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**SAIRAM**  
DIGITAL RESOURCES

YEAR  
**II**

SEM  
**IV**

**GE8291**

**ENVIRONMENTAL SCIENCE AND ENGINEERING**

## UNIT NO 4

### SOCIAL ISSUES AND THE ENVIRONMENT

- 4.3 case studies – role of non-governmental organization
- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust

### SCIENCE & HUMANITIES



## ROLE OF NGO's

- NGO's are nongovernmental organizations.
- voluntary organizations
- They can help by advising the government about some local environmental issues and at the same time interacting at the grass-root levels.
- They can act as an effective and feasible link between the two. They can act both as an 'action group' or a 'pressure group'.
- They can be very effective in organizing public movements for the protection of environment through creation of awareness.

## Objectives of NGO's

- i) To describe and discuss the common characteristics of health system functioning in the given socio - economic, socio- cultural, political and ecological settings.
- ii) The fundamental objective is to act as a catalyst in bringing about local initiative and community participation in overall improvement in quality of life.

## Some Roles of the NGO's

- NGO's that have played a landmark role in the society for conservation of environment.
  - Greenpeace is a non-governmental environmental organization. Activities of Greenpeace have made huge impacts all over the globe.
  - The “Chipko Movement” for conservation of trees by Dasholi Gram Swarajya Mandal or the “Narmada Bachao Andolan” organized by Kalpavriksh
- NGO's that have significant role in creating environmental awareness.
  - The Bombay Natural History Society (BNHS),
  - The World Wide Fund for Nature - India (WWF, India) Kerala Sastra Sahitya Parishad,
  - Centre for Science and Environment (CSE) and many others

# ENVIRONMENTAL ETHICS—ISSUES AND POSSIBLE SOLUTIONS

## Environmental ethics:

A search for moral values and ethical principle in human relations with the natural world.

It reflects our human- centric thinking or earth – centric thinking

These two world-views are discussed here in relation to environ-mental protection:

## Anthropocentric Worldview:

This view is guiding most industrial societies. It puts human beings in the center giving them the highest status. Man is considered to be most capable for managing the planet earth.

The guiding principles of this view are:

- (i) Man is the planet's most important species and is the in-charge of the rest of nature.
- (ii) Earth has an unlimited supply of resources and it all belongs to us.
- (iii) Economic growth is very good and more the growth, the better it is, because it raises our quality of life and the potential for economic growth is unlimited.
- (iv) A healthy environment depends upon a healthy economy.
- (v) The success of mankind depends upon how good managers we are for deriving benefits for us from nature.

## Eco-centric Worldview:

This is based on earth-wisdom.

The basic beliefs are as follows:

- (i) Nature exists not for human beings alone, but for all the species.
- (ii) The earth resources are limited and they do not belong only to human beings.
- (iii) Economic growth is good till it encourages earth-sustaining development and discourages earth-degrading development.
- (iv) A healthy economy depends upon a healthy environment.
- (v) The success of mankind depends upon how best we can cooperate with the rest of the nature while trying to use the resources of nature for our benefit.



Some important ethical guidelines known as Earth ethics or Environmental Ethics are as follows:

- ☐ You should love and honour the earth since it has blessed you with life and governs your survival.
- ☐ You should keep each day sacred to earth and celebrate the turning of its seasons.
- ☐ You should not hold yourself above other living things and have no right to drive them to extinction.
- ☐ You should be grateful to the plants and animals which nourish you by giving you food.
- ☐ You should limit your offsprings because too many people will overburden the earth.
- ☐ You should not waste your resources on destructive weapons.
- ☐ You should not run after gains at the cost of nature, rather should strive to restore its damaged majesty.
- ☐ You should not conceal from others the effects you have caused by your actions on earth.
- ☐ You should not steal from future generations their right to live in a clean and safe planet by impoverishing or polluting it.
- ☐ You should consume the material goods in moderate amounts so that all may share the earth's precious treasure of resources.



## CLIMATE CHANGE

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period- at least 30 years is called climate.

It is observed that earth's temperature has changed considerably during the geological times. The surface of the Earth has warmed, on average, 0.3 to 0.6 °C since the late 19th century.

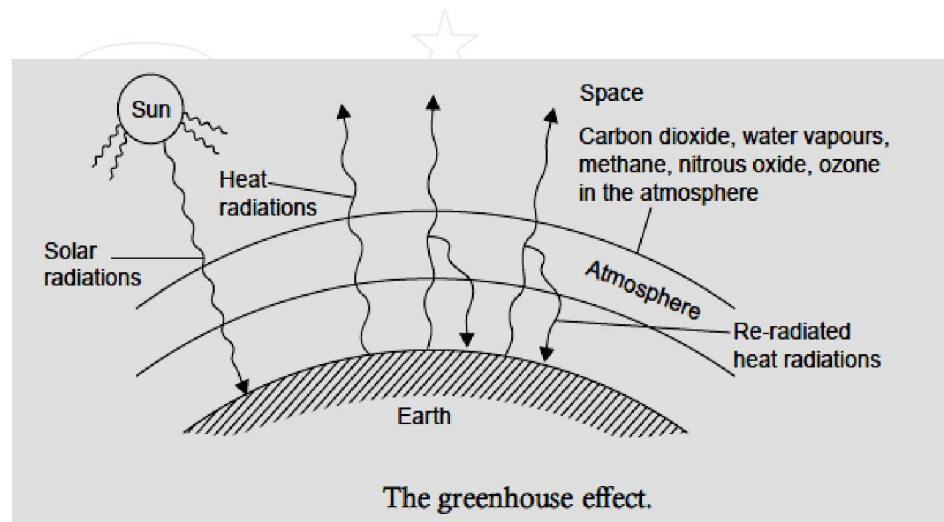
In addition, most of the ill effects of climate change are linked to extreme weather events, such as hot or cold spells of temperature, or wet or dry spells of rainfall, or cyclones and floods.

## GREEN HOUSE EFFECT AND GLOBAL WARMING

Sun is the primary source of energy for earth.

The amount of heat trapped in the atmosphere depends mostly on the concentrations of heat trapping or green house gases and the length of time they stay in the atmosphere.

The major green house gases are **carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbons (CFCs) and water vapour.**



As the effect is similar in nature to what happens in a botanical greenhouse (the glass panes allows the light energy to enter inside but diminishes the loss of heat), these gases are called greenhouse gases and the resultant warming from their increase is called the **greenhouse effect**.

Heat trapped by green house gases in the atmosphere keeps the planet warm enough to allow us and other species to exist.

The concentration of CO<sub>2</sub> in the Earth's atmosphere was about 280 parts per million by volume (ppmv) in 1750, before the Industrial Revolution began. By 1994 it was 358 ppmv and rising by about 1.5 ppmv per year. If emissions continue at current rate, the concentration will be around 500 ppmv, nearly double the pre-industrial level, by the end of the 21st century.

Global warming  
Due to manmade activities the concentration of green house gases are increasing at a fast rate. This causes the earth's surface temperature to rise slowly. Deforestation, use of fossil fuels, use of CFC's are responsible for such a situation. In the past few decades, earth's temperature has increased by 2-3 degrees. This effect is known as **global warming**. **Greenhouse effect** leads to global warming.

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## Causes of green house effect :

- i) **Deforestation:** Due to deforestation, photosynthesis takes place to limited extend, which increases CO<sub>2</sub> content in the atmosphere leading to global warming.
- ii) **Burning of fossil fuels:** Large amount of greenhouse gases (CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub> etc) are released into the atmosphere due to the burning of fossil fuels, oil, coal and gas.
- iii) **Electrical Appliances:** Chlorofluorocarbons (CFCs) are widely used in refrigerators as coolants, aerosol cans, foaming agents, fire extinguisher chemicals, and cleaners used in the electronic industry. These gases slowly make way into earth's atmosphere resulting in global warming.
- iv) **Population explosion:** Population growth increases CO<sub>2</sub> level (by respiration). With the increase in population, the needs and wants of people increase leading to urbanization and industrialization resulting in higher green house emission.

## Consequences of Greenhouse Effect

i) **Global temperature increase:** It is estimated that the earth's mean temperature will rise between 1.5 to 5.5°C by 2050 if input of greenhouse gases continues to rise at the present rate.

ii) **Rise in Sea Level:** With the increase in global temperature there will be rise in sea water levels mainly due to melting of polar ice caps and glaciers. An increase in the average atmospheric temperature of 3°C would raise the average global sea level by 0.2-1.5 meters. One meter rise in sea level will submerge low lying areas of cities like Shanghai, Cairo, Bangkok, Sydney, Hamburg and Venice. Agricultural lowlands and deltas in Egypt, Bangladesh, India, China and will be submerged in water. This will also damage to lagoons, estuaries and coral reefs.

iii) **Effects on Human Health:** Global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis etc. Warmer temperature and more water stagnation would favour the breeding of mosquitoes, snails and some insects, which are the vectors of diseases like malaria, filariasis.

iv) **Effects on Agriculture:** Global warming can lead to water scarcity and may result in drought. Soil moisture will decrease and evapo-transpiration will increase, which may drastically affect wheat and maize production in tropical and subtropical regions. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases. Pests will adapt to such changes better than the crops.

v) **Natural disasters:** The source of origin for many Indian rivers like Brahmaputra, Ganges, Indus are The Himalayas. Melting of ice can lead to frequent flooding. As the temperature of oceans rise, so will the probability of more frequent and stronger hurricanes.

vi) **Economic effects:** Extreme weather might reduce global gross domestic product by up to one percent, and that in a worst-case scenario global per capita consumption could fall 20 percent.

vii) **Ocean Acidification:** Increased atmospheric CO<sub>2</sub> increases the amount of CO<sub>2</sub> dissolved in the oceans. CO<sub>2</sub> dissolved in the ocean reacts with water to form carbonic acid, resulting in acidification



## Control of Global Warming

To slow down global warming the following steps will be important:

- (i) Cut down the current rate of use of CFCs and fossil fuels.
- (ii) Use energy more efficiently.
- (iii) Shift to renewable energy resources.
- (iv) Increase Nuclear Power Plants for electricity production.
- (v) Shift from coal to natural gas.
- (vi) Trap and use methane as a fuel.
- (vii) Adopt sustainable agriculture.
- (viii) Stabilize population growth.
- (ix) Control deforestation and plant more trees.

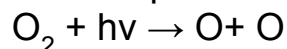
## OZONE LAYER DEPLETION

Ozone layer is a layer in earth's atmosphere containing relatively high concentrations of ozone ( $O_3$ ). It is mainly found in the lower portion of the stratosphere from approximately 20 to 30 kilometres above earth. The ozone layer is often referred to as the "**umbrella of life**" because it protects life on Earth from harmful UV rays.

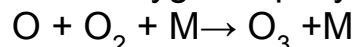
The **Dobson Unit** is the most common unit for measuring ozone concentration. One Dobson Unit is the number of molecules of ozone that would be required to create a layer of pure ozone 0.01 mm thick at a temperature of 0 C and a pressure of 1 atmosphere. Over the Earth's surface, the ozone layer's average thickness is about 300 Dobson Units or a layer that is 3 millimeters thick.

### Formation and Function of ozone layer

Ultraviolet radiations less than 242 nm decompose molecular oxygen into atomic oxygen (O) by photolytic decomposition.

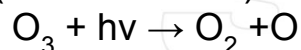


The atomic oxygen rapidly reacts with molecular oxygen to form ozone.



(M is a third body necessary to carry away the energy released in the reaction).

Ozone thus formed distributes itself in the stratosphere and absorbs harmful ultraviolet radiations (200 to 320 nm) and is continuously being converted back to molecular oxygen.



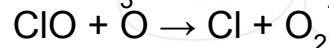
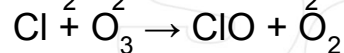
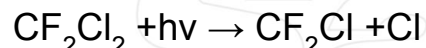
Absorption of UV radiations results in heating of the stratosphere. Thus there is equilibrium between the formation and destruction of ozone. This equilibrium is disturbed by reactive atoms of chlorine, bromine etc. which destroy ozone molecules and result is thinning of ozone layer generally called **ozone hole**.

### Causes for ozone hole formation

**Cholorofluorocarbons:** Major reason for the depletion of ozone layer is halogen atoms (F, Cl, Br) which are formed by the photochemical decomposition of CFC's.

**CFC** is an organic compound that contains only carbon, chlorine, hydrogen and fluorine. CFC's are widely used as coolants in refrigeration systems and air conditioners, propellants for aerosols due to low boiling point. These slowly rise up and reach stratosphere and cause depletion of ozone.

The chemical reaction can be represented as



In the second step, Cl is generated again which can cause the reaction to continue like a chain reaction. One chlorine atom can thereby destroy thousands of ozone molecules. Similarly other atoms present in CFC like Fluorine and Bromine can also cause similar effect.

## Effects of Ozone Depletion

Ozone depletion in the stratosphere will result in more UV radiation reaching the earth especially UV-B (290-320 nm).

### In humans

- i) The UV-B radiations affect DNA. Any change in DNA can result in mutation and cancer.
- ii) Cases of skin cancer (basal and squamous cell carcinoma) which donot cause death but cause disfigurement will increase.
- iii) Easy absorption of UV rays by the lens and cornea of eye will result in increase in incidents of cataract.
- iv) Melanin producing cells of the epidermis (important for human immune system) will be destroyed by UV-rays resulting in immuno-suppression. Fair people (can't produce enough melanin) will be at a greater risk of UV exposure.

## In plants and animals

i) Phytoplanktons are sensitive to UV exposure. Ozone depletion will result in decrease in their population thereby affecting the population of zooplankton, fish, marine animals, infact the whole aquatic food chain.

ii) Yield of vital crops like corn, rice, soybean, cotton, bean, pea and wheat will decrease.

iii) The UV radiation enhances the rate of evaporation through stomata and decreases the moisture content of the soil. This condition adversely affects the growth and development of crop plants and reduces the crop yield.

## Other implications

i) Degradation of paints, plastics and other polymer material will result in economic loss due to effects of UV radiation resulting from ozone depletion.

ii) It contributes in the Global Warming. If ozone depletion continues, the temperature around the world may rise even up to 5 degrees.

## Control of ozone layer depletion

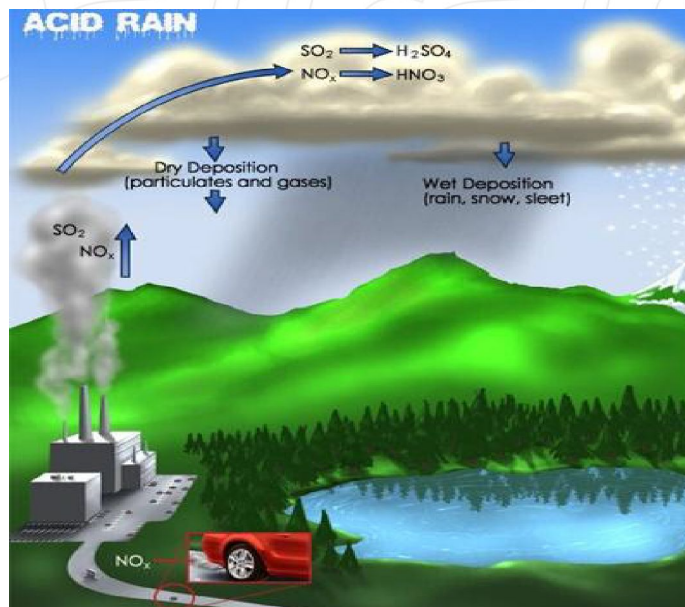
- i) **Reduce/replace the usage of CFC's:** One molecule of CFC destroys more than few thousands of ozone molecules via chain reaction. So usage of CFC's has to be discouraged and kept minimum. Use of other alternative coolants which are less damaging has to be promoted.
- ii) **Reduce the use of methyl bromide:** Methyl bromide is an insecticide used for fumigation of soils structures and storage. It is a source for bromine atoms which can destroy ozone. Its use of has to be controlled.
- iii) **Control of deforestation:** Check in deforestation will ensure slightly higher percentage of oxygen in the atmosphere.
- iv) **Proper maintenance:** Air conditioning and refrigerating units should regularly be checked for leaks and corrected if any.



## ACID RAIN

Acid rain is a rain or any other form of precipitation that is unusually acidic (pH below 5.6). Natural rain water has a pH of 5.6 at 20°C because of formation of carbonic acid due to dissolution of CO<sub>2</sub> in water. Acid precipitation is a mixture of strong mineral acids sulphuric acid (H<sub>2</sub>SO<sub>4</sub>), nitric acid (HNO<sub>3</sub>) and in some locations, hydrochloric acid (HCl).

Acid rain literally means 'the presence of excessive acids in rain waters'. Acid rain can be wet or dry.



## Causes:

### i) Oxides of Nitrogen:

Oxides of nitrogen, represented by NO<sub>x</sub> is mainly responsible for acid rain. Automobile exhaust, factory emission contains large amounts of NO<sub>2</sub>. It is also emitted by natural processes like lightning, volcanic eruptions, forest fires, and action of bacteria in the soil.

Nitrogen dioxide (NO<sub>2</sub>) reacts with water to form nitrous acid (HNO<sub>2</sub>) and nitric acid (HNO<sub>3</sub>)



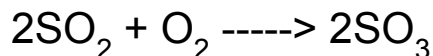
**ii) Oxides of sulphur:**

Oxides of Sulphur ( $\text{SO}_2$  and  $\text{SO}_3$  represented as  $\text{SO}_x$ ) are produced when fossil fuels containing sulphur are burnt. Small amounts are found in automobile exhaust. Large amounts of these gases are while processing of crude oil, in utility factories, and iron and steel factories.  $\text{SO}_2$  is also produced naturally by volcanic activity.

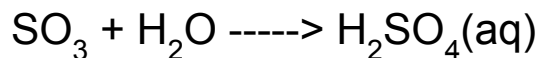
Sulfur dioxide reacts with water to form sulfurous acid ( $\text{H}_2\text{SO}_3$ )



Sulfur dioxide ( $\text{SO}_2$ ) can be oxidised gradually to sulfur trioxide ( $\text{SO}_3$ )



Sulfur trioxide ( $\text{SO}_3$ ) reacts with water to form sulfuric acid ( $\text{H}_2\text{SO}_4$ ):



## Effects of acid rain

### On plant life:

- i) **Loss of waxy coating on leaves:** Frequent acid rain dissolves the waxy protective coating of the leaves. This makes the plant susceptible to disease. When the leaves are damaged, the plant loses its ability to produce sufficient amounts of nutrition for it to stay healthy.
- ii) **Root damage:** Roots of plants are damaged by acid rain, causing the growth of the plant to be stunted, or even in its death.
- iii) **Death of micro organisms:** Useful micro organisms which release nutrients from decaying organic matter, into the soil are killed off, resulting in less nutrients being available for the plants.
- iv) **Loss of beneficial nutrients from the soil:** Acid rain washes away the beneficial minerals and nutrients in soil before the plants have a chance of using them for their growth.

## On animal life:

- i) **Heavy metal leaching:** Acid rain causes harmful elements like mercury and aluminium to be leached from the soil and rocks and it is then carried into the lakes where aquatic life may be affected.
- ii) **Death of aquatic organisms:** As the pH reaches 5.5, plankton, certain insects and crustaceans begin to die. At a pH of around 5.0, the fish population begin to die. Below pH 5.0, entire fish population may die.
- iii) **Loss of fertility:** It results in the fish's ability to maintain their calcium levels. This impairs reproduction the ability of the fish, because the eggs become too weak or brittle. This can result in killing of fish.

## In humans

- i) **Respiratory problems:** Acid rain can cause nose and eye irritation, headache, asthma and dry coughs. Acid rain can aggravate asthma.

## Buildings and monuments

i) **Deterioration of buildings:** It causes deterioration of buildings especially made of marble e.g. monuments like Taj Mahal. It caused the tarnishing of Taj Mahal (Dry acid deposition containing  $\text{SO}_2$  primarily from the exhaust of Mathura refineries. Oil refineries in Mathura emit nearly 25 tonnes of  $\text{SO}_2$  per day despite using low sulphur content coal).

ii) **Deterioration of objects:** Acid rain corrodes ceramic, textiles, paints, and metals. Rubber and leather deteriorate if exposed to acid rain. It damages metals and car finishes.

## Control of acid rain

- i) **Use of low sulphur content coal:** Coal with lower sulphur content is desirable to use in thermal plants.
- ii) **Replacement of coal by natural gas:** Replacement of coal by natural gas would also reduce the problem substantially.
- iii) **Reduction of NO<sub>x</sub> and SO<sub>x</sub> emission:** Emission of SO<sub>2</sub> and NO<sub>2</sub> from industries and power plants should be reduced by using pollution control equipments.
- iv) **Strict law enforcement:** Strict laws must be brought for air pollution reduction (especially CO<sub>2</sub>, NO<sub>2</sub> and SO<sub>2</sub>). Heavy fine must be imposed if accepted emission levels are crossed.
- v) **Use of renewable sources of energy:** Use of alternate eco friendly sources of energy can minimize pollutants and hence acid rain.
- vi) **Use of eco-friendly vehicles:** Pollutants can be minimized by using pollution control devices like catalytic converters in vehicles. Another method is the usage of natural gas as fuel in automobiles.



## NUCLEAR ACCIDENTS AND HOLOCAUST

The release of large amounts of nuclear energy and radioactive products into the atmosphere.

Nuclear energy was researched by man as an alternate source of energy compared to fossil fuels. Although this did happen along with the benefits came its downfall.

In the short history of nuclear energy there has been a number of accidents that have surpassed any natural calamity. A single nuclear accident causes loss of life, long term illness and destruction of property on a large scale.

## CASE STUDY 1.THE CARELESS SITING OF INDUSTRIES-Bhopal gas tragedy

The careless siting of industries and relatively poor regulatory controls leads to ill health in the. The Bhopal gas tragedy on December 2nd 1984, where Union Carbide's Plant leaked 43 tons of Methyl Isocyanate and other substances, used in the manufacture of pesticides is one of the worst industrial accidents in the recent past. Of the 5,20,000 people who were exposed to the gas - 8,000 died during the first week and another 8,000 later. The impact of the survivors is visible even today.



**Bhopal gas tragedy plant**

## 2. CHERNOBYL REACTOR INCIDENT

On April 25, 1986, Russian engineers and scientists begin preliminary tests on Chernobyl power plant's 4th reactor. In order to control the experiment, the automatic control system was shut down. After some work, stability was reached at very low power outputs.

Unfortunately, manual control of the water pressure wasn't maintained. The reactor began to create excess heat. Without the automatic control, the control rods couldn't be reinserted in time; a deadly chain reaction had begun. Within a matter of 3-4 seconds, the reactor went from 5% output to 100 times its normal level.

The water in the reactor flash-boiled, creating an explosion that leveled thousands of tons of concrete and steel, including the housing for the reactor. The steam carried almost 70% of the nuclear material out of the reactor into the surrounding environment.

Several thousand volunteers died on the scene, and it is estimated that 7,000 to 10,000 volunteers died in total, considering short and long-term effects. Thousands of miles from the scene, the birth defect rate became double the world average.

It is also estimated that 150,000 were put at risk for thyroid cancer, and over 800,000 children were put at risk of contracting leukemia. 2 million acres of land (1/5 of the usable farmland in the Ukraine) was, and still is, completely unusable.

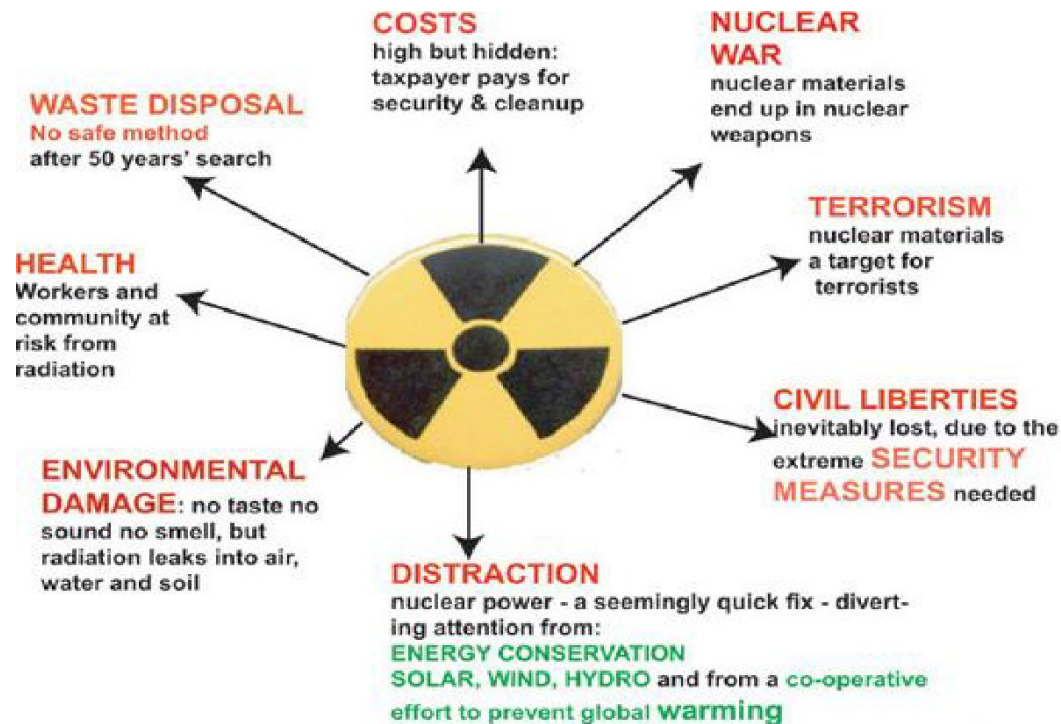
It remains difficult to determine the scope of the disaster; radiation resulting from the event was detected all over the globe. It is estimated that it may cost up to \$400 billion and will take up to 200 years to correct the damage done to the area, and to compensate those affected by the meltdown.



**Chernobyl Reactor**

## Effects

- Nuclear winter
- Ignition of all combustible material



## Effects of Nuclear Hazards Control Measures

- Suitable precautions to avoid accident
- Constant monitoring of the radiation level
- Checks and control measures done by Atomic Energy Regulatory Board.

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