

# **Impact of Coal Mining on Water Resources**

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# Introduction

The economic development of a region depends largely on the availability and optimal utilisation of mineral resources.

Developing countries such as India, have laid increasing emphasis on energy generation for achieving higher economic growth.

Even though oil, gas and water constitute important sources of energy, because of cheaper production, coal is the most popular source of energy.

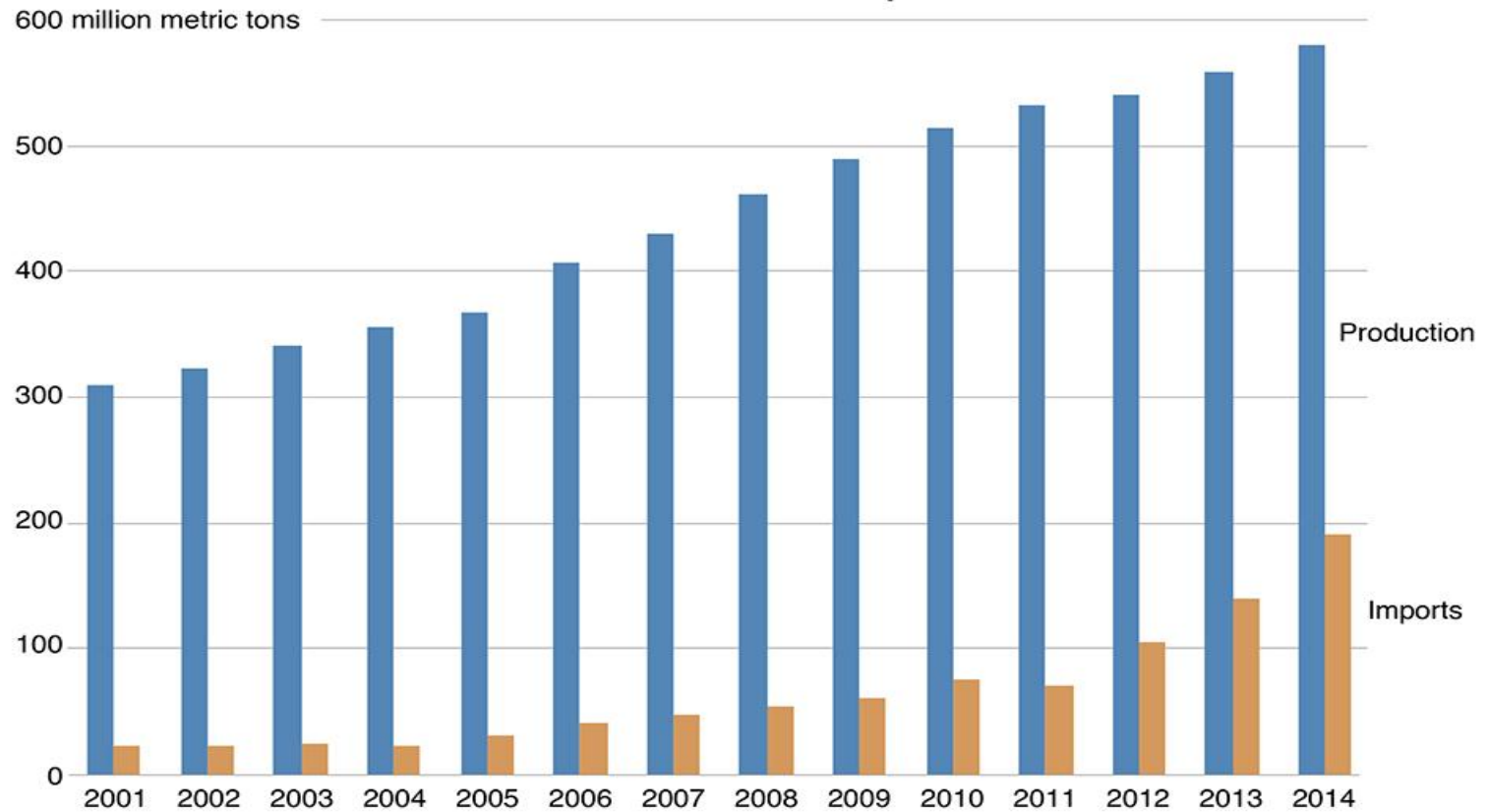
In India, Coal fired thermal power plants are increasing in number leading to an acceleration of coal mining.

The consumption of coal in thermal power generation has grown many fold from 34.5 mt in 1980-81 to 886.05 mt during 2012-13

The share of coal in the commercial energy has increased from 49.79% in 1970-71 to 67% by 2002-03.

With increased coal production, its negative impact on the environment has also intensified, rising concern over future coal mining.

### India's Coal Production and Imports

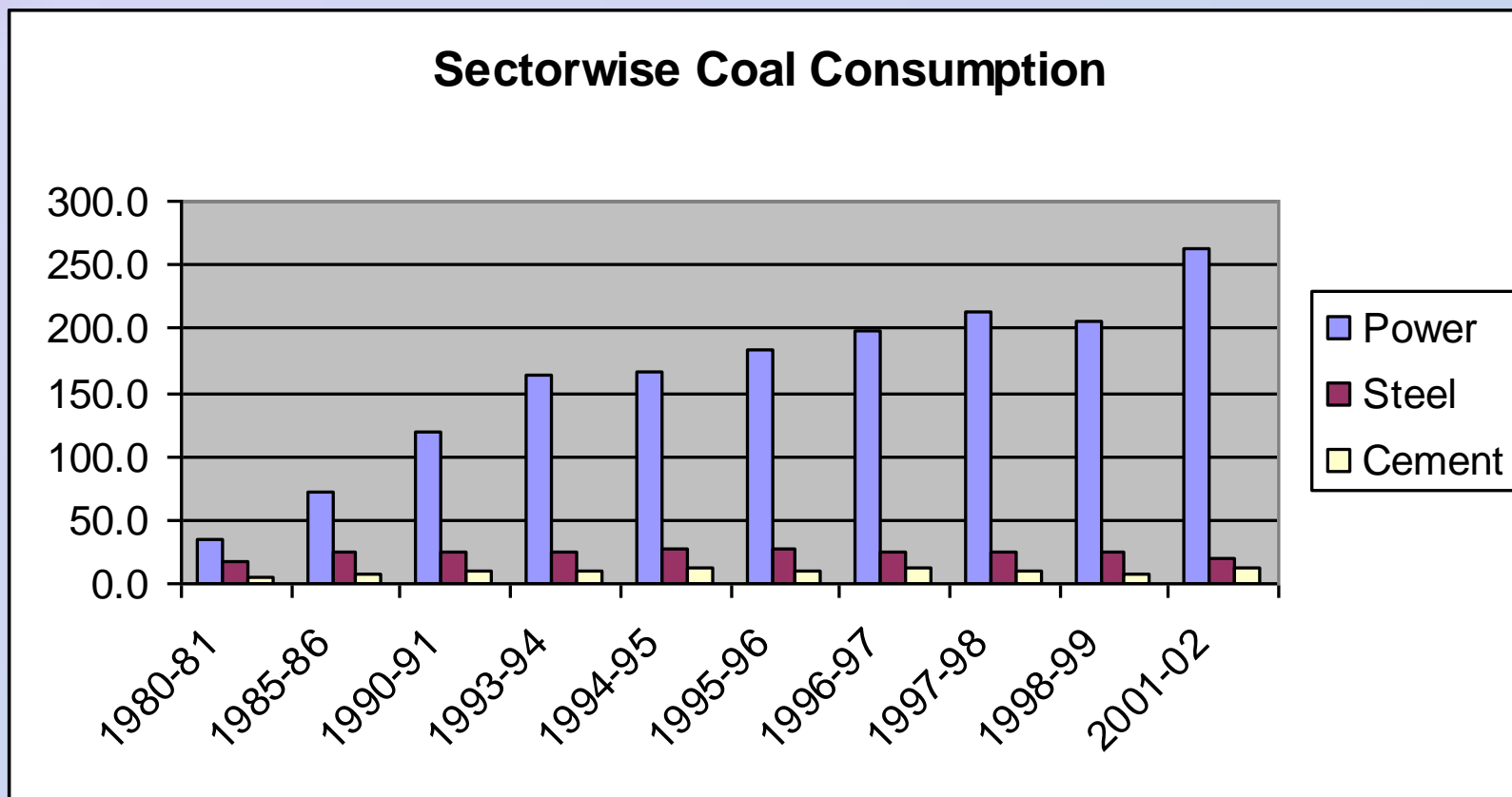


SOURCES: India Ministry of Statistics and Programme Implementation, India Ministry of Coal

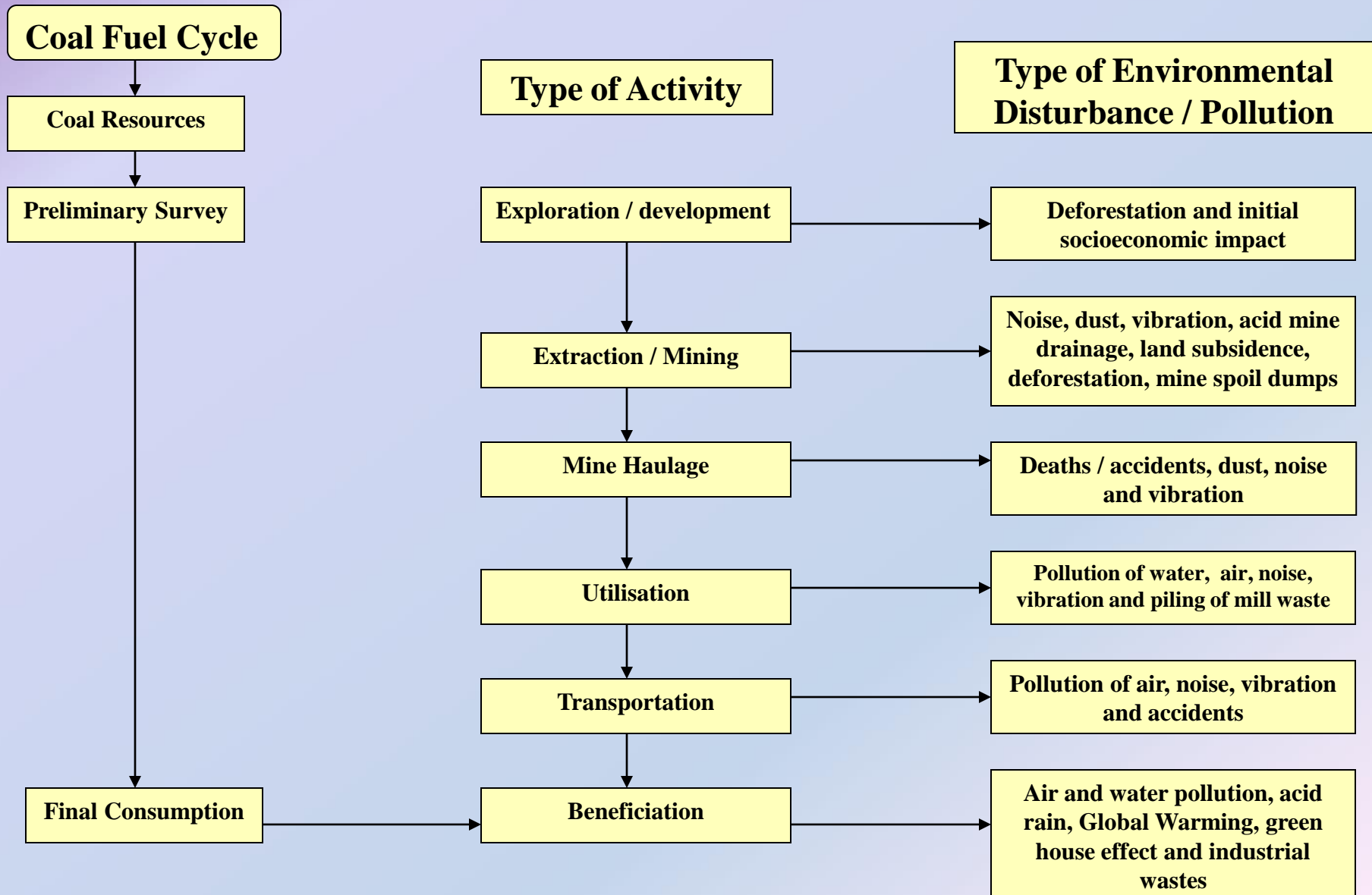
# Consumption of Coal

Year	Consumption	Change
1980	118,825.00	NA
1985	172,213.00	4.99 %
1990	243,345.00	6.93 %
1995	325,108.00	6.13 %
2000	393,630.00	3.76 %
2005	511,045.00	5.55 %
2010	746,261.00	4.12 %
2013	886,052.00	3.77 %

## Sector wise Coal consumption (in m.t.)



# COAL FUEL CYCLE AND ENVIRONMENTAL DISTURBANCE



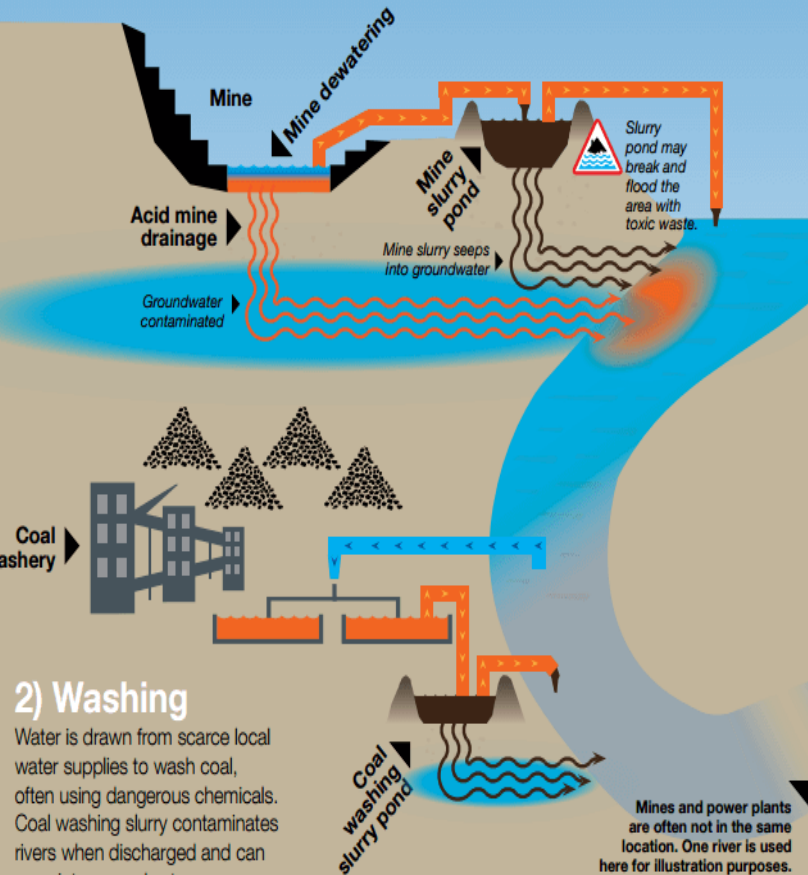
# Types of Environmental Impact

- Coal mining results in various environmental effects throughout coal fuel cycle. The various impacts of coal mining on environment can be grouped as under:
  - i)Impact of mining on land,
  - ii)Impact of mining on water,
  - iii)Impact of mining on air,
  - iv)Impact of mining on wild life and ecology,
  - v) Impact of mining due to blasting,
  - vi)Impact of mining due to transport and storage,
  - vii)Impact of mining on health and safety of workers and
  - viii)Socio-Economic impact of mining.

# Effects of Mining

## 1) Mining

Large quantities of groundwater are pumped out to access the coal. Mine slurry seeps into local water supplies. Acid mine drainage is a major cause of long-term pollution of surface and ground water and is notoriously difficult to treat.

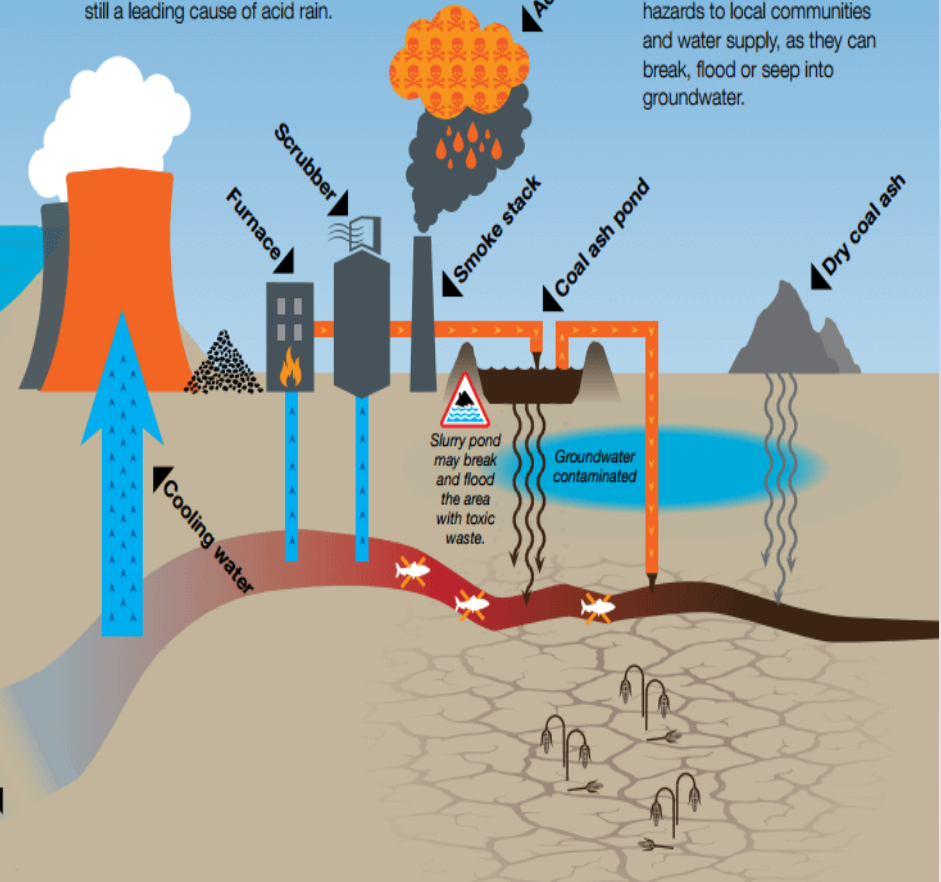


## 2) Washing

Water is drawn from scarce local water supplies to wash coal, often using dangerous chemicals. Coal washing slurry contaminates rivers when discharged and can seep into groundwater.

## 3) Cooling

Water is used for cooling, running the steam turbine and washing out the coal ash. A 500MW coal plant using once through cooling can empty an Olympic sized swimming pool of water every 3 minutes. Water is also needed to operate scrubbers to remove pollutants such as mercury, sulphur dioxides and nitrogen oxides. Despite that, burning coal is still a leading cause of acid rain.



## 4) Waste

Burning coal produces huge quantities of toxic waste which is stored in large coal ash ponds and ash dump sites. These coal waste impoundments are long term hazards to local communities and water supply, as they can break, flood or seep into groundwater.



# **Impact of Coal Mining on Land**

Irrespective of the type of mining used for extracting coal, mining invariably results in enormous land disturbance.

More than 80,000 ha of land in India are affected by various mining activities.

It is estimated that a total land of 539 sqkm is disturbed through opencast coal mining during the Tenth Plan period.

Open cast coal mining is being used extensively because of its cost effectiveness and productivity; despite large scale land disturbance.

Underground mining has considerably less impact but causes enough damage through subsidence e.g. Jharia and Raniganj coal fields.

Land reclamation is an important tool of counteracting the negative after-effects of coal mining, it helps in restoring land productivity, its ecological integrity and economic and aesthetic value.

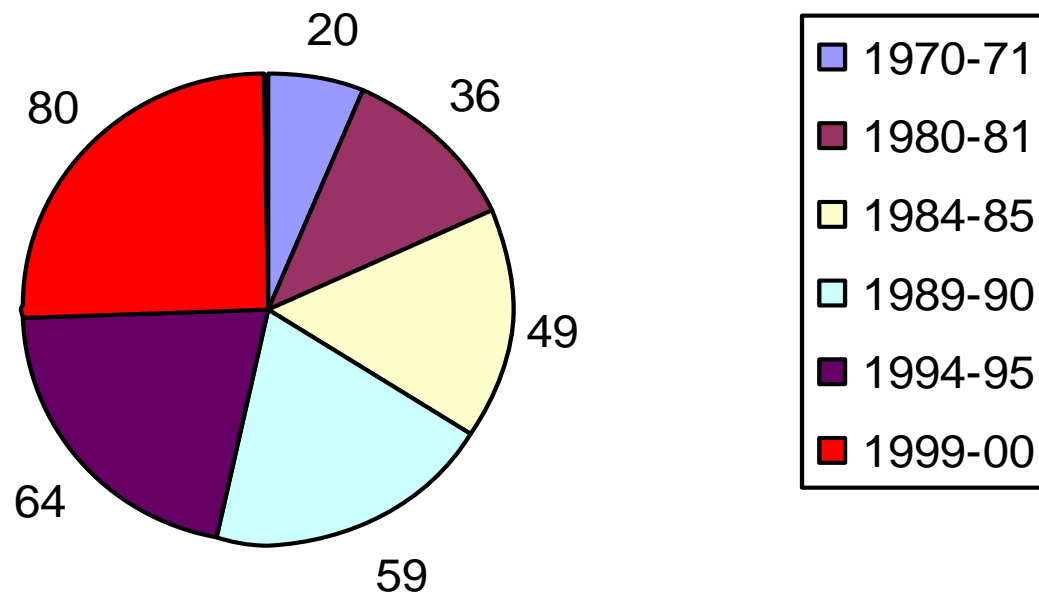
# Impact of Mining on Land







# Coal Production by Open Cast Mining (in percent)





# Initial work in mine development leads to environmental degradation



# Mine head impact in a box type mining



# Impact of strip mining



Fig. Impact of strip mining and consequent spontaneous combustion due to dereliction



# Large scale Coal mining and its impact





# Impact on Biodiversity/ Deforestation



# Landscape Damage

The ornamental stone extraction inevitably produces some negative consequences in the landscape



# **Impact of Coal Mining on Air**

Air pollutants originate from drilling, crushing, screening, blasting, coal washing, vehicular traffic and truck haulage. Transportation of coal from mines to plants is a major source of dust.

In order to control air pollution the following steps need to be taken.

1. The haul roads are to be sprayed with water to suppress dust
2. Tree Planting on the roadsides.
3. Dust suppression and extraction systems should be provided at crushing and grinding units.
4. Coal refuse should not be deposited on or near any refuse disposal area known to be burning.
5. It is essential to mix highly reactive coal refuse with inert material to minimise the ignition of coal refuse.



## Air Pollution at the Mine Head



# Truck transporting water to the Mining site



# INDIAN WATER CRISIS

- India has 2.45 % of the world's land area, 16 % of the population and 4 % of its water resources - yet water is an increasingly scarce resource, unless we learn to manage it better.

# **Impact of Coal Mining on Water**

Coal mining requires large quantities of water for dust control, fire protection and coal washing.

The average use of water in coal mining varies from 63 to 120 litres per metric tonne in underground mining and about 17 litres per tonne for surface mining.

In addition to this, 33 litres of water per tonne is required for waste disposal.

Coal processing also causes serious water pollution, e.g. it is estimated that the washery and beneficiation activities amount to dumping of 10-15% of coal into rivers such as Damodar.

The black-water produced through coal washing is a potential pollutant if it is discharged into streams without treatment.

Open ditches should be constructed to allow the flow of this run-off.

Other options such as recycling of wastewater, using mine water for irrigation wherever practicable and treatment of effluents before discharge.



# Types of mine water

- There are a number of classifications of mine water, which can vary in their quality and potential for contamination:
- **Mine water:** refers to any surface or groundwater present at the mine site
- **Mining water:** it is the water which has come into contact with any mine workings
- **Mill water:** the water used to crush and grind ore, may contain dissolved minerals and/or metals
- **Process water:** the water used in the chemical extraction of metals, commonly contains process chemicals
- **Leachate:** water which has trickled through solid mine wastes and may contain dissolved minerals, process chemicals, and/or metals
- **Effluent:** Mining, mill, or process water which is being discharged into surface water, often after being treated
- **Mine drainage water:** Surface or groundwater which flows or has the potential to flow off the mine site.



# Factors responsible for water contamination

- **Type of ore being mined:** Some ores, such as sulphide ores, are more chemically reactive than others, and have a greater tendency to dissolve and contaminate water.
- **Chemicals used in the mineral preparation and metal extraction processes:** Chemicals used to process metal ores include cyanide, sulphuric acid, and organic chemicals. A single mine may use a combination of physical and chemical processes to separate metals from ore.
- **Climate:** The amount of water available and potential for contamination at a mine site can vary depending on the climate.
- **Life stage of the mine:** Whether a mine is under construction, operating, or closed can affect its potential to contaminate water.
- **Environmental management practices in place:** Modern water management practices and mine designs greatly reduce the potential for water contamination at mine sites.
- Old abandoned mine sites have a higher potential to pollute nearby waterways.

# Groundwater Contamination



*Pumping of water from Cavrem Sheikh Salim mine, severely lowering  
groundwater table in the village  
Image courtesy: Sebastian Rodriguez, Mand Goa*





# Water logging in an abandoned Mine



*Barge carrying coal and iron ore on the Mandovi*



# Mining near Reservoir





# Mounds of Mining Waste



# Pollution due to processing of Ore Minerals





# Acid Mine Drainage (AMD)

- Acid Mine Drainage refers to the outflow of acidic water from metal mines or coal mines.
- Acid rock drainage occurs naturally within some environments as part of the rock weathering process. AMD is a potentially severe pollution hazard that can contaminate surrounding soil, groundwater, and surface water .
- The formation of acid mine drainage is a function of the geology, hydrology, and mining technology employed at a mine site.
- The primary sources for acid generation are sulfide minerals, such as pyrite (iron sulfide), which decompose in air and water. Many of these sulfide minerals originate from waste rock removed from the mine or from tailings.
- If water infiltrates pyrite-laden rock in the presence of air, it can become acidified, often at a pH level of two or three. This increased acidity in the water can destroy living organisms, and corrode culverts, piers, boat hulls, pumps, and other metal equipment in contact with the acid waters and render the water unacceptable for drinking or recreational use.

# Acid Mine Water





# Acid Mine Drainage





# Impact on Ground water



CEVALOR



# Ground Water pollution





# Land Degradation



## Deforestation & degradation





# Aforestation





# **Impact of Noise and Vibration in Coal Mining**

Coal mining involves a complex process of activities viz:

1. Removal of topsoil and overburden in case open cast method is used, driving shafts and adits for underground mining.
2. Extraction of coal through drilling, crushing, loading, hauling, handling and transporting of coal, and
3. Restoration of the disturbed land.

Noise is best controlled at source by choosing machinery and equipment suitably by their proper installation and by providing noise insulating padding.

The application of silencers, reactance mufflers, absorption mufflers etc. would reduce the noise levels.

# **Impact of Transport in Coal Mining**

Coal travels long distances through various modes during fuel cycle.

Road, rail, water, conveyer belt, aerial ropeway and slurry pipe lines are the main modes

The principal environmental impact of transportation of coal is the fugitive coal dust arising from loading, unloading, transportation and storage.

Both road and rail transport generate noise, vibration, and air pollution through dust and engine exhausts.

It has been estimated that 7 accidents occur per 10<sup>6</sup> vehicle-miles and there are 0.03 deaths and 0.5 injuries per accident during coal transportation by truck.

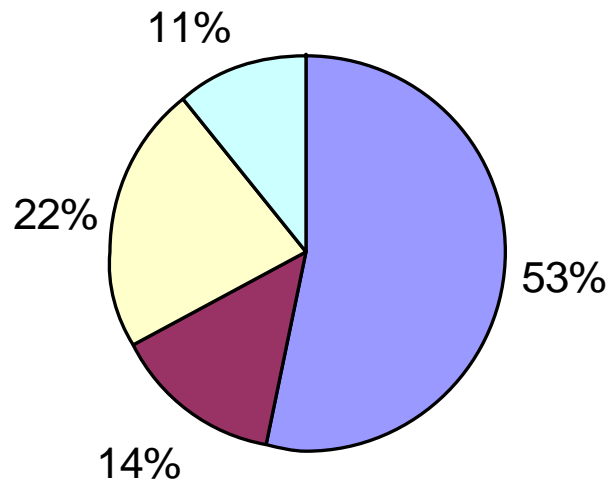
Railways, which carry 53% of the total coal transported, constitute the major system of coal transportation.

The quantum and direction of coal movement is governed by the coal linkages established between the coalfields and the consumer centers.

Even on a conservative estimate, approximately 0.04 % of coal (about 6 to 8 million tonnes of coal annually) is lost during loading/unloading and en route.

# Mode of Coal Transportation

**Mode of Coal Transportation & % share**



- (a) Railways
- (b) Road
- (c) MGR System
- (d) Other Belt Conveyor (Ropeways, Rail-cum-Sea Routes etc)

# **Impact of Coal Mining on Wild Life and Ecology**

Many of the coal deposits of India are located in thick forests that serve as abode for wildlife.

The damage is mainly caused by the human intrusion as well as machines, odour and noise; destruction of vegetation and other terrestrial habitats; and changes in water flow and the quality of water and air.

Often, tailing ponds may contain toxic solutions and oil scums which are great hazards to wild life.

The long term effects of mining depend on the adequacy of pre-mining planning and control and also on the success of reclamation.

After successful reclamation, an area damaged by mining may show increased carrying capacity for wildlife, especially if it is re-vegetated with mixed plant types.



# **Impact of Coal Mining on the Health and Safety of Workers**

Despite improved technology, there are still an alarming number of deaths and accidents in coal mines.

Heavy earth moving equipment in open cast mines constitutes the third biggest source of all fatal accidents.

The fatality rates in coal mines vary from country to country. India, with a fatality rate of 0.30 in 2000 ranks lowest in mine safety, while the France (fatality rate 0.13) has attained the highest level of safety.

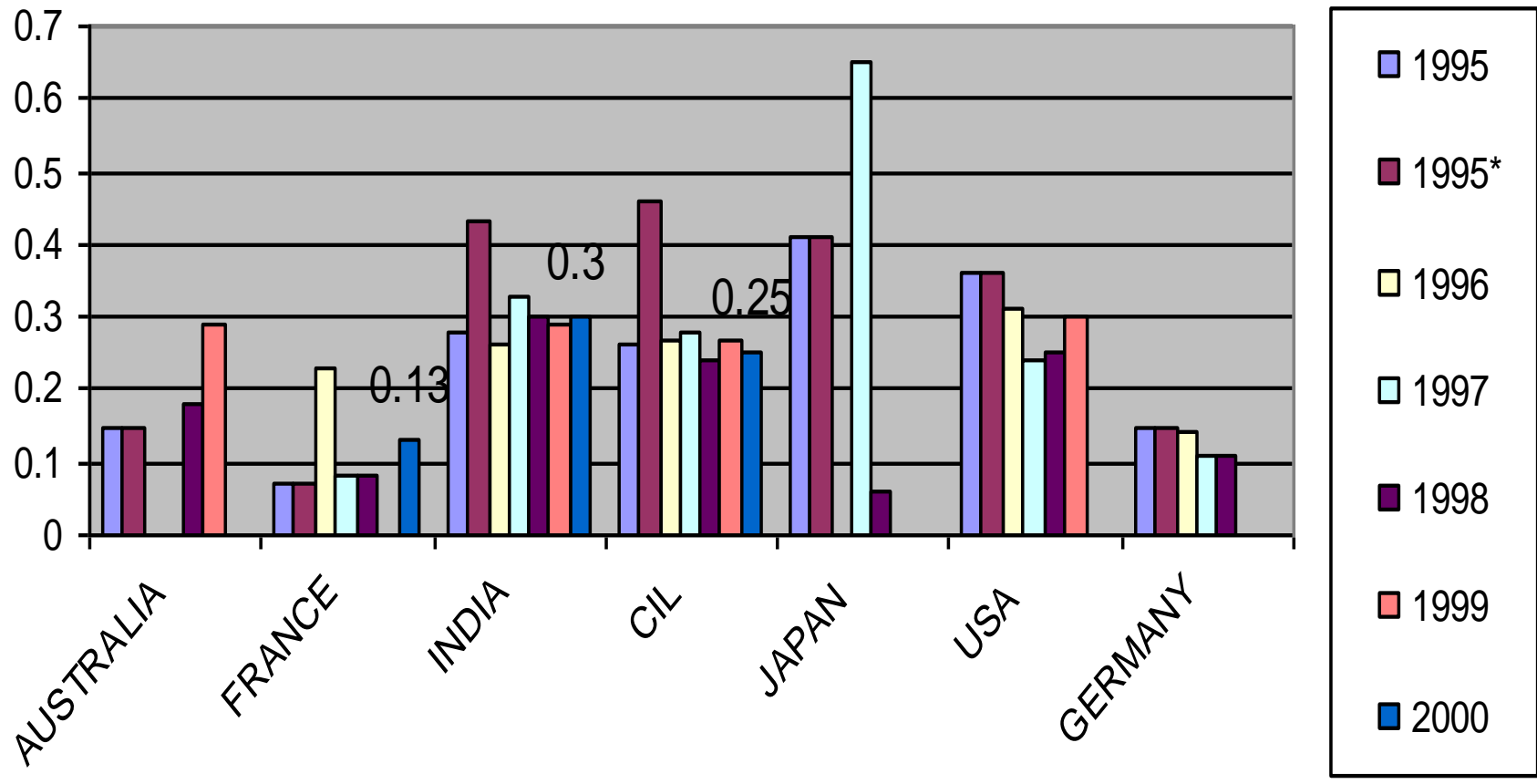
In terms of absolute data, CIL has registered 233 deaths (1975) - a figure which has gradually decreased to 68 (2002).

The total number of fatal injuries has declined from 1515 in 1975 to 397 in 2002.

For overall improvement in mine safety it is essential to create awareness among workforce through regular training

# Fatality Rate

## Fatality Rate per 1000 persons employed



# **Socio-Economic Impact of Coal Mining**

Mining is most likely to affect five aspects of a society: viz:

Population, Quality of living, Social and cultural systems, Economy and Technological systems.

The important factor that determines the extent of social impact is the size of the incoming labour force.

Mining communities experience social strain when the local population increases at an annual rate in excess of 4 to 5 %.

The mining impact on the society is largely dependent on the following four factors:

1. Method and size of the mining operation.
2. Duration of the operation.
3. Persons owning the operation and legislative controls currently in vogue.
4. The social, economic and political structure of the society

Strategies to combat, should include heavy investment in public facilities.

Participation and co-operation of old and new communities in adjusting to the new environment, and safeguarding it through self-awareness.

## **Policy Issues**

Environmental management consists of deliberate planning and administering policies to ensure environmental protection.

Involvement of specialists from various disciplines is needed in order to seek solutions and formulate policies.

A policy framework is imperative for ensuring that coal companies actually spend the investments allocated to them in respect of reclamation.

Balance should be maintained between the need to preserve the quality of environment and the economic goals and needs as the latter depend on the availability of energy.



# **Existing Policies and Legislations**

A new thrust was given to environment during the Seventh Five Year Plan which emphasized the need to prepare EMP

Though several legislations were enacted, (e.g. The Water (Prevention and Control of Pollution) Act 1974, & 1978; The Water Cess Act 1977 and 1978; The Forest (Conservation) Act: 1980; The Air (P&C) Act 1981, etc.) in order to protect the environment, their visible impact is yet to be felt.

Without additional financial support earmarked for ensuring environmental preservation, it is unrealistic to expect that the coal companies would abide by such policy suggestions.

## **Major Policy Issues**

There are some areas of main concern both from the economic and the environmental perspectives, to be considered while formulating policy. They are:

1. Productivity,
2. Method of Mining,
3. Pricing of coal,
4. Mine safety,
5. Environmental Impact Assessment and
6. Conservation

## **Alternative Strategies to meet the Energy Requirement**

Indian economy is bound to be increasingly energy-intensive

In technological terms, there are basically two solutions to the problem - one a short-range and the other a long-range solution.

The short-range solution consists of enforcing environmental control on the existing mines at whatever cost.

The long-range alternative lies in finding a permanent solution through R&D, to discover a viable alternative method that would eliminate or minimize the environmental problems.

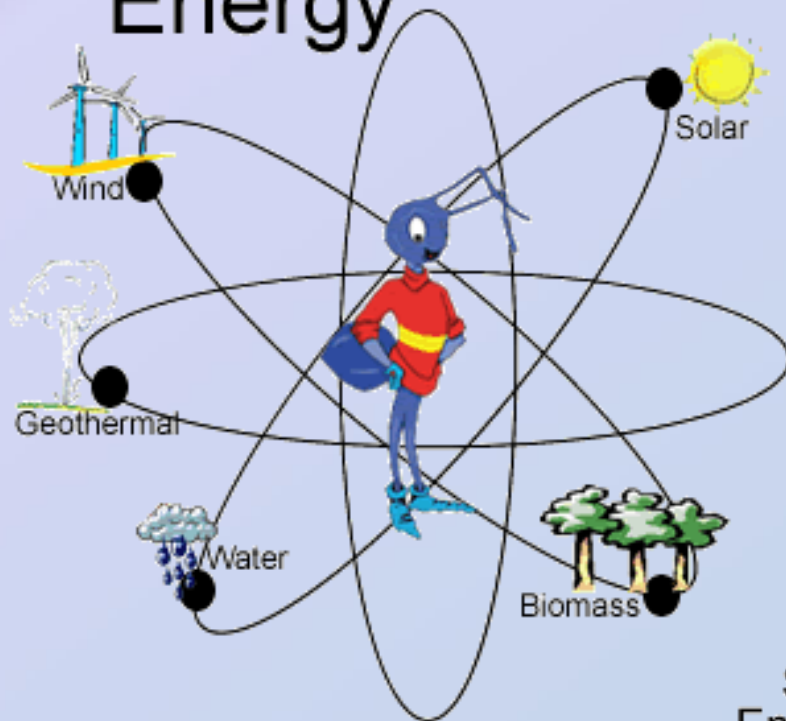
Such alternatives ought to include conservation, efficient utilization, substitution of energy preferably by renewable energy sources and technological innovations and improvements, both to supplement energy and to restore the ecological balance.

Future development of energy should always take into account the immediate needs of the poor people in rural areas.

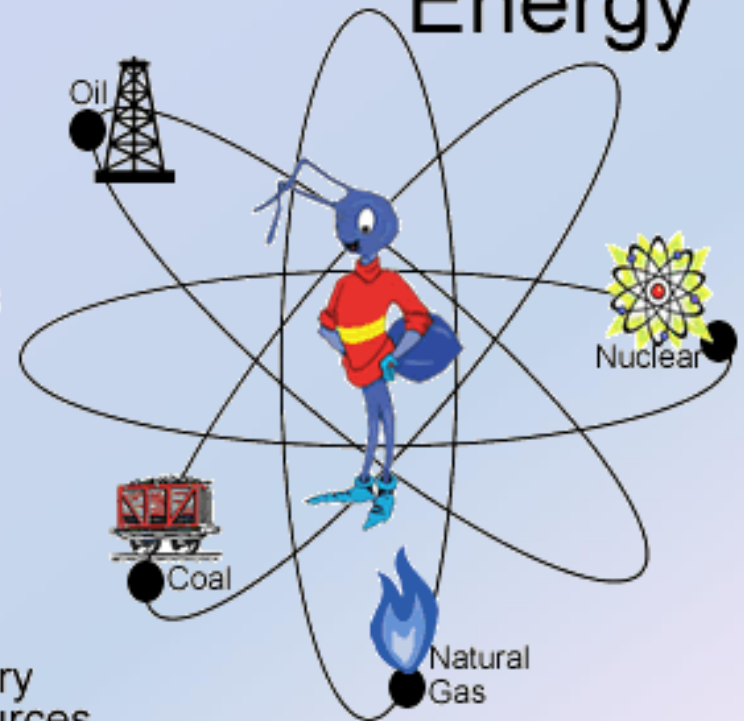
The most viable alternative is to plan for tapping more and more renewable energy sources such as, solar, hydro, wind, tidal etc. to substitute the coal energy.

# Harness non conventional and renewable energies

## Renewable Energy



## Non-Renewable Energy



Secondary  
Energy Sources

# Harness wind energy through wind mills

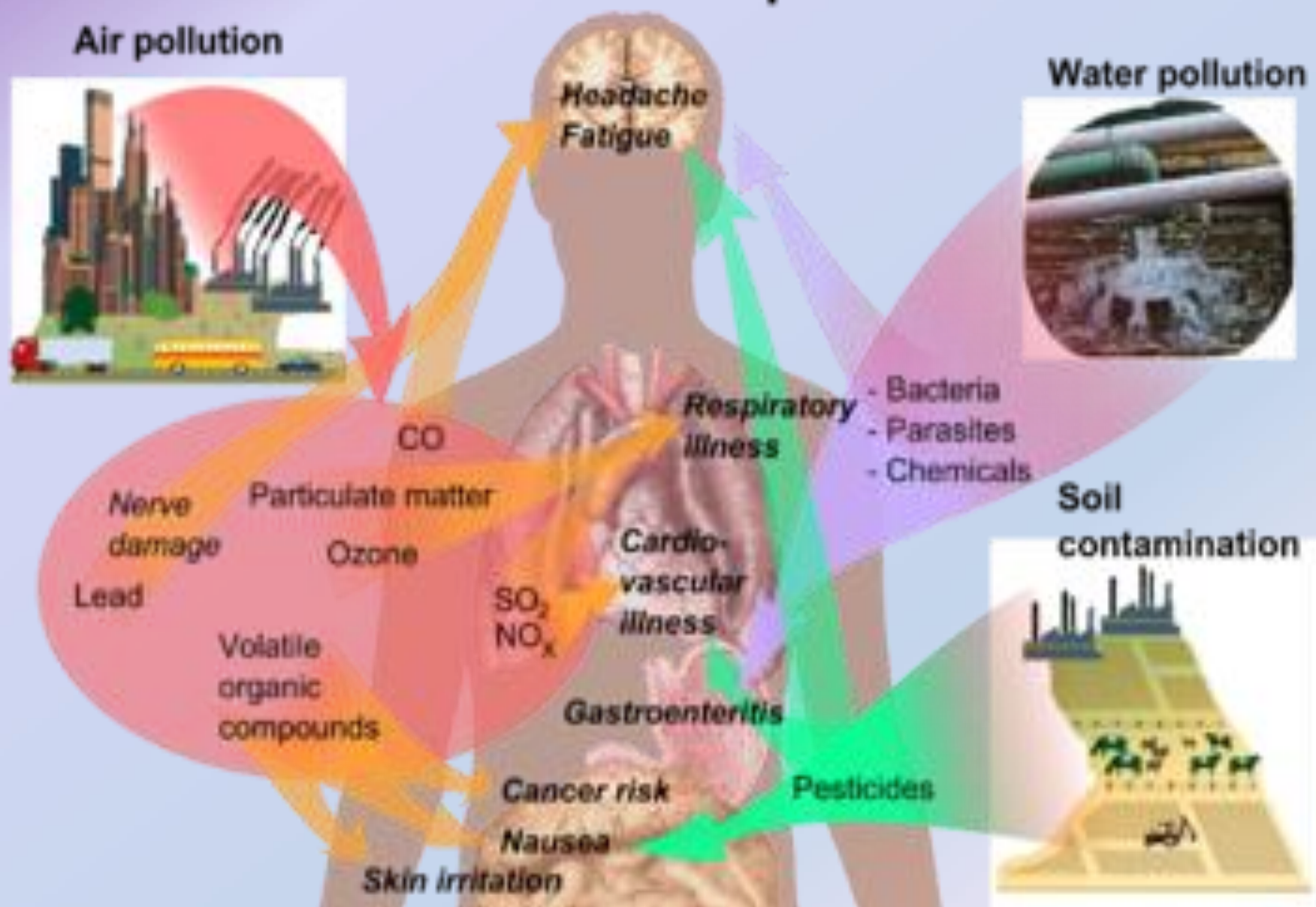




# Solar Energy



# Health effects of pollution





# Conclusions

- Coal would continue to serve as the primary energy source.
- The increased demand would result in increased coal mining and consequently the concern over its environmental impacts.
- Coal mining affects environment in multiple ways and Surface mining in particular causes severe damage on the environment compared to Underground mining.
- The employment of underground technique, longwall mechanized method in particular, should be preferred in the future.
- In the long run, coal mining may not turn out to be beneficial unless land reclamation policies are strictly enforced.
- It is essential that coal mining and consuming industries to incorporate provisions for the proper restoration of the mined land, as an integral part of the original mine plan as well as its operation.
- Even though mining brings in its wake several disasters, it is also beneficial to society.
- It is essential to strike a balance between mineral development on the one hand and the restoration of the environment on the other.

“You can have anything you want  
If you want it badly enough.  
You can be anything you want to be,  
Do anything you set out to accomplish  
If you hold to that desire with  
Singleness of purpose”

**Abraham Lincoln**





**THANK YOU**