins.
- Point Source Pollution- Is the release of pollutants from a single, clearly identifiable site. It is easier to manage and clean up than non-point source pollution because its origin can be identified.
- POPs- Are persistent organic pollutants that are resistant to environmental degradation which can accumulate in food chains. Once chemicals enter food chains, the top predators are often at extra risk because of the biomagnification effects of some chemicals.
- Biodegradable Pollution- is able to be broken down by organisms and so does not persist in food chains.

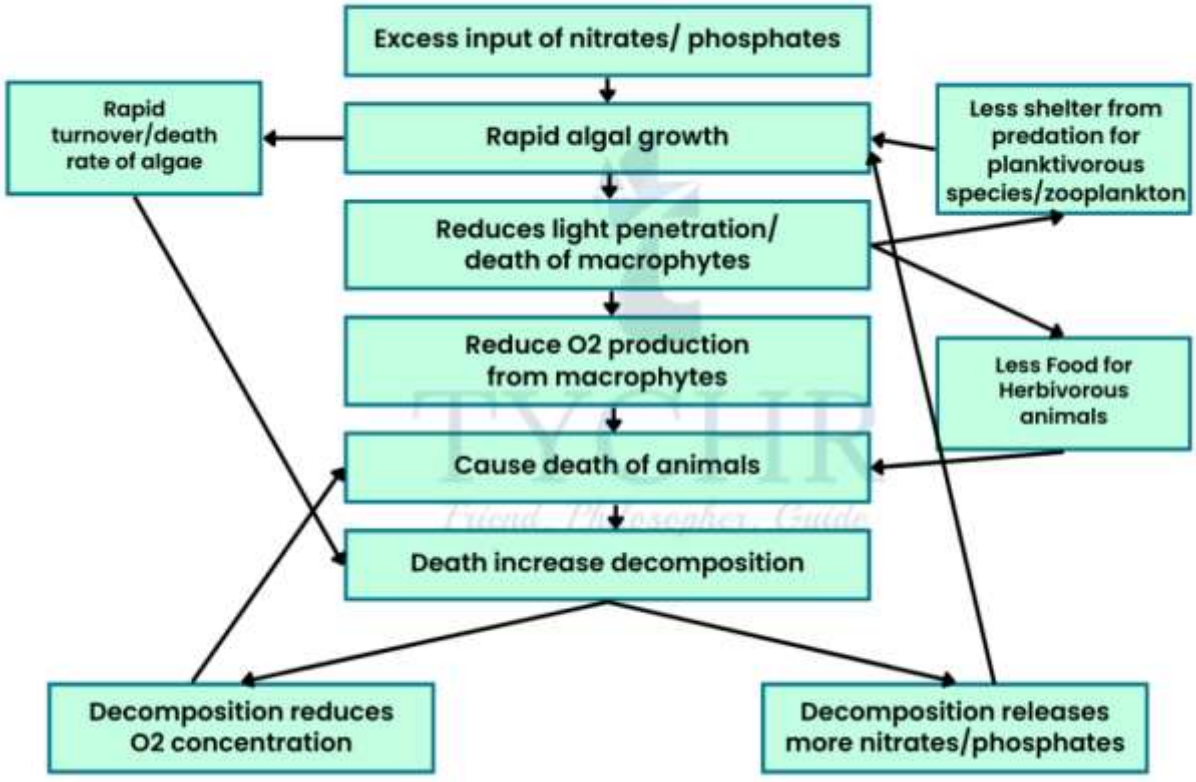


Figure 18 Systems diagram showing the role of positive feedback mechanisms in affecting the equilibrium of an aquatic ecosystem during the process of eutrophication.

- Acute & Chronic Pollution- The effect of certain pollutants like UV radiation, due to a reduction of the ozone layer as a result of pollution from CFCs, may be acute or chronic. The effects of UV radiation may include temporary blindness, mutations during cell division, sunburn and skin cancers. In terms of air pollution, acute effects include asthma attacks. Chronic effects include lung cancer, chronic obstructive pulmonary disease (COPD) and heart disease.
- Primary Pollutant- Is one which is active on emission and directly impacts the environment. For example, CO2 is released from burning fossil fuels and actively contributes to global warming; CFCs are released from aerosols and actively contributes to ozone depletion.
- Secondary Pollutant- Is one that is formed from a primary pollutant through physical or chemical change. For example, CO2 combines with seawater to form carbonic acid that has an impact on calciferous shelled organisms or corals.Acid precipitation is produced when NOx and water combine. Photochemical smog is brought about by NO2's production of ozone.
- Persistent Pollutant-are passed along food chains because living things can't break them down. Persistent organic pollutants are organic compounds that do not break down in the environment through biological, chemical, or photolytic processes.
- Biodegradable pollutants- Are not stored in biological matter or passed along food chains. Most modern pesticides, used to treat crops to as to ensure maximum yield, are biodegradable

1.5.2 DDT

Dichlorodiphenyltrichloroethane (DDT) is a man-made pesticide that has both advantages and disadvantages. Its main advantages are in the control of diseases such as malaria and in improving crop yields. During the 1940s and 1950s, it was used extensively to control lice and mosquitoes.

figure 19 DDT is a persistent organic pollutant that is readily adsorbed to soils and sediments, which can act both as sinks and as long-term sources of exposure affecting organisms.

Environmental Impacts

- DDT is a POP that is extremely hydrophobic and strongly absorbed by soils. DDT is not very soluble in water but is very soluble in lipids (fats). It can build up in fatty tissue.
- Bioaccumulation is the body's retention or accumulation of chemicals that are either slowly biodegradable or non-biodegradable.
- Biomagnification The process of increasing a chemical's concentration at each trophic level through biological amplification
- The end result is that top predators may have in their bodies concentrations of a

Health Impacts

The effects of DDT on human health are disputed and conflicting. For example, some studies have shown that:

- Farmers occupationally exposed to DDT had an increased incidence of asthma and/ or diabetes.
- Some people exposed to DDT had a higher risk of liver, breast, and/or pancreatic cancer.
- DDT exposure is a risk factor for early pregnancy loss, premature birth, and/or low birth weight.
- A 2007 study found increased infertility among South African men from communities where

	chemical several million times higher than the same chemical's concentration in water and primary producers.	DDT is used to combat malaria.

1.5.3 Pollution Management

Modern technology can reduce the impact of pollution and so can human behaviour.

Changing Human Activities	Regulating Activities	Cleaning Up Afterwards	Integration Of Policies
• Switching to solar, hydro- or wind would reduce emissions of greenhouse gases, and there would be less risk of global warming. • Reusing and recycling materials has and would further reduce consumpt	• Reduction in the amount of pollution at the point of emission is achieved by extracting the pollutant from the waste emissions. • The use of flue gas desulfurization (FGD). FGD is widely used to control the emissions of sulphur dioxide	• The most expensive option is to clean up the environment after it has been polluted. • Under natural conditions, bacteria take time to break down pollutants before the ecosystem recovers. • In cold conditions, bacterial activity is	• Plans for integrated pollution management are increasingly likely to incorporate elements from all three approaches. • It's less expensive to catch contaminations at the source in the long haul since they won't have dirtied the climate at that stage-

ion of resources. • Disposing E waste responsibly. Reduce the volume of waste that ends up in landfill sites.	(SO2) from coal- and oil- fired power stations and refineries. • Flue gas treatment (FGT) is the process used for removing pollutants from waste incinerators.	reduced so pollutants in colder environments persist for longer than in warm environments. • When people are employed in the clean-up process, it is often labor-intensive and expensive.	so no cleanup. • Cleaning up widespread pollution is necessary, but it is the least effective option.

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