

Environmental Studies - Introduction

An Update on Major Environmental Issues, and an Introduction to
Environmental Science and Sustainability

Definition : It deals with every aspect that affects a living organism. It is essentially a Multidisciplinary approach that bring about an appreciation of our natural world and human impact on its integrity.

Objectives of EVS

Awareness

Knowledge

Attitude

Skill

Participation

Importance of EVS

EVS enlighten us about the importance of protection and conservation of our environment.

EVS has become significant for the following reasons:

Environmental issues being of international importance.

Problems cropped in the wake of development.

Explosive increase in pollution.

Need for an alternative solution.

Need to save humanity from extinction.

Need for wise planning of development

Benefits of EVS

Conservation of energy and fast depleting natural resources.

Increase in economic productivity.

Imparting knowledge about waste management, treatment and disposal.

Develop social responsibility towards environment protection.

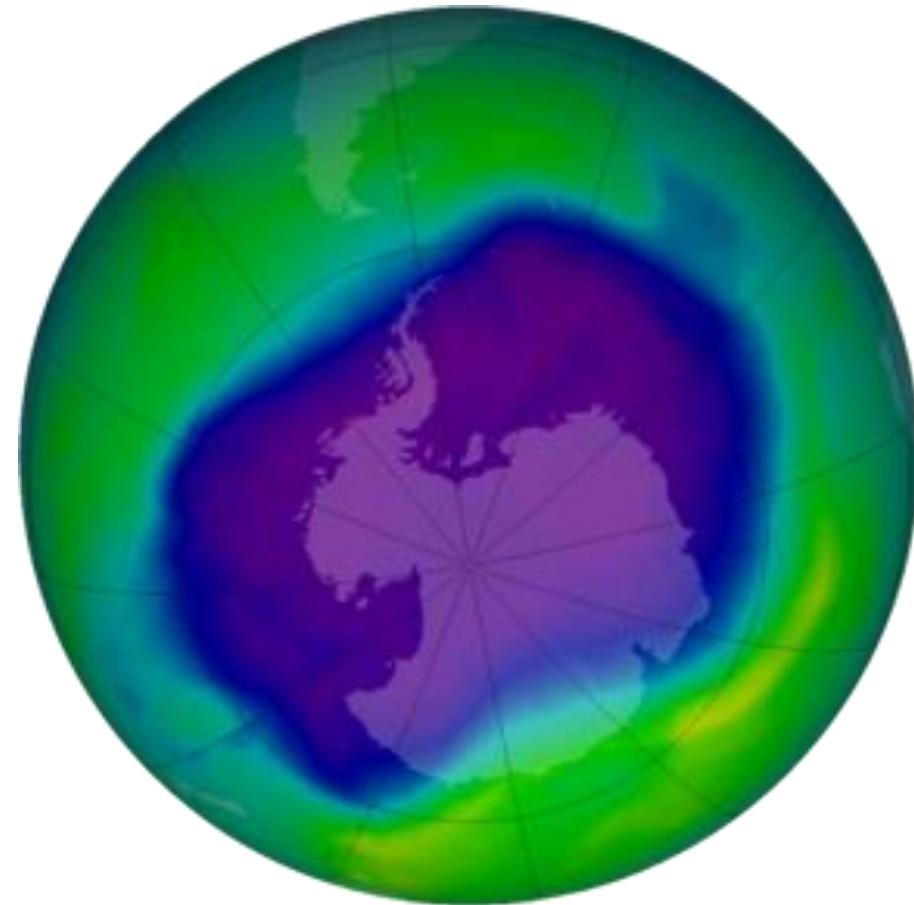
Creating awareness to control population.

Inculcating attitude and values towards understanding interdependence of nature, man and work towards sustainable development.

Major Environmental Issues

- Ozone Layer Depletion
- Pollution
- Extinction
- Global Warming
- Resource Depletion

Ozone Layer Depletion



Source: *wikimedia*

- Ozone is a gas in the stratosphere which converts the incoming UV radiation from the sun into infrared rays by what is known as the **ozone-oxygen cycle**.
- In the above diagram, the blue part is the “ozone hole” over the Antarctic. It is the part of the stratosphere where the concentration of Ozone is very low.



Ozone Layer Depletion- Solved!

WIRED

Technology | Science | Culture | Gear | Business | Politics | More ▾

Meet us at WIRED Smarter this October

BOOK TICKETS

Hole in the ozone layer 'solved' reports Nasa



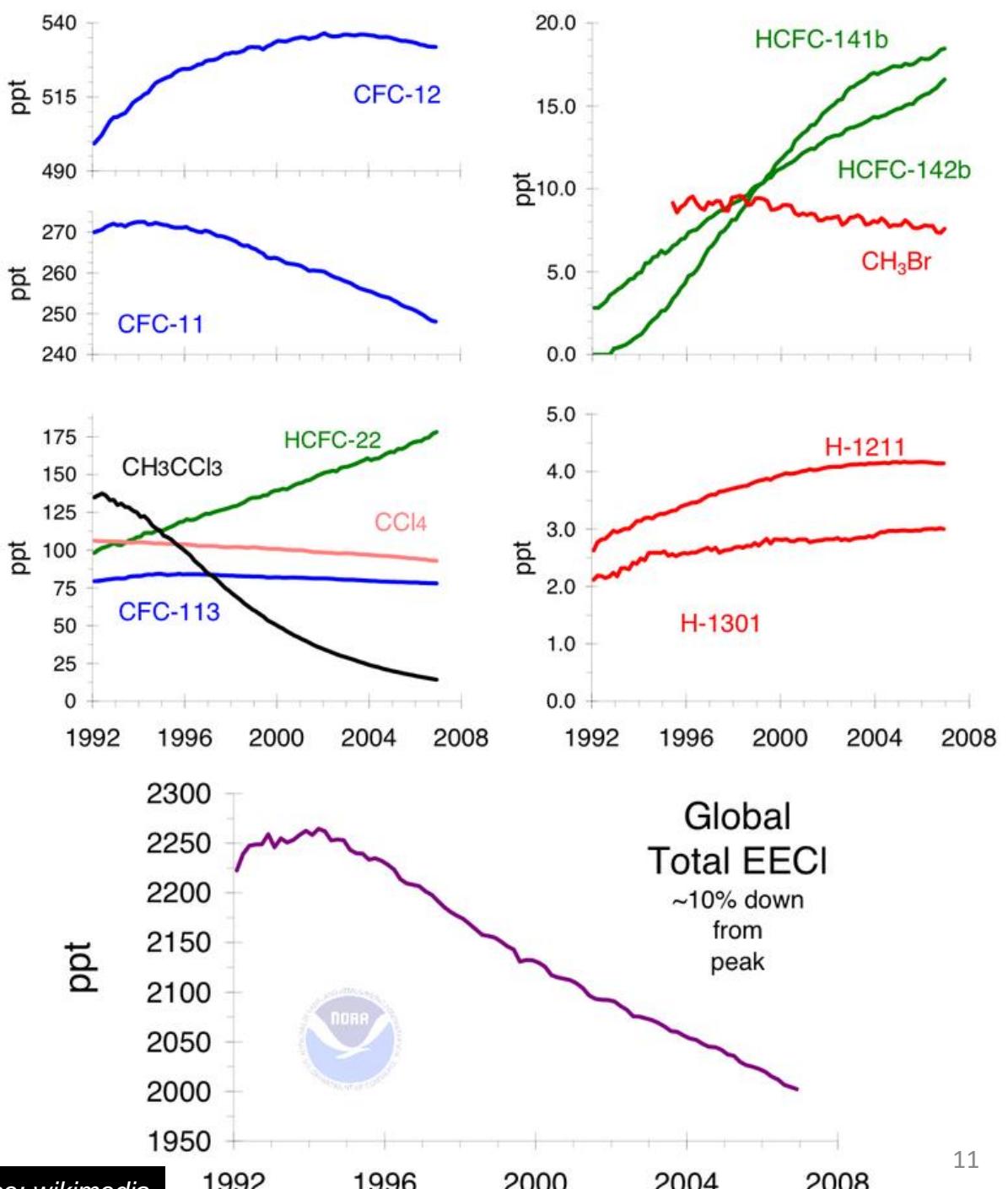
By MICHAEL RUNDLE

Thursday 7 May 2015



- It is a problem we have successfully solved by imposing a worldwide ban on CFC and other Ozone Depleting substances via the Montreal Protocol (1987).
- The “Ozone hole” is expected to close by 2040.

Trends of various Ozone-depleting gases like HCFC,CFC, Bromomethane, carbon tetrachloride



- These are the trends of the ozone-depleting gases in the atmosphere. Only a few gases like HCFCs are on the rise but are expected to be phased out by 2030. Other slight rises are due to weak regulation in East Asian countries and are expected to go down as well as those countries become more developed and impose regulations more stringently. Overall, Ozone hole issue has been declared as resolved. The only reason one should discuss this problem now is to understand how the entire planet came together to solve this very complex problem. These lessons can be used to solve other, much pressing, environmental issues.

Major Environmental Issues

Ozone layer Depletion

Pollution

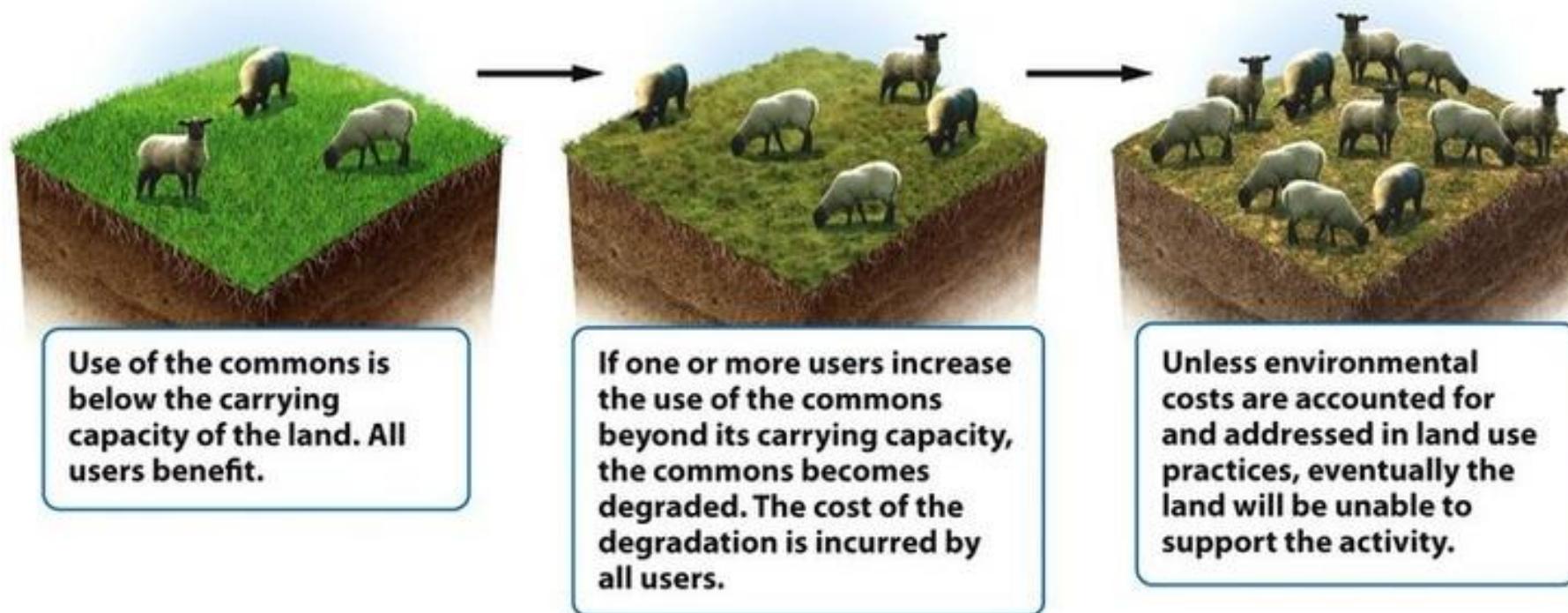
Extinction

Global Warming

Resource Depletion

Tragedy of the Commons

Tragedy of the Commons

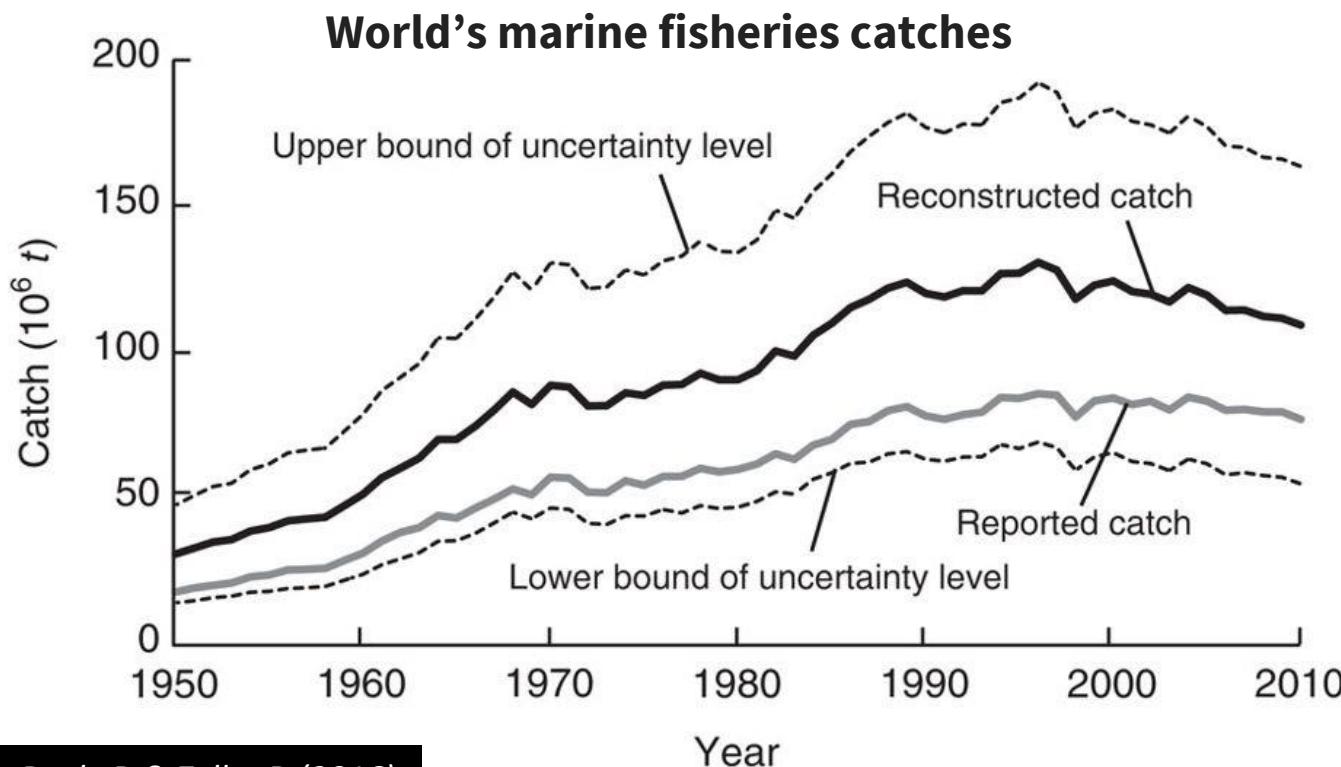


Source: NTU

“Tragedy of the commons” is a term that was first used to explain how the exploitation of common grazing lands by farmers in Great Britain and Ireland. It is a situation where on a jointly owned resource like grazing land, river, air, roads etc. (otherwise called commons), individuals acting independently based on their own self interest will cause harm to the resource and to the benefit of all the users from that resource. In the short run, the individuals acting on their self interest will benefit by shifting the burden of maintenance of the commons on the other parties, but eventually everyone will suffer from the degradation of that resource. Hence the word tragedy is used.

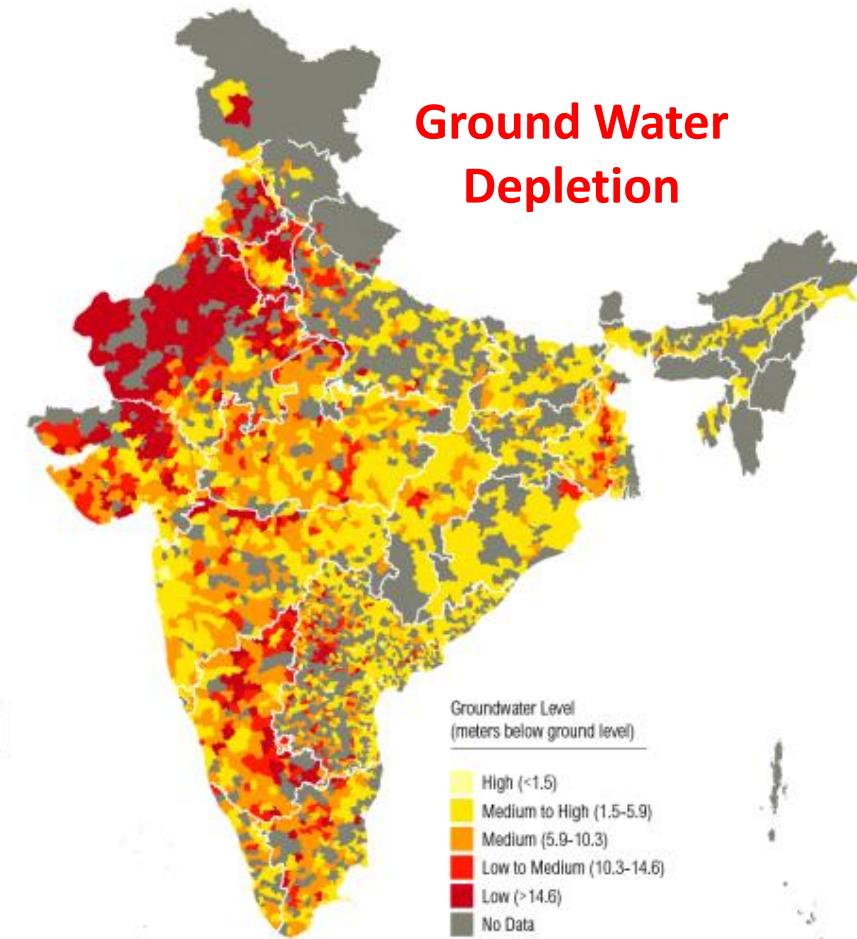
Examples of Tragedy of the Commons

Overfishing



54%
of India's
Ground-
water
Wells Are
Decreasing

www.indiawatertool.in



WORLD RESOURCES INSTITUTE

Ground water is a tragedy of the commons issue because underground water is a commons property. Individuals extract water from their bore wells but the underground aquifer is common to all. If one extracts heavily, it affects the supply of others. The graphic on the right shows this tragedy happening in India as of today.

Overfishing is commons problem because though fish stocks are a renewable resource, they are common to all fisherman and are renewable only if they can breed in the same numbers as they are being extracted. If some fishermen over extract fish, the other fishermen have a lesser fish stock to fish, straining the overall population of fish. As a result, each subsequent population of fish will be smaller than the previous causing a “tragedy” for all. In the short run, some fishermen who exploit are benefited but in the long run everyone suffers as their catch decreases. In the graph you can see the global fishing catch declining, heralding the tragedy of this commons.

Solutions?

- Government Intervention?
- Privatization?
- Local Management?
- Is there a technological solution?

There is no definite solution

Nobel Prizes and Laureates

Prize in Economic Sc

◀ 2009 ▶

► About the Prize in Economic Sciences 2009

▼ Elinor Ostrom

Facts

Biographical

Prize Lecture

Prize Presentation

Interview

Diploma

Photo Gallery

Other Resources

► Oliver E. Williamson

All Prizes in Economic Sciences

All Nobel Prizes in 2009



The Sveriges Riksbank Prize in Economic Sciences in Memory of
Alfred Nobel 2009
Elinor Ostrom, Oliver E. Williamson

Share this: [f](#) [g+](#) [t](#) [+](#) 42 [e-mail](#)

Elinor Ostrom - Facts



Photo: U. Montan

Elinor Ostrom

Born: 7 August 1933, Los Angeles, CA, USA

Died: 12 June 2012, Bloomington, IN, USA

Affiliation at the time of the award: Indiana University, Bloomington, IN, USA, Arizona State University, Tempe, AZ, USA.

Prize motivation: "for her analysis of economic governance, especially the commons"

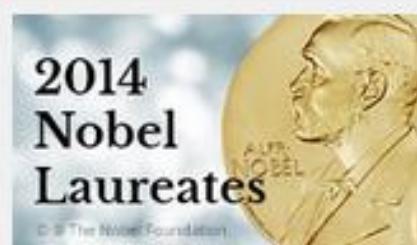
Field: economic governance

Contribution: Challenged the conventional wisdom by demonstrating how local property can be successfully managed by local commons without any regulation by central authorities or privatization.

Join us
on Facebook

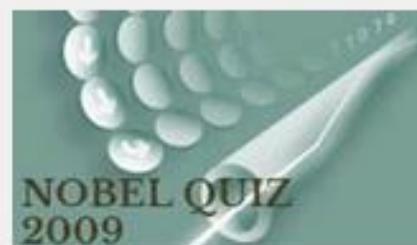


Summer Listening:
Six Lectures



2014
Nobel
Laureates

© The Nobel Foundation

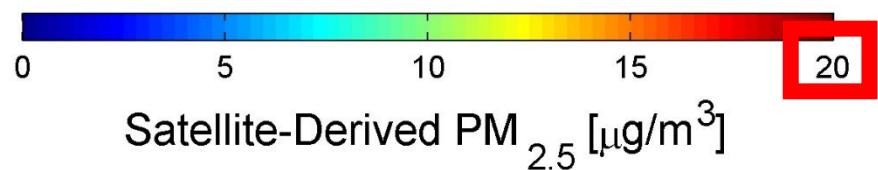
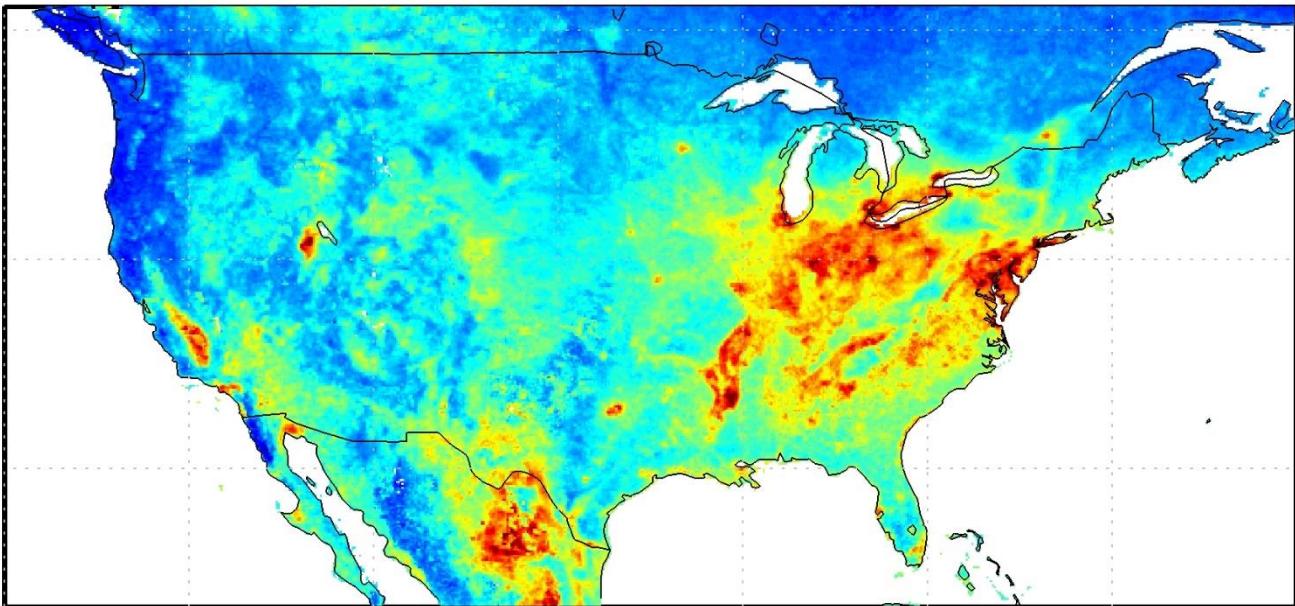


NOBEL QUIZ
2009



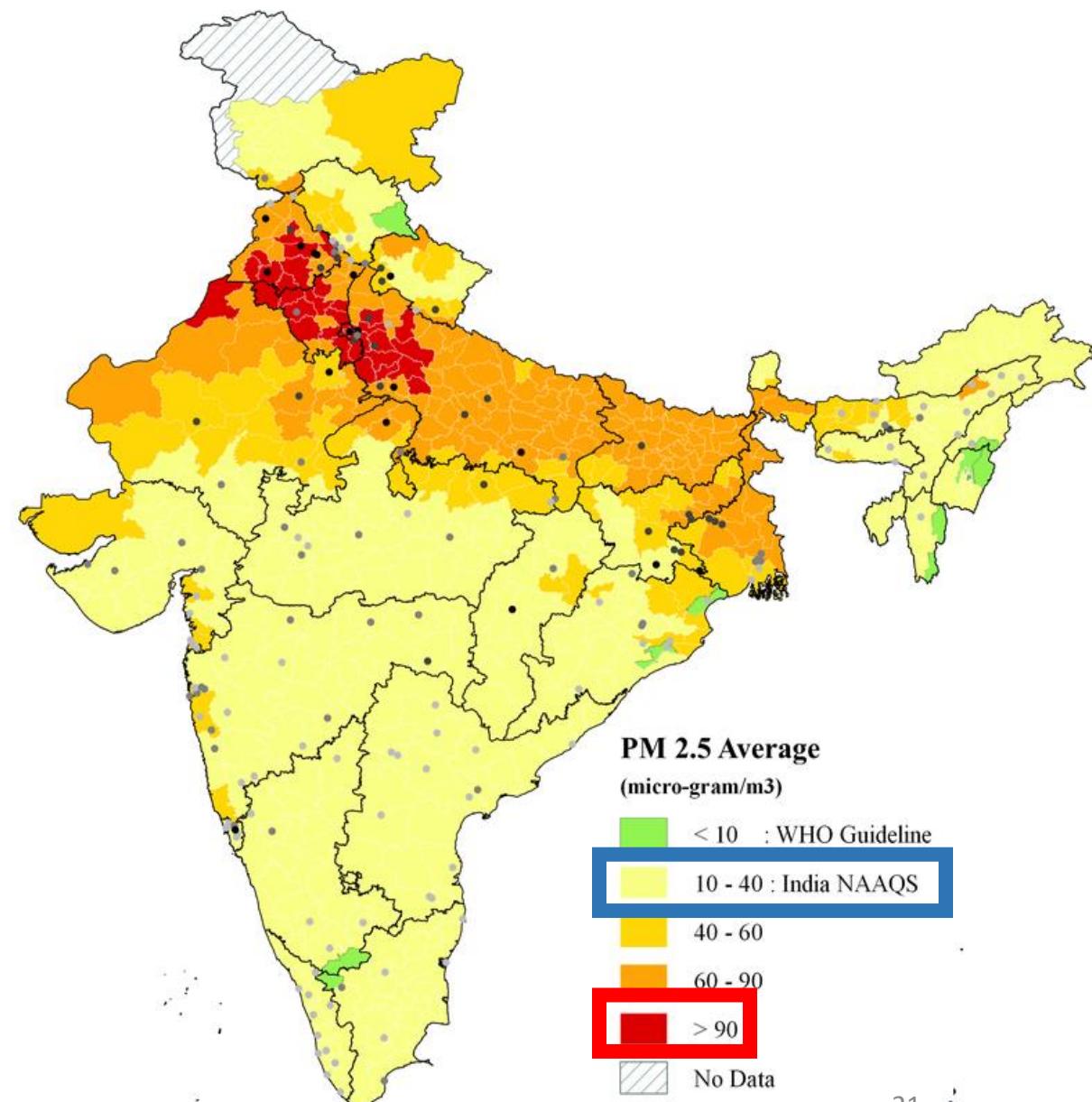
Explore the
Nobel Prize
Talks Podcast

Elinor Ostrom is the first woman to win the Nobel Prize in Economics. She won it for her work that showed for the first time that the local commons can be successfully managed by locals without any regulation by government or privatization. Till her work was seen, it was assumed that only the latter two options existed for solving this problem.



NASA

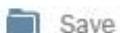
Pollution



- Pollution is a serious problem in India. To give an example of how bad it is, take the case of Air Pollution. On the left is a map of the United States PM 2.5 (considered one of the most serious pollutant for human respiratory health) concentration in the atmosphere. US follows the WHO guidelines which says that up to 10 ug/m³ is safe, after which it is can be detrimental. The scale in the US map reflects this with 10 ug/m³ designated as green. The highest that scale goes to is 20ug/m³. If the PM2.5 goes to this level, they usually announce health advisory and generally discourage people from going out of their houses.

Cutting Through India's Smog

By THE EDITORIAL BOARD FEB. 23, 2015



mistress
america
august 14



This story is
included with your
NYT+ subscription.

Educators and Students Get unlimited digital access at the Education Rate.

Proof of the grave air pollution problem confronting India is seen not just in the suffocating smog that on many days crowds out the sun in New Delhi, the world's most polluted city. It can be measured as well in the fact that the country has the world's highest death rate from chronic respiratory diseases, which kill an estimated 1.5 million Indians every year. A 2014 World Health Organization report concluded of the 20 most polluted cities in the world, India has 13.

After years of denial and indifference, ordinary Indians appear to be waking up to the dangers of relying on some of the dirtiest energy sources on the planet, including coal, diesel oil and burning garbage, to sustain economic growth and an exploding population. Yet the government has failed to address with any urgency what is



New Delhi Tsering Topgyal/Associated Press

It is of no surprise then that we have one of the highest death rate related to chronic respiratory issues. And of the 20 most polluted cities in the world, we are home to 13. As shown in this article from New York Times.

Earth has entered sixth mass extinction, warn scientists

Humans are responsible for so many species dying out that we are now in a sixth mass extinction, Stanford University has warned





The last mass extinction saw the dinosaurs wiped out. Photo: Alamy



By Sarah Knapton, Science Editor
7:00PM BST 19 Jun 2015

[Follow](#) | 5,956 followers

Earth has entered its sixth mass extinction with animals now dying out at

Search - enhanced by OpenText

Saturday 01 August 2015 |  UK News feed



MANIPAL
ACADEMY of HIGHER EDUCATION

(Deemed to be University under Section 3 of the UGC Act, 1956)


The Telegraph 
[Like Page](#) 2.4m likes


A website in 3 minutes!
Using The Grid, the world's first artificial intelligence platform that designs websites.
"The Future"
FST@MPANY
[FIND OUT HOW](#)


Bin Laden relatives killed in Hampshire plane crash

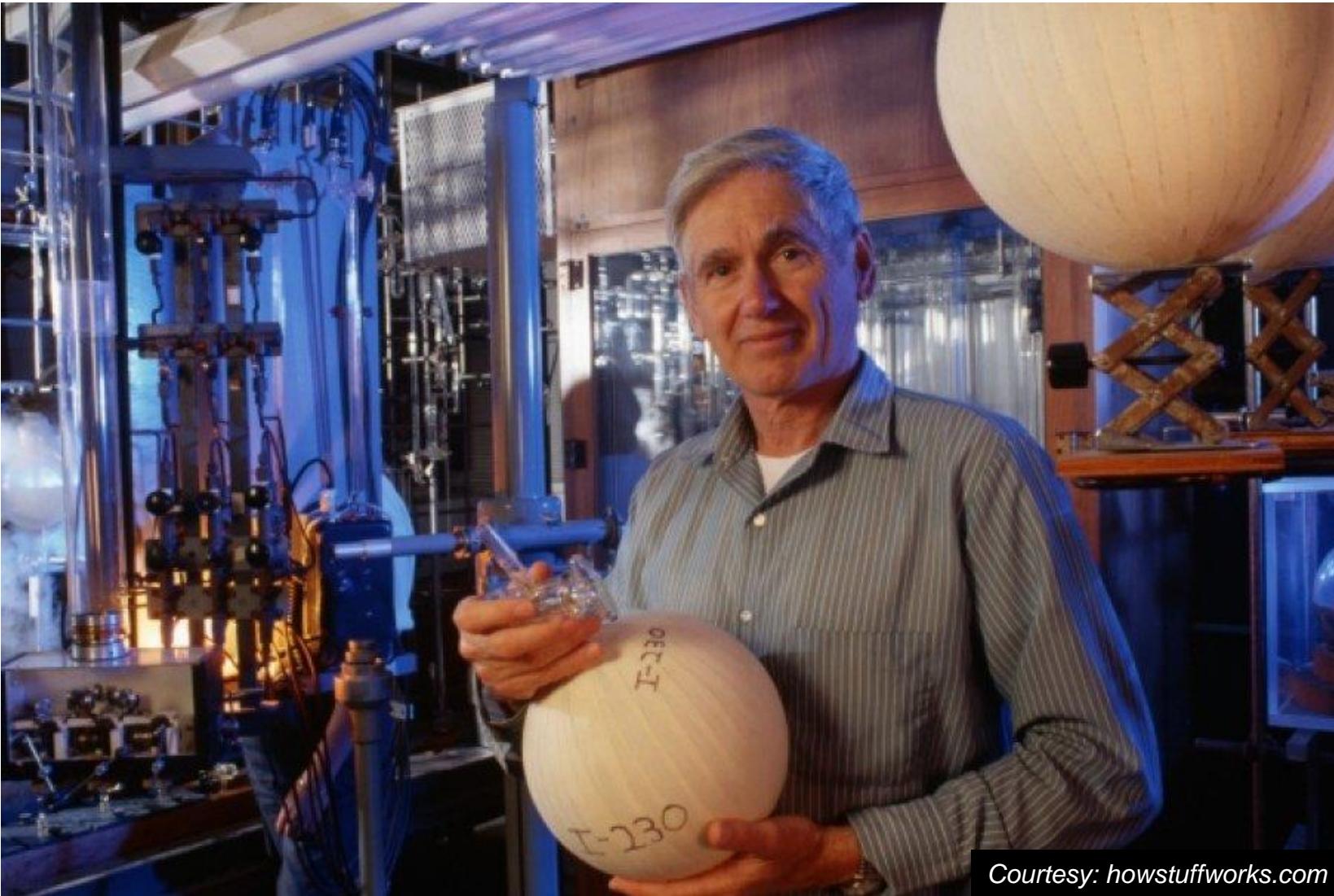

RAF intercepts Russian jets in single patrol


BBC reporter uses invisible iPad in bizarre bulletin sign-off


Migrants break through police line in Calais

Extinction

- Though we know extinction is happening, what is surprising is the rate at which it is happening. It is so fast that scientists now think that the 6th mass extinction has begun. In many instances, we are losing species faster than we are discovering them.



Courtesy: howstuffworks.com

Charles David Keeling

- To understand this, it is important to look at the work of Charles David Keeling. He was a geochemist who built the first instrument to take precise measurements of CO₂ in the atmosphere and took preliminary readings from Mauna Loa in Hawaii. Before his work, the CO₂ measurements in the atmosphere varied quite a bit and were wholly unreliable. Mauna Loa was chosen as the first test site because it is away from the mainland US and as winds come from the ocean to the mainland, the readings he would get would not be contaminated by local influence such as cars and industries. He would truly get the average conc. of CO₂ in the atmosphere.

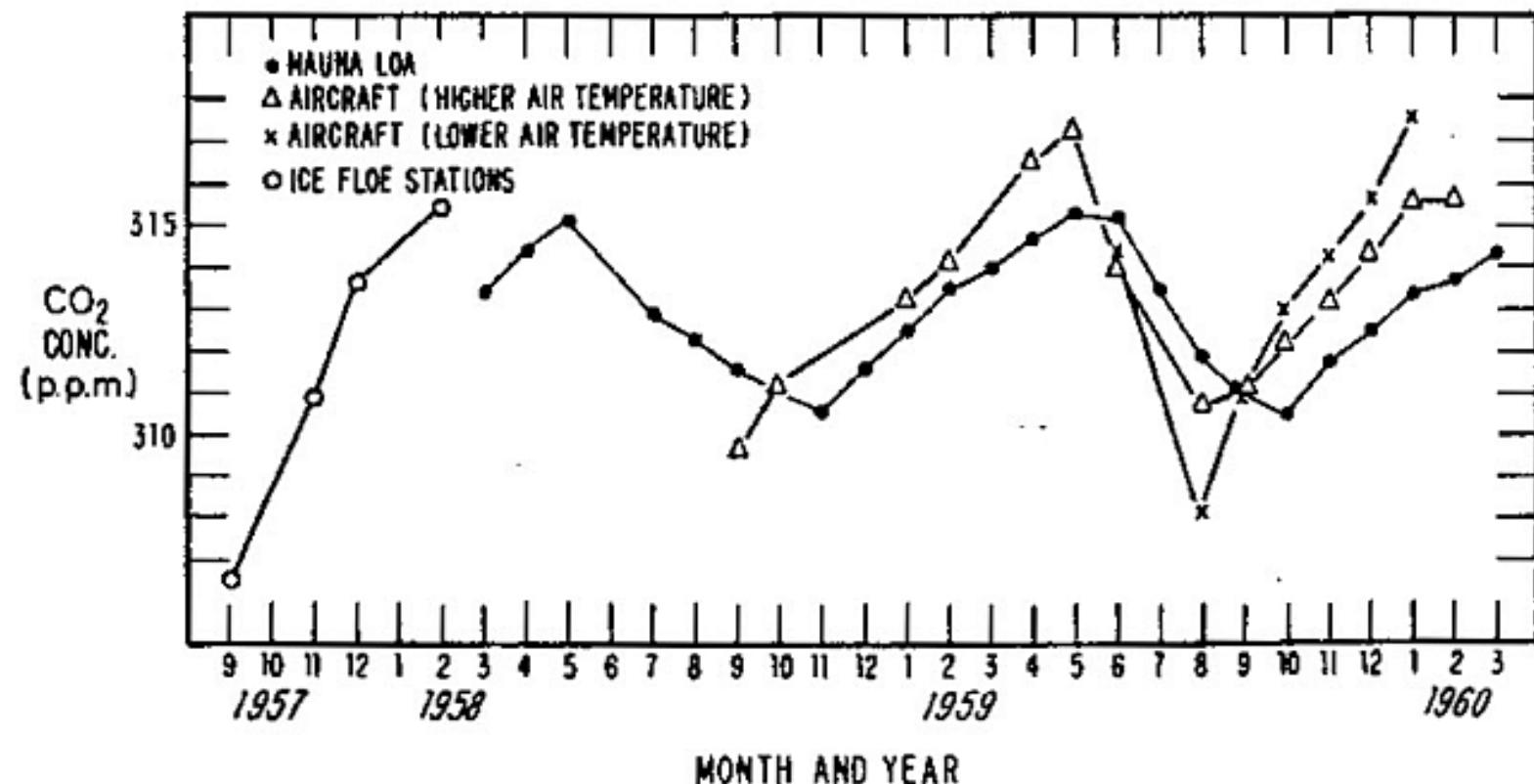
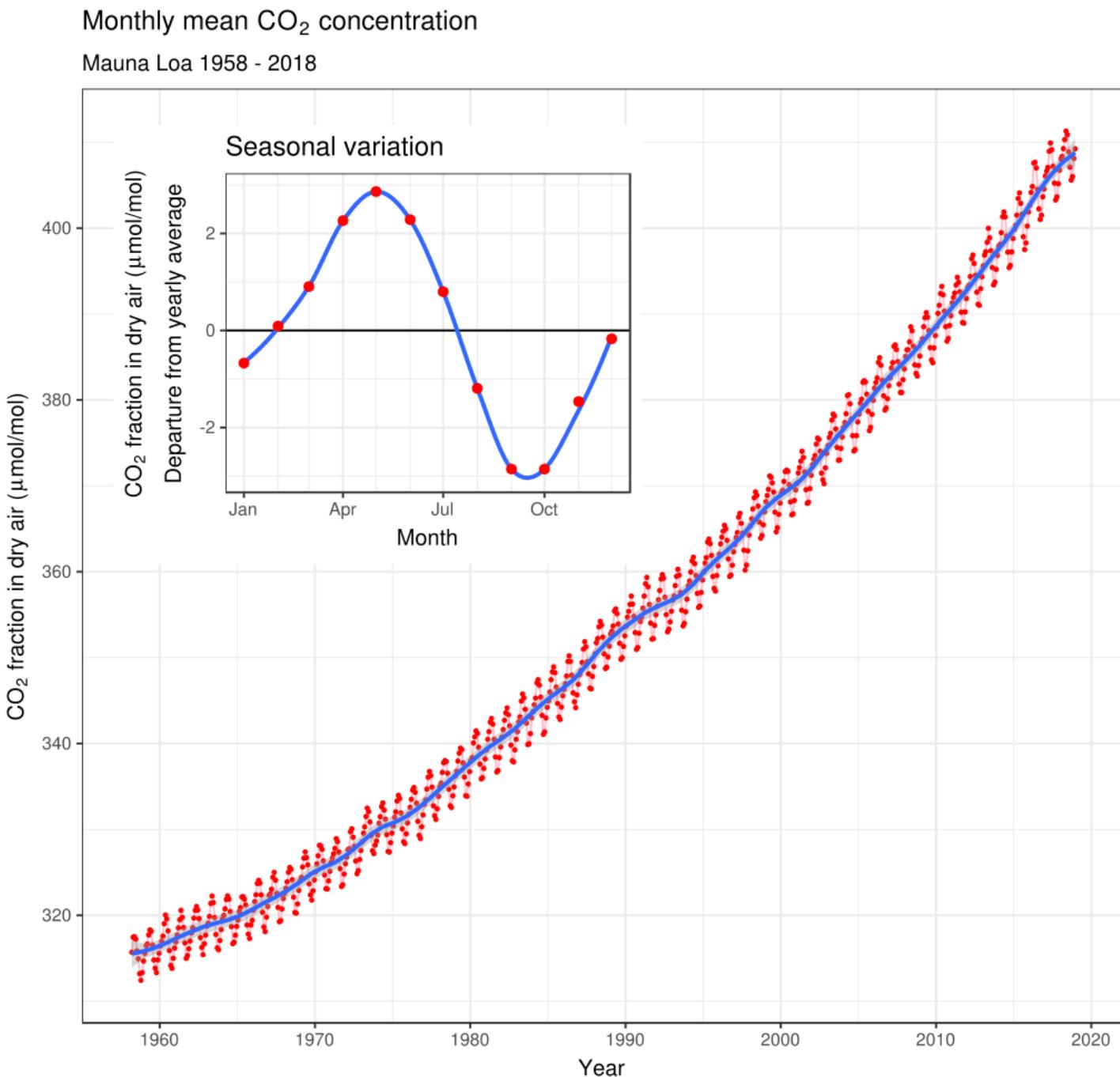


Fig. 1. Variation in concentration of atmospheric carbon dioxide in the Northern Hemisphere.

Tellus XII (1960), 2

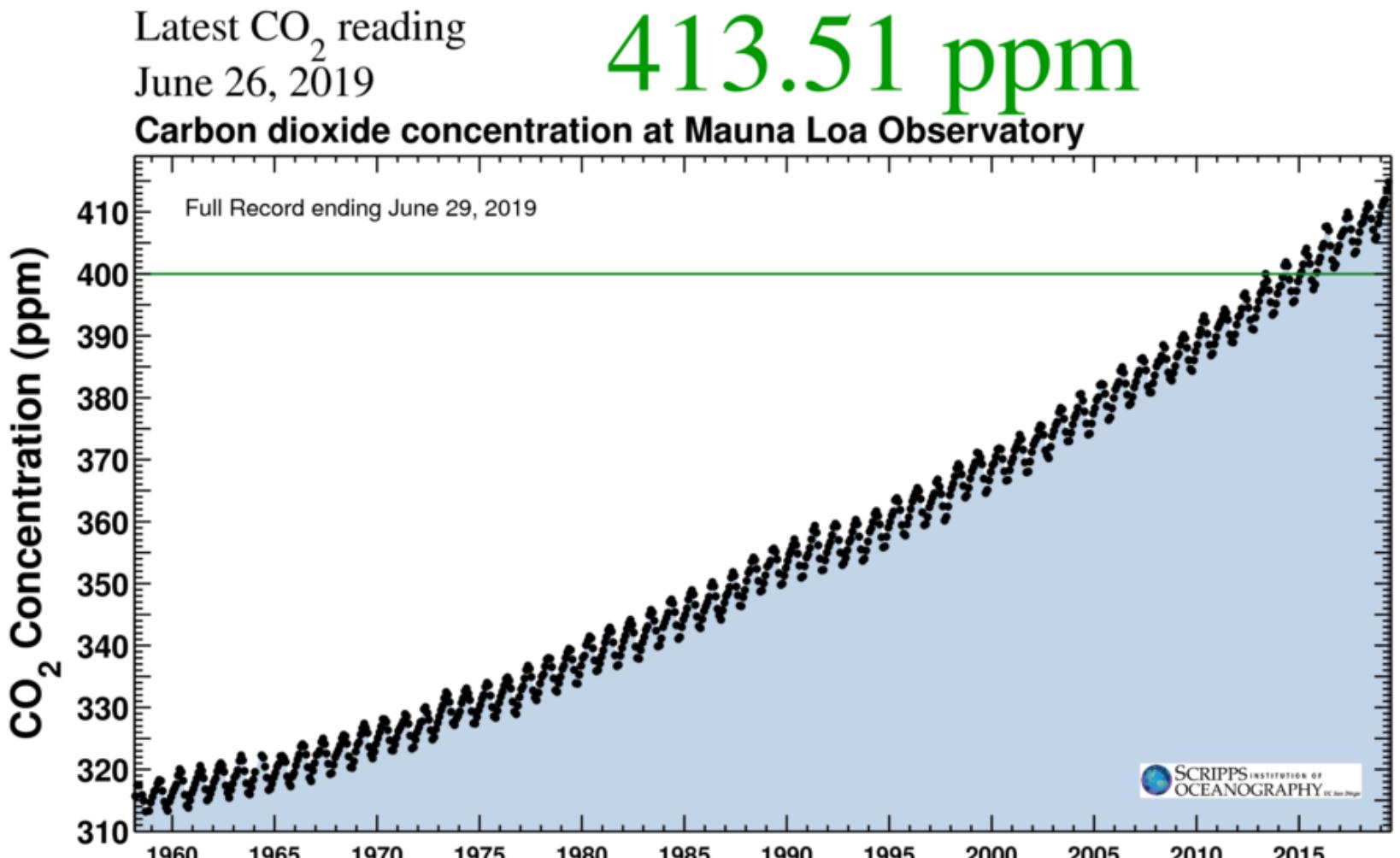
He took readings from 1957 to 1960. He also sent copies of his instruments to ice floe station in the South Pole and high and low altitude aircrafts. The graph is the result of his measurements. It has **three** major breakthroughs. **First**, that the CO₂ conc. in the atmosphere is not a constant. It varies according to season. In the spring and summer seasons, trees grow leaves in the northern hemisphere which reduces the amount of CO₂ in the atmosphere. In fall and winter seasons, these trees shed leaves and also lose their CO₂, which causes a rise of CO₂ in the atmosphere. **Second** breakthrough was that if you were draw a trend line through this graph, you would see a slight uptick. He roughly calculated this uptick is at the same rate of fossil fuel emissions in the world. **Third**, though the rate is the same, the total estimated quantity of CO₂ increase in the atmosphere is not the same as the amount emitted in the atmosphere by fossil fuels. He conjectured that some of it was being absorbed by natural systems like forests and oceans (and hence not all of it was being absorbed back by earth systems).

The Keeling Curve



Though some of his results were controversial at that time, his measurements gained enough support to secure funds and set up a permanent observatory in Mauna Loa. The graph above is the result of this effort. Though somewhat vaguely present in his 1960 graph, this one shows a clear uptick in the CO₂ conc. and an increase of roughly 100ppm of CO₂ in the atmosphere since 1957. Mauna Loa is now the worlds longest continuous CO₂ measuring station. In commemoration of his efforts, this curve is now called “The Keeling curve”. It has been heralded as one of the most influential scientific works of our time.

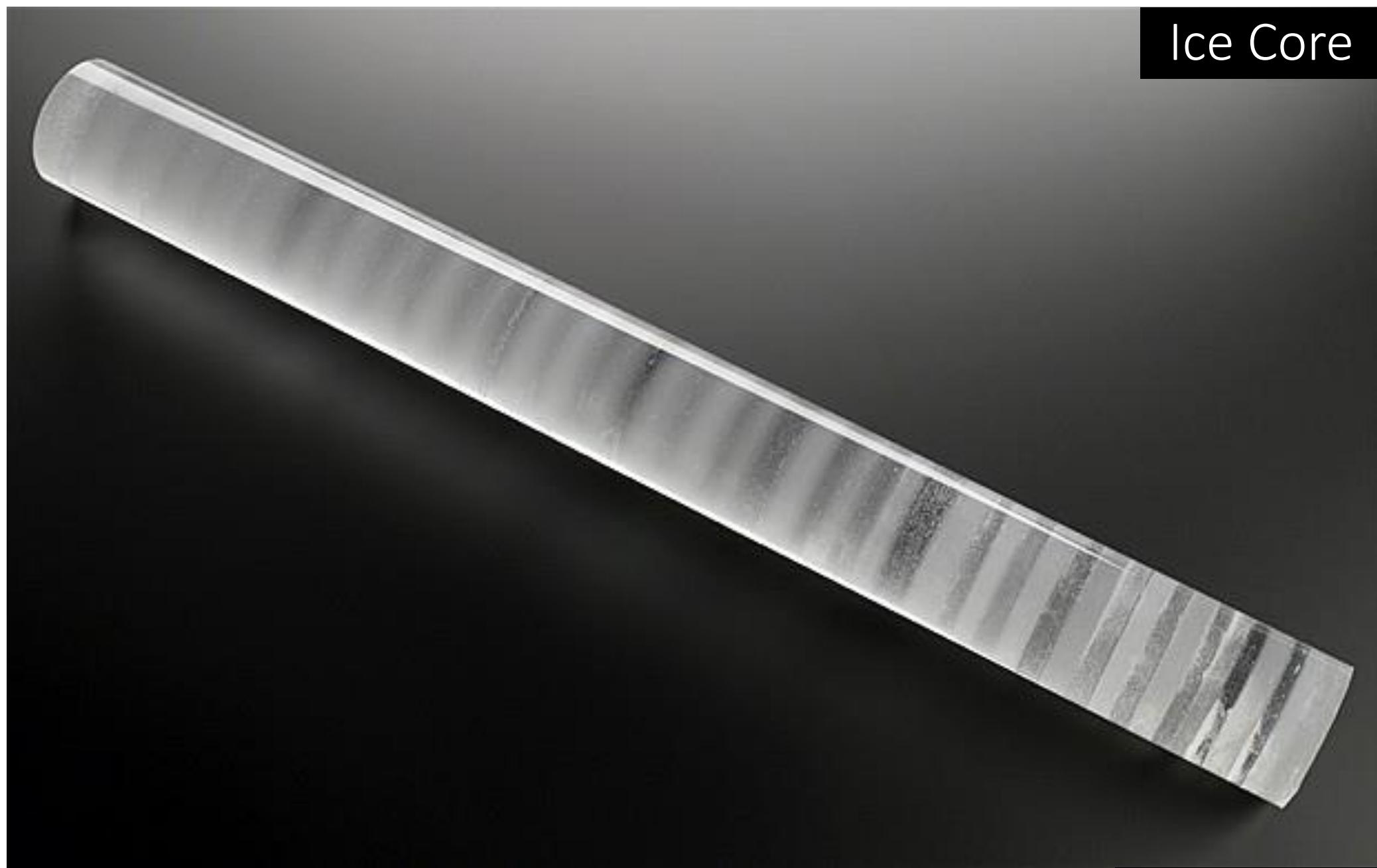
So what?



The Keeling Curve

This is the latest reading of CO₂ conc. in the atmosphere. It is important to ask why this value should be taken seriously. So what if the value of CO₂ conc. in atmosphere is 413.51ppm. So what if it is roughly 100ppm more than the first measurement in 1957. That does not mean anything without proper context. For this, one needs to look at ice core data.

Ice Core



Courtesy: *The Telegraph*

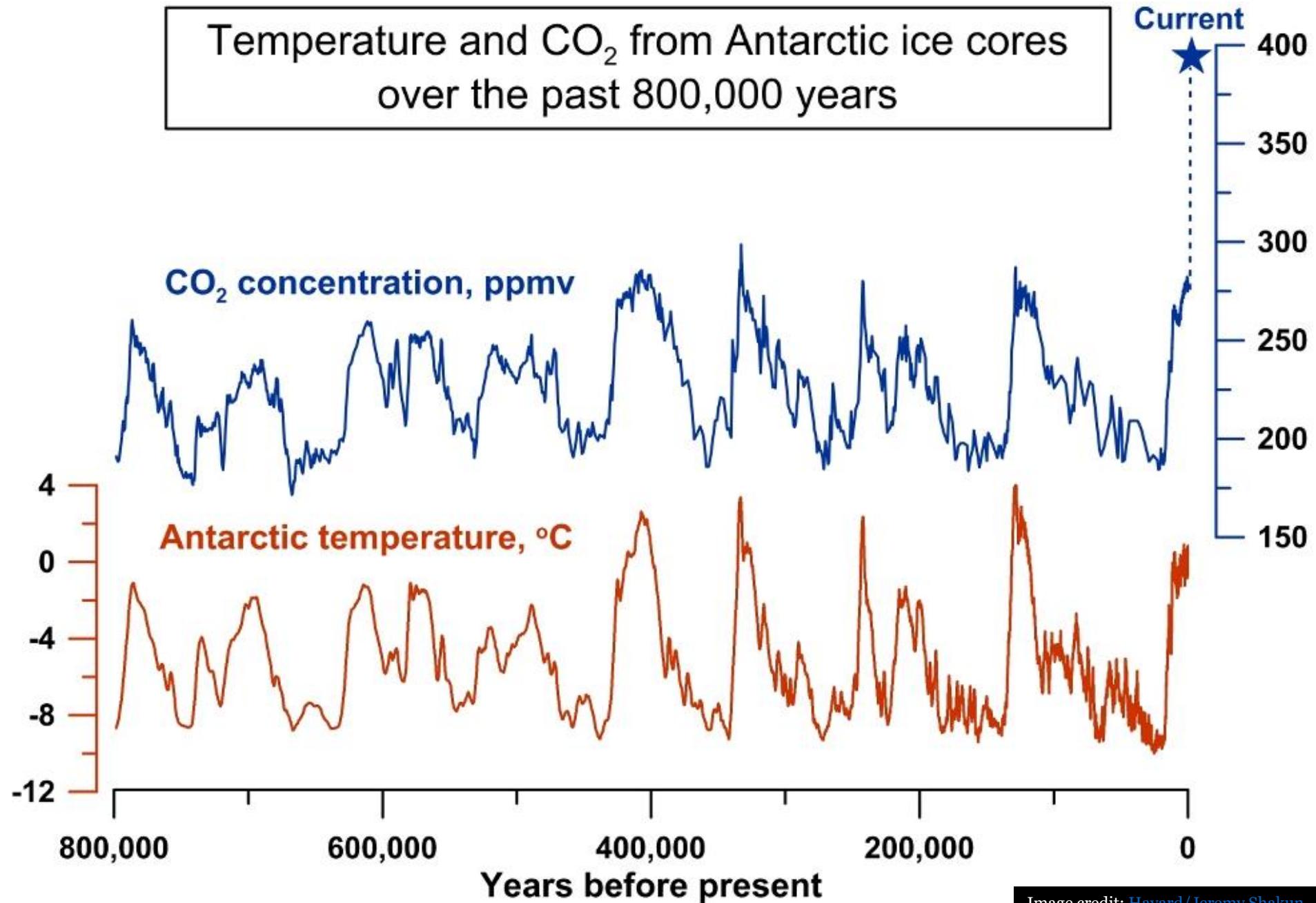
Ice cores look like this. They are cylindrical blocks of ice dug out of from permafrost. Permafrost as the name suggests is permanent frost. In certain places in the world, like the poles, when snow forms in the winter, it never melts. When this snow forms, it traps small air pockets within itself, and as snow forms every winter every year, each year forms a layer of ice over the last years ice deposit. If one were to dig vertically into these layers and extract the air pockets from each layer of ice, you would get a temporal scale of atmospheric composition of the planet. You can use this composition to decipher the amount of CO₂ in the atmosphere and also the ambient temperature of the planet in that year.

Ice Core Drilling

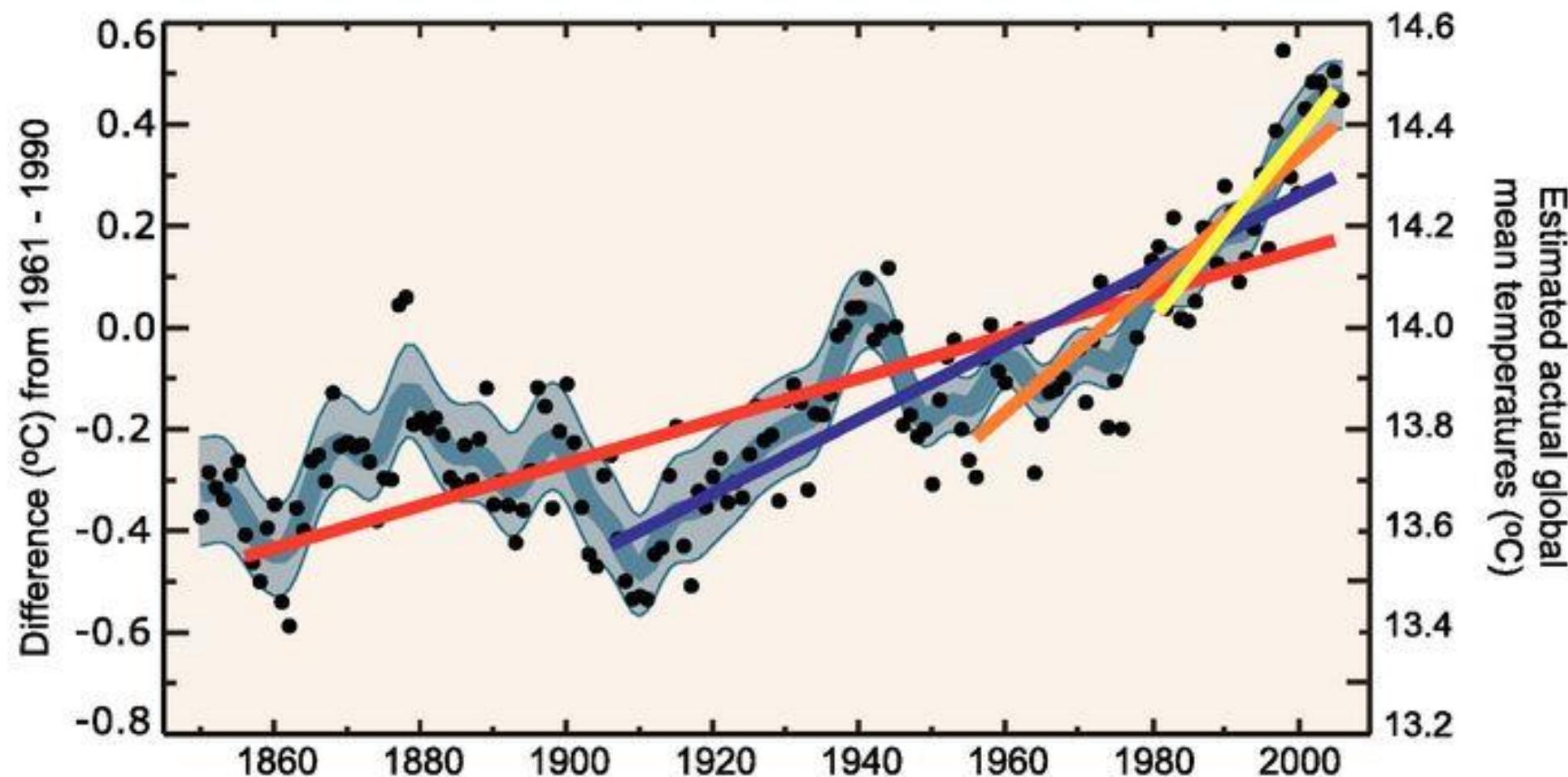


Courtesy: Frontier Scientists

Temperature and CO₂ from Antarctic ice cores over the past 800,000 years



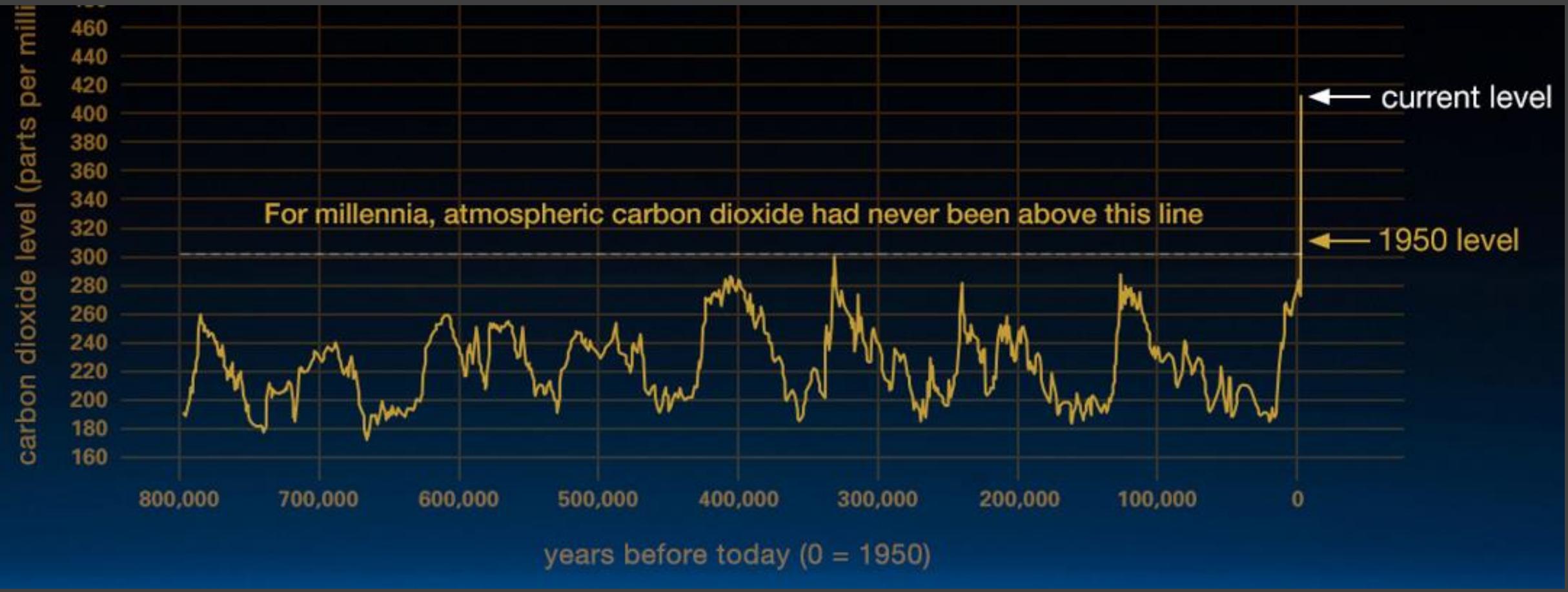
Scientists have been able to reconstruct earth's CO₂ and avg. Antarctic temperature history for the past 800,000 years through ice cores data. In this graph, each trough represents an ice age. In the last 800,000 years, we have seen 7 ice ages. As is evident from this graph, Earth is presently coming out of an ice age. As is also clear from the graph, temperature and CO₂ are strongly correlated (the relationship between them though, is not linear). This is where the concern is raised. If CO₂ and temp are correlated, and if every time CO₂ has increased in the atmosphere, the Earth has warmed enough to come out of an ice age, what will the current amount of CO₂ do to the present climate. As is clear from the graph, earth has never seen so much CO₂ in the atmosphere in its past 800000 year history. This excess CO₂ is clearly a cause of major concern and is entirely due to man made reasons. There is nothing natural about this CO₂ conc. in the atmosphere.



Period	Rate
Years	°C per decade
25	0.177±0.052
50	0.128±0.026
100	0.074±0.018
150	0.045±0.012

IPCC, 2007A

This problem is further made worse by the fact that the rate of change of CO₂, as shown in the graph has accelerated despite our efforts to curtail it in the last couple of decades. This shows that all the measures we have taken till date to tackle this issue have been woefully inadequate.



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO₂ has increased since the Industrial Revolution. (Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO₂ record.)

Evidences



1. Shrinking ice sheets : The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost an average of 286 billion tons of ice per year between 1993 and 2016, while Antarctica lost about 127 billion tons of ice per year during the same time period.



2. Declining Arctic sea ice : Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.
(Image: Visualization of the 2012 Arctic sea ice minimum, the lowest on record)

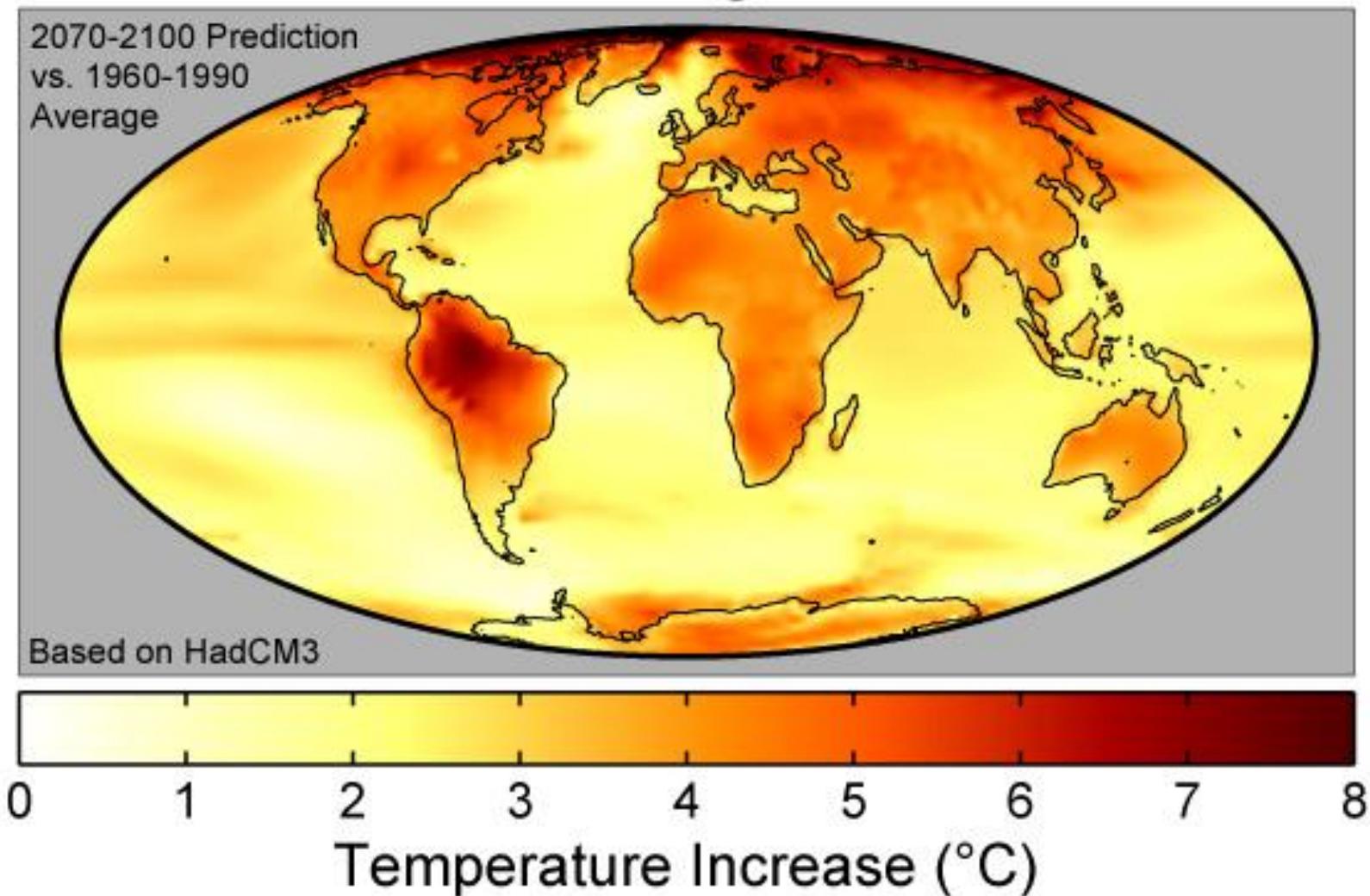


3. Extreme events : The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.



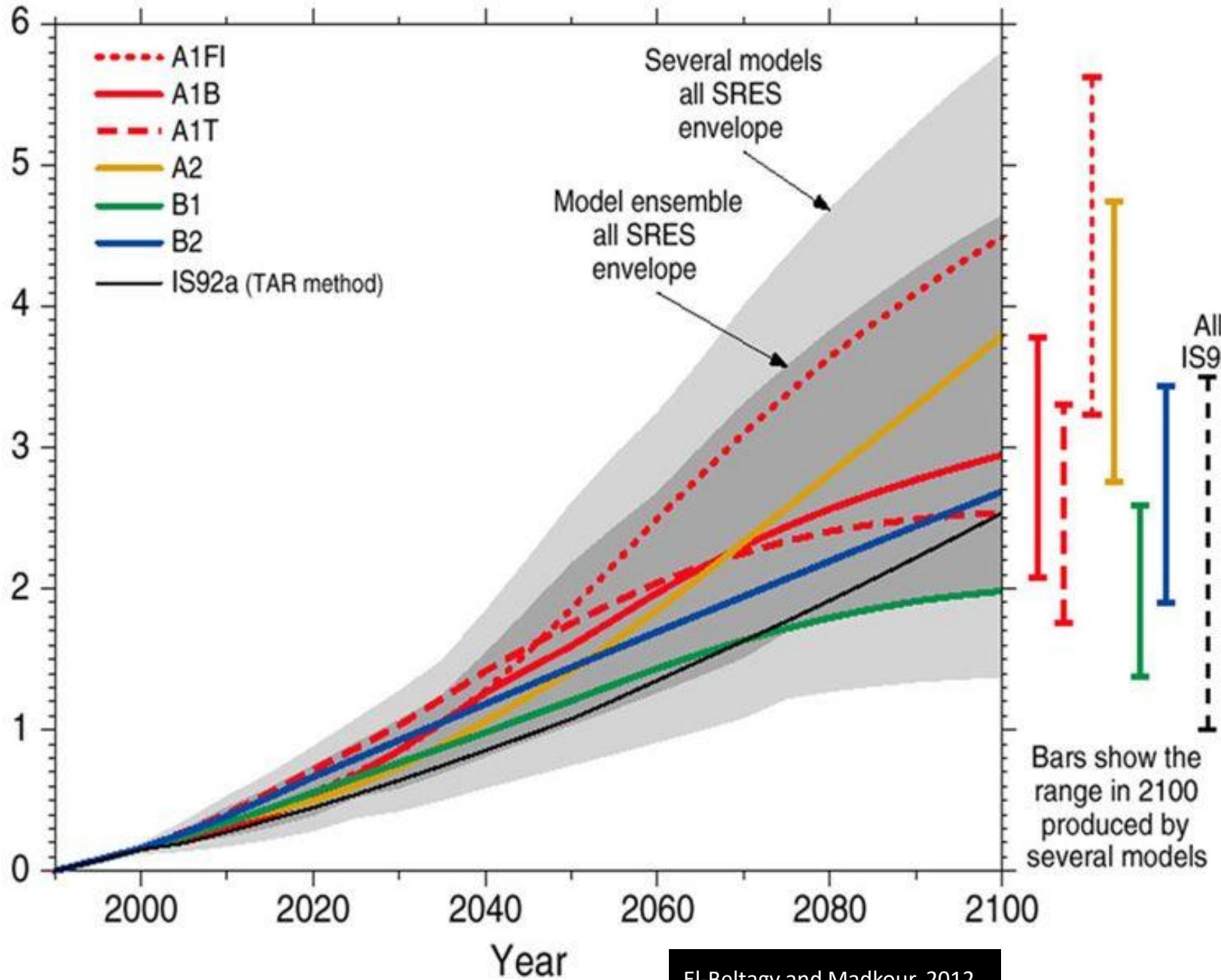
4. Ocean acidification : Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent. This increase is the result of humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the oceans. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year.

Global Warming Predictions



Another layer of complexity to this problem comes when you take this data and try to predict what is going to happen in the future. Because Earth is a **non-linear dynamical system**, it is hard to anticipate how the future of climate is going to look.

Temperature change



Temperature change under different scenarios

This is a graph of temperature change in the year 2100 under different scenarios. Each line represents a different model which takes into different, but equally valid assumptions about how the temperature of planet will rise. As you can see, the variation is quite large. It ranges from about 1.5 degree C to about 6 degree C which, is quiet a large difference. 6 degree C change will mean evacuation of many coastal areas and islands around the world. 1.5 degree C change will mean slight but manageable sea level rise. Both those extreme scenarios require diametrically opposite policy interventions.

CLIMATE CHANGE (COP21)



KEEP GLOBAL TEMPERATURES RISE

WELL BELOW

WITH ASPIRATION TO

2°C

1.5°C

ALL COUNTRIES TO
REPORT REGULARLY
ON THEIR EMISSIONS AND
EFFORTS TO REDUCE THEM



NEW TRANSPARENCY
AND ACCOUNTING
SYSTEM IN PLACE

EVERY
5
YEARS

REVIEW EACH COUNTRY'S
CONTRIBUTIONS TO GHG EMISSIONS
CUTS SO THAT THEY CAN BE SCALED UP

DEVELOPED COUNTRIES TO PROVIDE

\$100BN

CLIMATE FINANCE PER YEAR UNTIL 2025

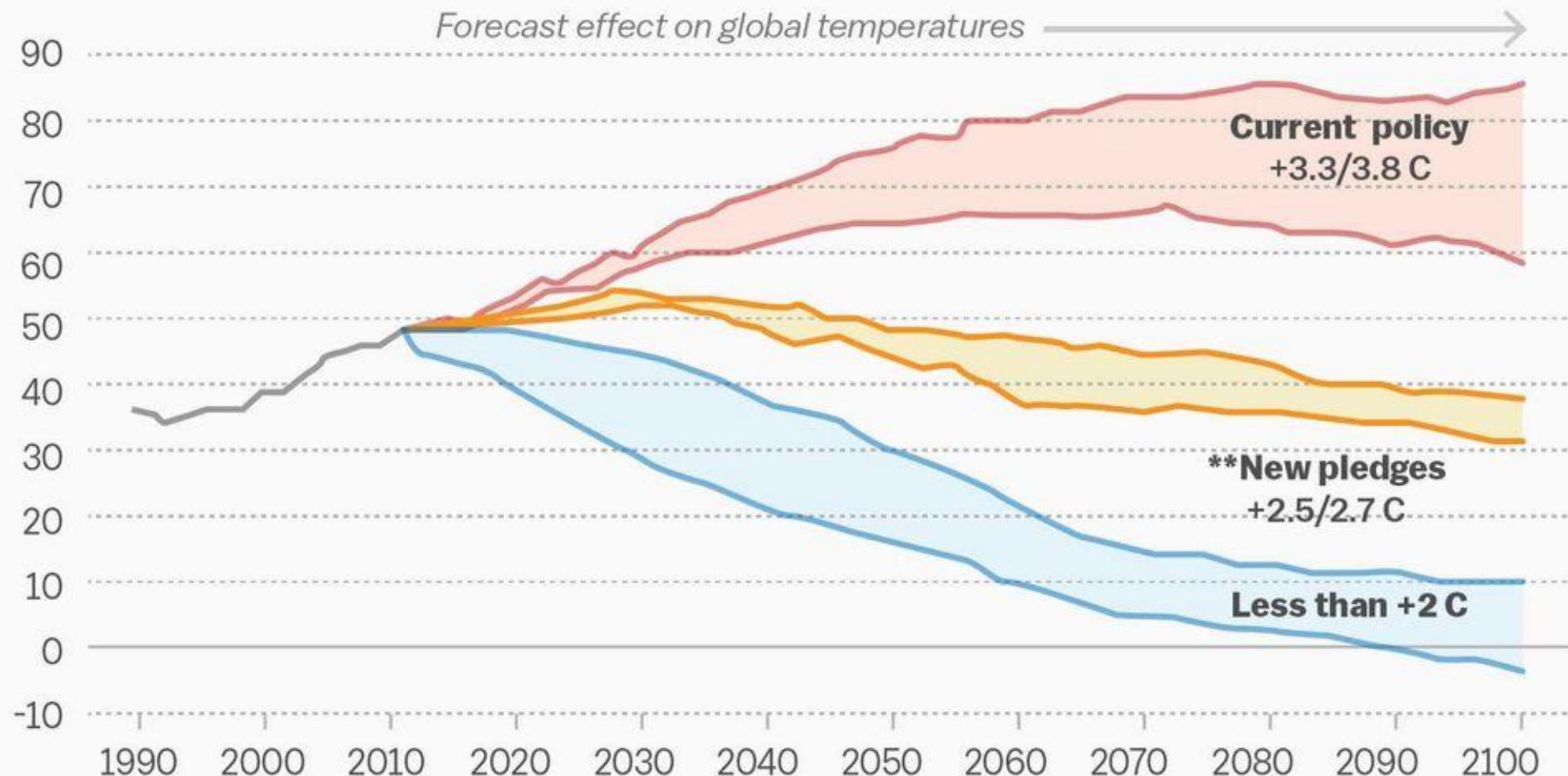


Image Credit: Friends of the Earth

COP21 or otherwise known as the Paris Climate Agreement, signed in 2015, has the ambitious goal of keeping global temperature rise by 2100 to below 2 degree C with aspirations to keep it below 1.5 degree C. These goals are nearly unattainable keeping in mind the projections seen in previous slide.

Estimated global greenhouse gas emissions

In gigatons, CO₂ equivalent



*Expected temperature change by 2100, versus period before Industrial Revolution

** Based on intended nationally determined contributions submitted to UNFCCC by Oct. 1

SOURCE: Climate Action Tracker

This graph highlights this issue. Even with the current policies, we are realistically looking at about 4 degree C rise, which is catastrophic. Some new proposed environmental policies are expected to bring this down to 2.5-2.7 degree C but nothing close to the 2 degree C or 1.5 degree C as per COP21 goals.

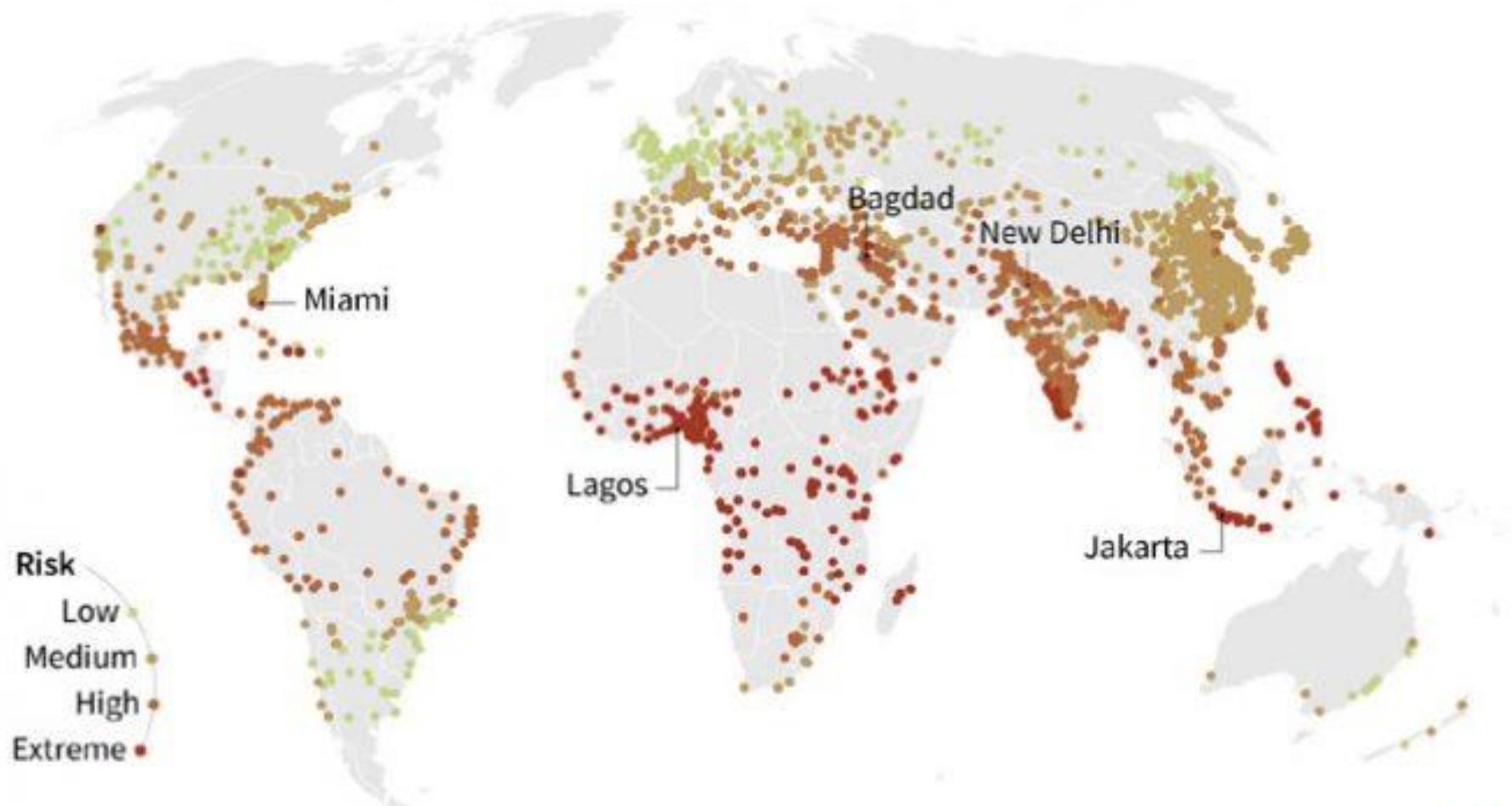
Cities at risk from climate change

Estimates of the vulnerability of large cities



MANIPAL
ACADEMY of HIGHER EDUCATION

(Deemed to be University under Section 3 of the UGC Act, 1956)



Source: Verisk Maplecroft

© AFP

Sustainable Development

Sustainable Development (SD)

“Development that meets the needs of the present without compromising the ability of future generation to meet their own needs”

1987 report of the World Commission on Environment and Development (WCED).

What is Sustainable about Development?

- What is development?
- How do you measure sustainability in the current paradigm of development?
- Is your definition of sustainability in line with environmental sustainability?

What is development?

Definition of Development:

Gross Domestic Product (GDP)

“GDP measures the monetary value of final goods and services—that is, those that are bought by the final user—produced in a country in a given period of time”- IMF

Measurement of throughput of natural resources

- In our world, development is primarily defined by GDP. Lesser developed economies have lower GDP. Developed economies have higher GDP. Therefore, for development to happen GDP must rise. But GDP is actually a measure of how much natural resources are consumed. So, resource consumption must increase for development to happen.

Challenges to Sustainable Development

- Rising income inequality (Economical Kuznets curve)
- Environmental degradation (Environmental Kuznets curve)

Economical Kuznets curve : Refers to relating growth and income redistribution.

Environmental Kuznets curve : Refers to relating growth and environment.

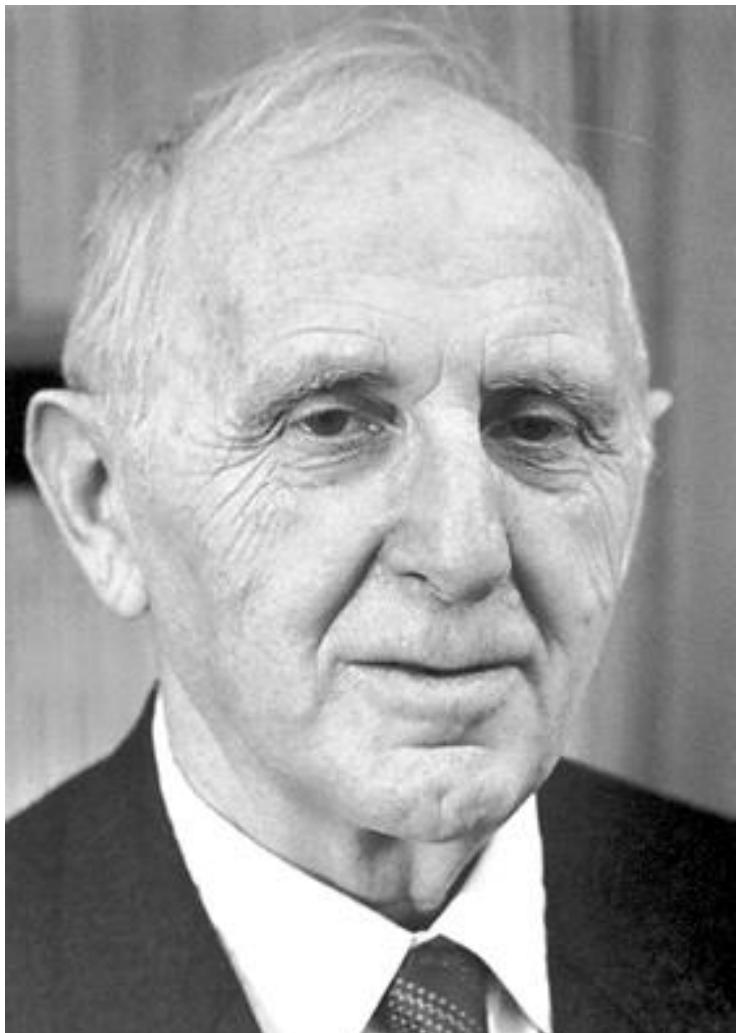
How to measure sustainability?

- For the case of development- **Sustainable growth**
- For the case of the environment- **Environmental sustainability**
- Environmental sustainability requires that we don't consume nonrenewable resources. In such a scenario, GDP should be close to zero.

Sustainable Growth ≠ Environmental Sustainability

- Therefore, for development to happen at a regular pace, we need a “sustainable” **GDP** growth. But this means that we are increasing our resource consumption at a regular pace.
- Environmental sustainability requires that we don’t consume non-renewable resources since any consumption of such resources will reduce the environment as an entity.
- Therefore, sustainable growth and environmental sustainability necessarily cannot be the same thing.

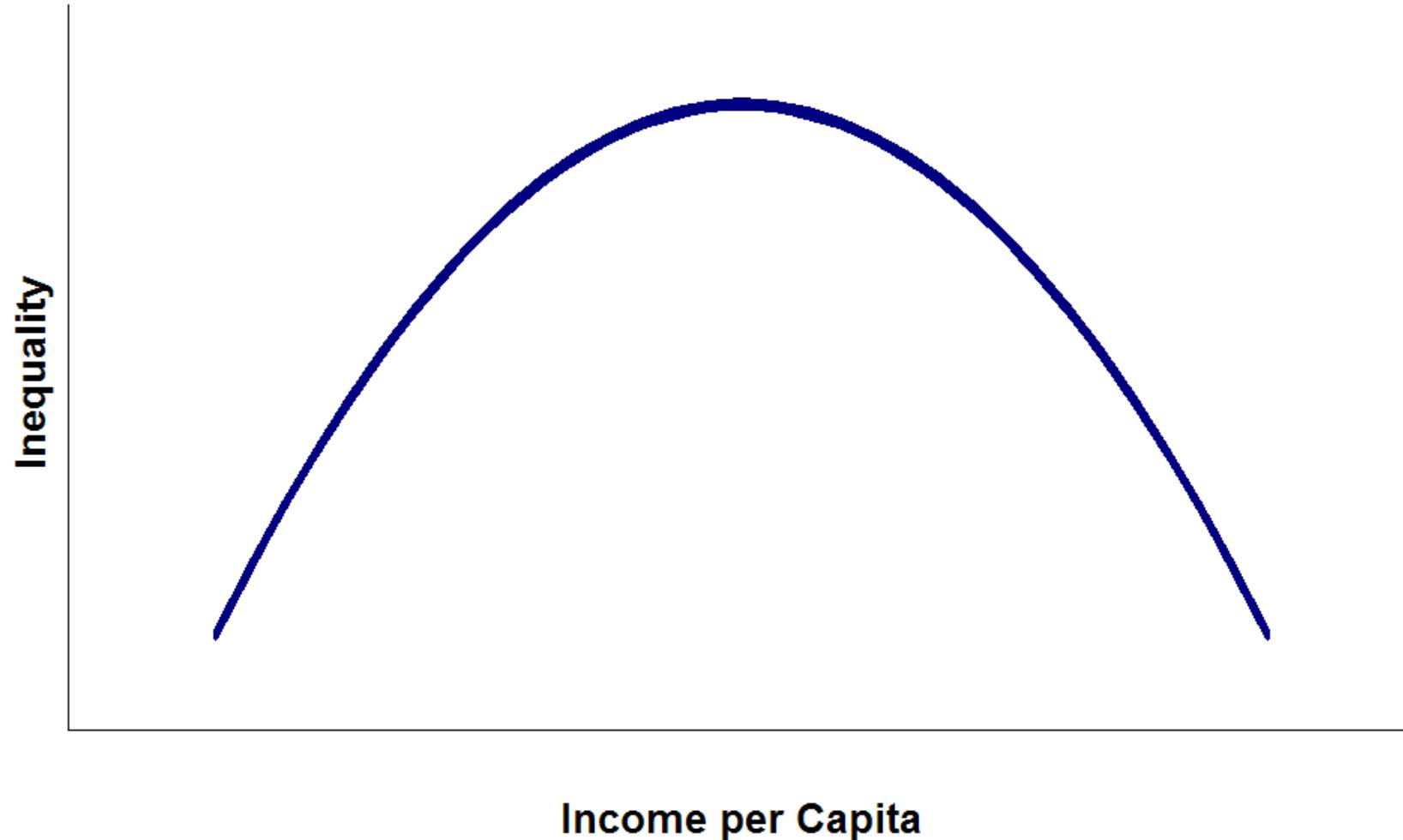
Why do we use GDP as a metric
for overall improvement in
human life?



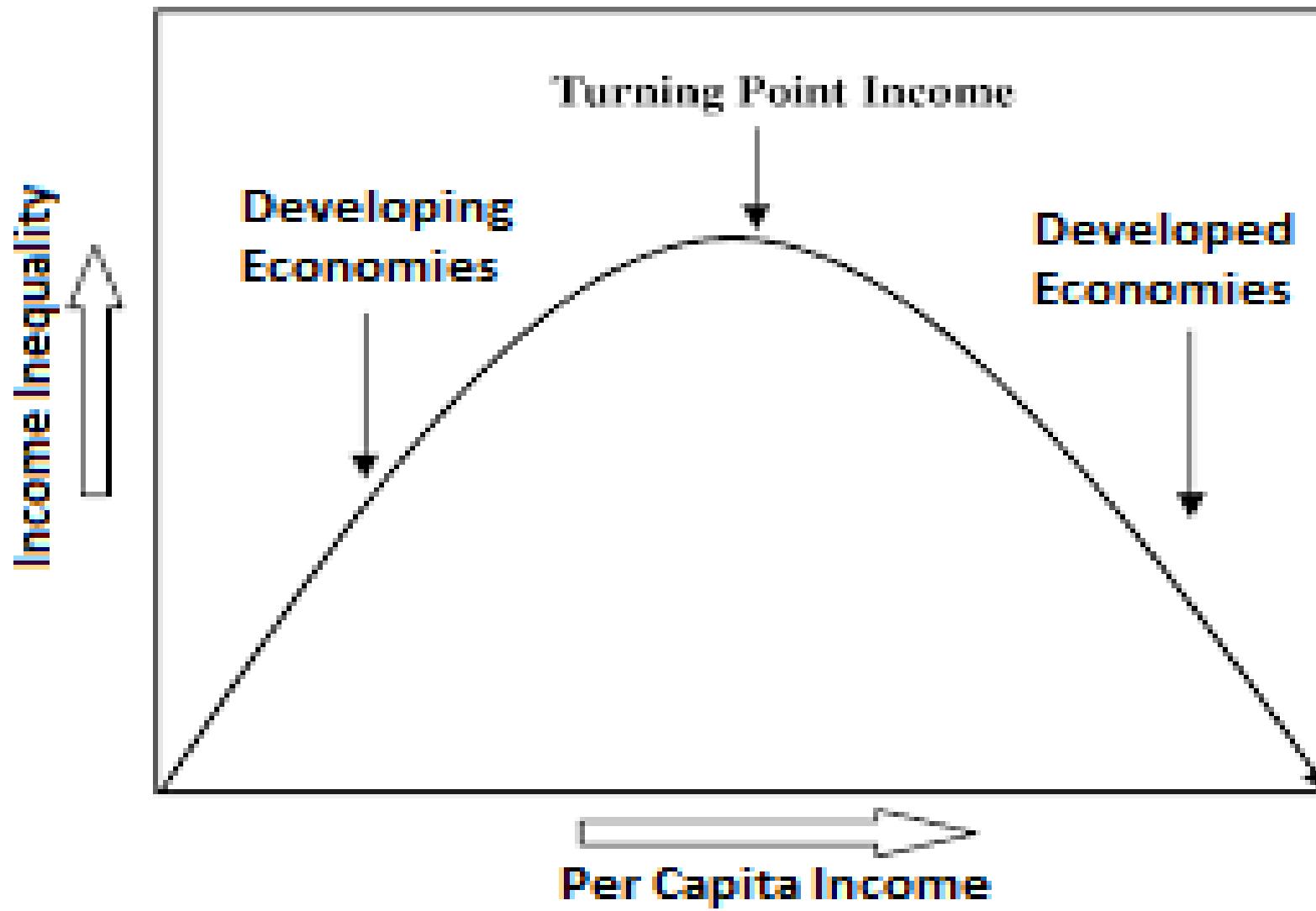
Simon Kuznets

Simon Kuznets was the first person to introduce the concept of GDP to understand year on year development rate of a country and quantify it. Before his time, industrial growth was only measured in indirect terms and was very vague. This lead to serious issues in framing proper economic policies. The great US depression of 1929 is a good example of the problems caused by this vague understanding. He was also the first person to collect data for the US and some European countries to calculate their GDPs.

Kuznets Curve

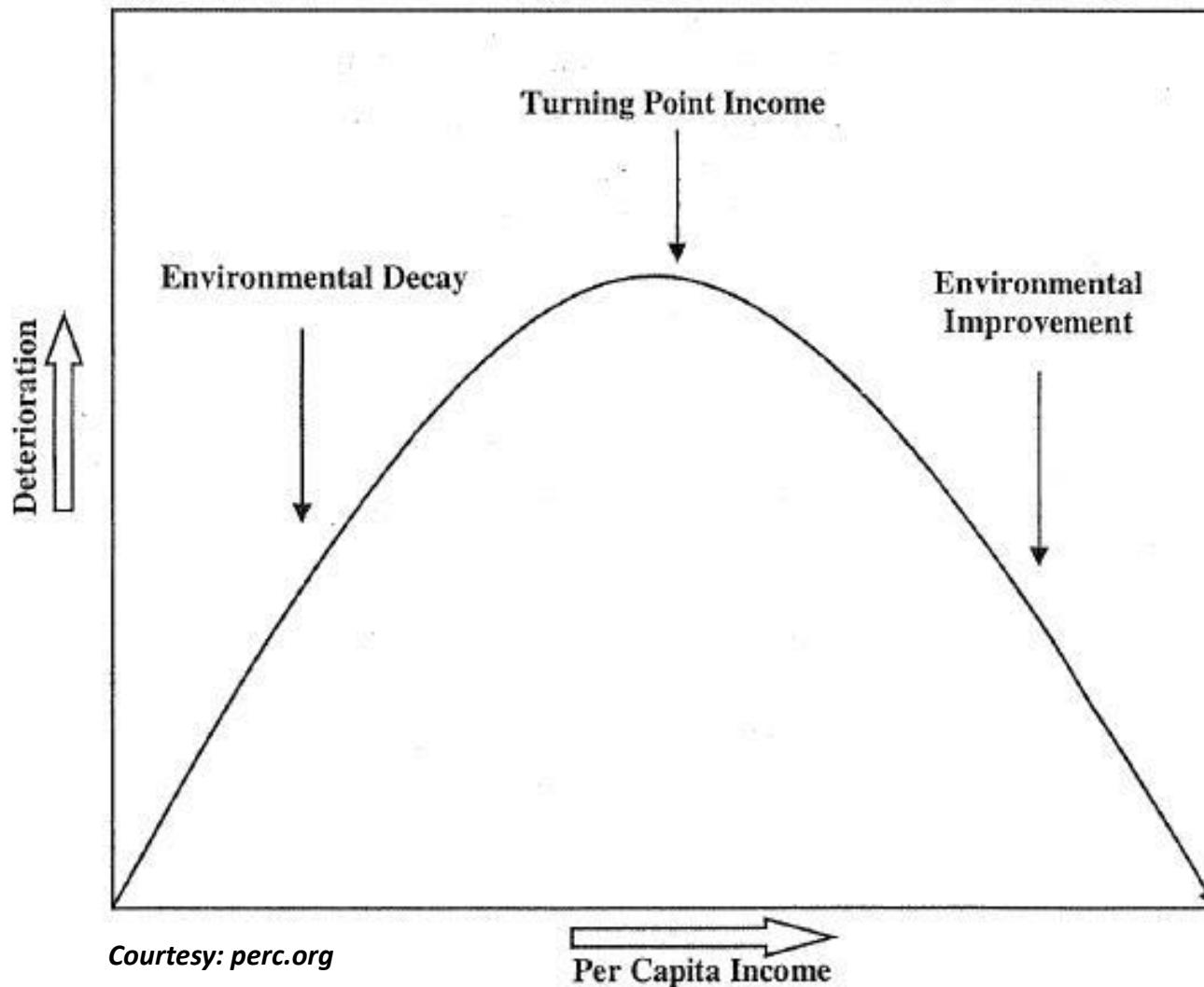


KUZNETS CURVE



- While he was collecting this data, he observed that as the income per capita increases, so does the income inequality of the country, but only up to a certain point.
- Any subsequent increase in the income per capita then decreases Inequality. He did not comment on how this happens or why it happens. Just that it happens. He even said that this conclusion was “*Perilously close to pure guesswork*” as the data he was working with was very limited.
- But, nonetheless, it became very popular especially for many underdeveloped/developing economies. The policy for removing income inequality was now simple. Just focus on GDP (Income per capita as an aggregate will be GDP).
- As long as the GDP rose, inequality would rise but at some point come down on its own. Take the case of the western economies. They are on the right hand side of this curve and their income inequality is low. India is somewhere near the top left side of the curve and our inequality is high. Intuitively, this graph makes sense.

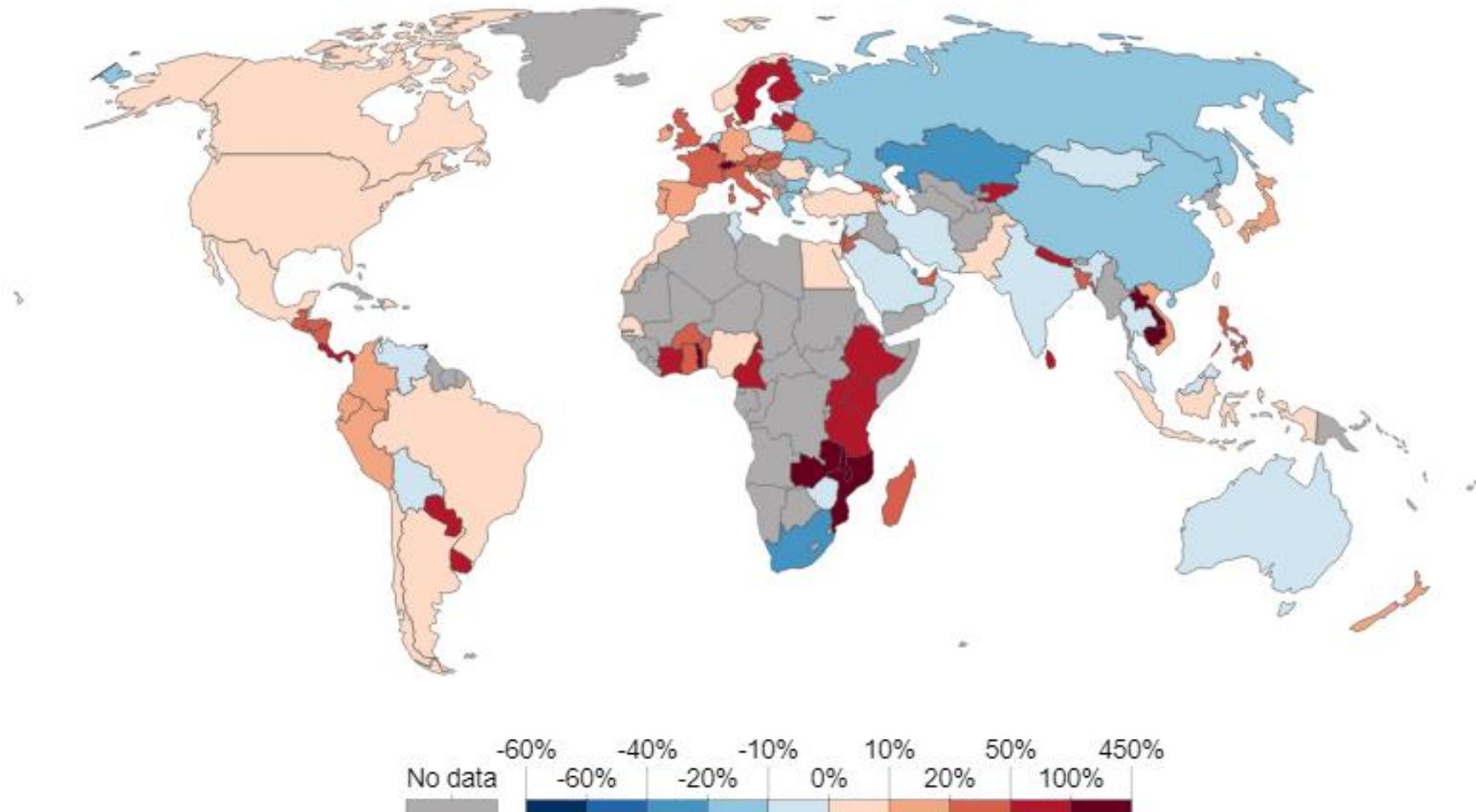
Environmental Kuznets Curve (EKC)



- This understanding got carried forward to the environment as well. As a country is developing, it will consume resources at a rate which will cause environmental decay, but after a certain point, environmental decay will come to a halt and will start to improve.
- Again, if you take the case of Europe and India, it makes intuitive sense. Europe is rich enough to spend some of its income on protection of their environment. India is not quite there yet and is seeing destruction of its environment. Many developing countries are doing worse. This is an amazing insight for a policy maker or the government.
- With this and the previous graph combined, what it means for them is that if they focus just on growing the GDP, though in the short term inequality and environmental destruction will rise, in the long run both of those major issues will be resolved ***automatically***.

CO₂ emissions in imported goods as a share of domestic emissions, 2014

Share of carbon dioxide (CO₂) emissions embedded in trade, measured as emissions exported or imported as the percentage of domestic production emissions. Positive values (red) represent net importers of CO₂ (i.e. "20%" would mean a country imported emissions equivalent to 20% of its domestic emissions). Negative values (blue) represent net exporters of CO₂.



But lets stop to think about how the EKC actually works. Take the case of Europe. Europe is very sensitive to its environment and have very stringent rules for its protection. But does that mean they have low carbon footprints? No! On the contrary it has one of the highest per capita CO₂ emissions of the world. It manages to have a clean environment by shifting the onerous of doing polluting jobs to other countries and importing the products from them. This allows them to be clean while also causing environmental degradation. This is clearly not a sustainable way to reduce environmental degradation in the world as countries like India and China also “develop”. The EKC is right if you take countries in isolation but very wrong when taken for the whole world. There is therefore a need to move to better policies to reduce environmental degradation and actually develop sustainably.

Thank you



NATURAL RESOURCES

Natural Resources

- **Natural resources includes** air, water, forests, animals, fishes, marine life, biomass, fossile fuels, like coal, petroleum and natural gases, wild life, renewable energy sources like solar energy, wind energy, biomass energy, geothermal energy etc.
- **Prosperity of a nation** is dependent on the natural resources available in the nation.

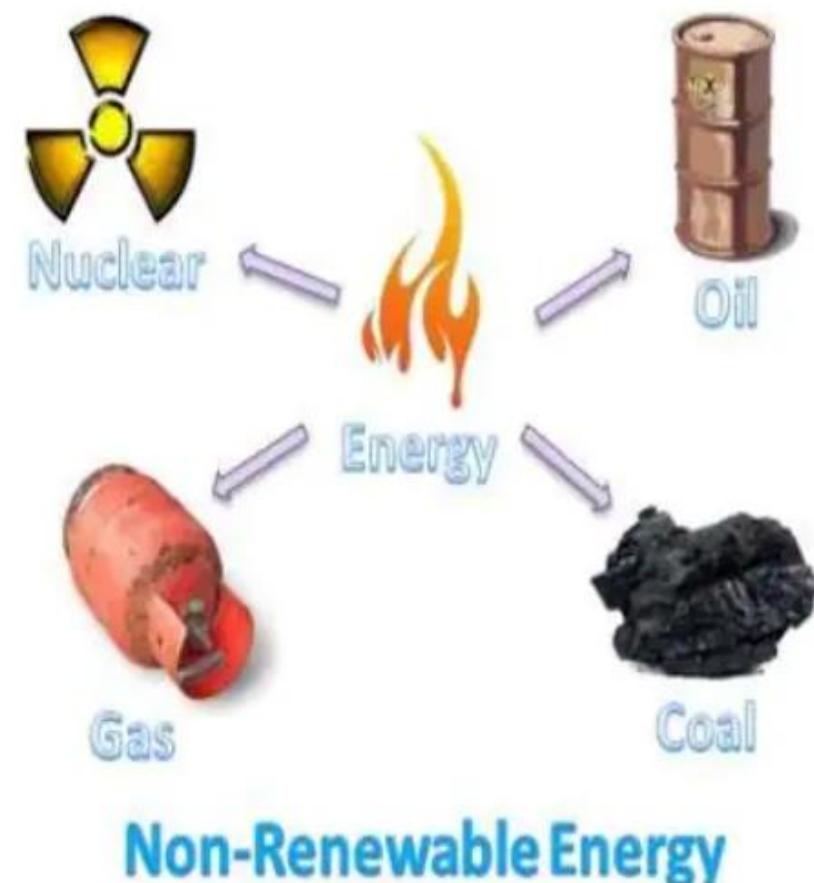
Renewable Resource

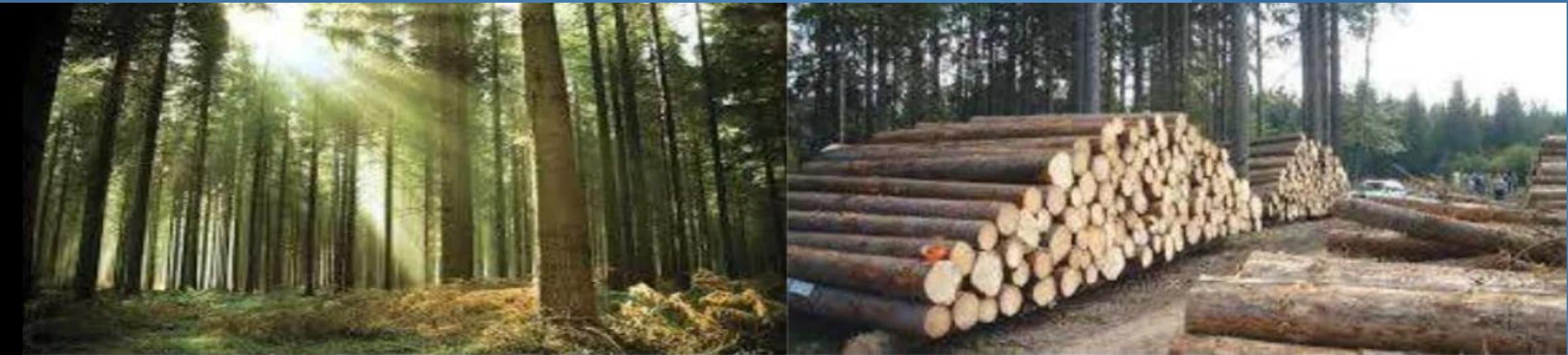
- Renewable energy is energy which is generated from natural sources i.e. sun, wind, rain, tides and can be **generated again and again** as and when required.
- They are available in plenty and by far most the **cleanest sources** of energy available on this planet.
- **Solar Energy, Wind Energy, Geothermal Energy, Biomass Energy From Plants, Tidal Energy** are the examples of Renewable resources.

					
Solar	Wind	Geo	Hydro	Bio	Tide

Non Renewable Resource

- A non renewable resource is a natural resource that **cannot be re-made or re-grown** at a scale comparable to its consumption.
- Non-renewable sources are **not environmental friendly** and can have serious effect on our health.
- They are called non-renewable because **they cannot be re-generated within a short span of time**.
- Non-renewable sources exist in the form of fossil fuels, natural gas, oil and coal.



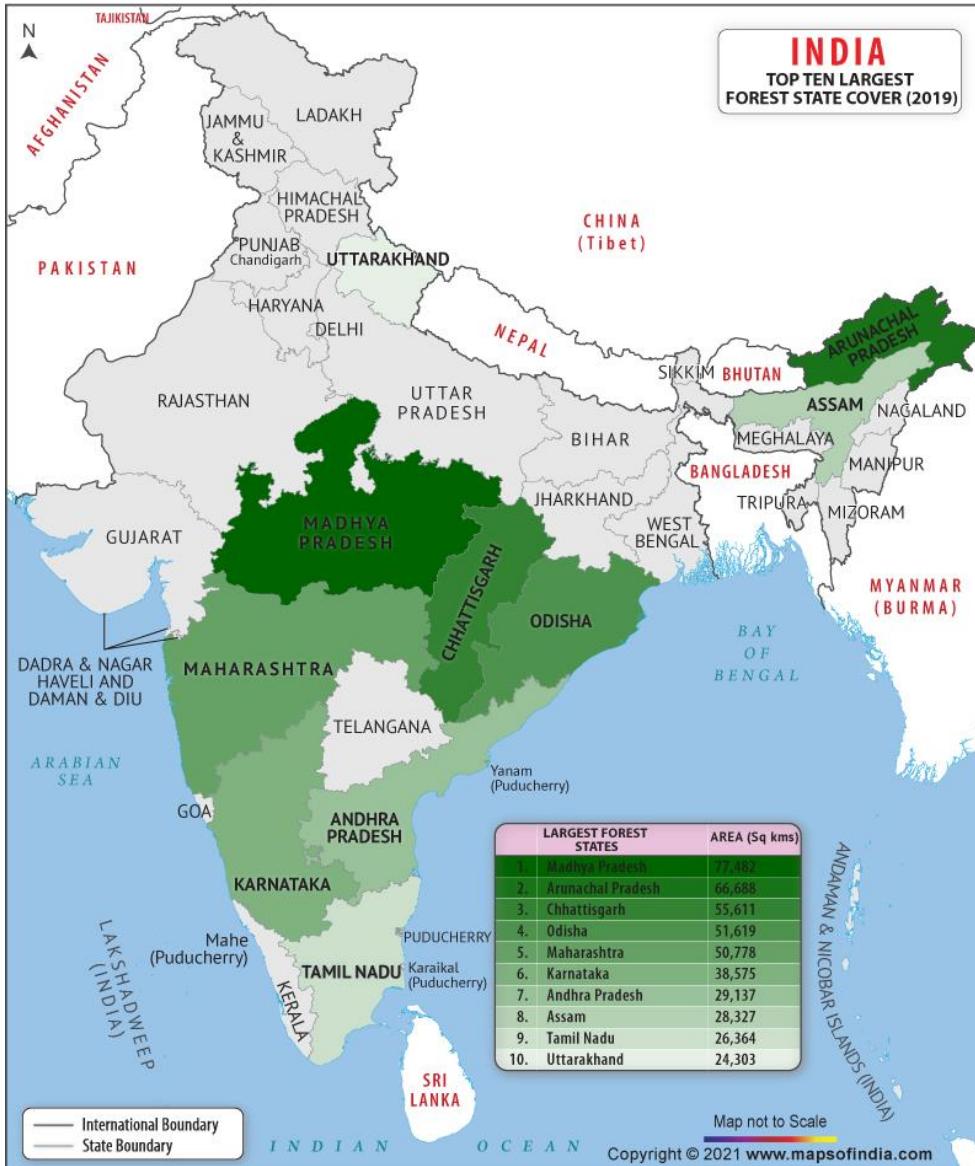


Forest Resources



Forests in India...

- In India, the forest cover is 6,97,898 sq.km(21.23%).
- 2.54% very dense forests (tree canopy density-TCD >70%),
9.7% moderately dense forests (TCD <70% >40%) and
9% open forests (TCD<40% >10%)
- Largest forest cover is in Madhya Pradesh (77,522 sq.km)
- Followed by Arunachal Pradesh (67,321 sq.km.) & Chhattisgarh (55,621 sq.km)



Why are they important?

- Play a very crucial role in every nation's economical, social and cultural activities
- Many river systems originate in forests and anchor rich biodiversity.
- Forests provide:
 - Timber
 - Industrial wood
 - Fuel wood
 - Pulp for paper and
 - Many non-timber products to the local communities and national economy.

Why are they important...

- Valuable source of biodiversity & provide important ‘Gene-Pool’ from which we derive medicines, domesticated plants, animals etc.
- Reduce the energy of rainfall (sponge action) and reduce soil erosion.
- Also reduce floods; moderate climate and serve as sink for carbon dioxide.
- Shelter for large number of animals species.

Impact of Forests

- In India more than 2,00,000 villages are located in the fringe of forests.
- More than 20 crore people (including 7 crore tribals) depend on forests for their livelihood.
- About 3 crore people are directly involved in gathering & trading non-timber forest products like fruits, seeds, flowers, leaves, honey, gum etc.
- Any impact on forest vegetation & biodiversity will have adverse implications for livelihood of forest-dependent communities.

Causes of deforestation

- Increase in population
- Urbanization & industrialization
- Mineral exploration
- Construction of dam reservoirs
- Infrastructure development
- Over grazing & Forest fires
- Human encroachment & exploitation
- Pollution-acid rain

Adverse effect of depletion of trees

- It has contributed to **rise in temperature**.
- It has contributed to **lesser precipitation**.
- It is responsible for **increased rate of soil erosion**.
- It is responsible for **increase in the frequency and volume of floods**.
- It has lead to **loss of soil productivity**.
- It is responsible for **loss of biodiversity**.
- It has lead to **extinction of several species of plants and animals**.
- It has caused **imbalance in ecosystem**.

Conservation of Forest

- Regulated and planned cutting of trees.
- Control over forest fires.
- Reforestation.
- Afforestation
- Check on forest clearance for agriculture and human habitation and settlement.
- Development green belt around cities.
- Check on mining activities in forest areas.
- Protection of existing forest.
- Conservation of threatened species of trees.



Conservation of Forest

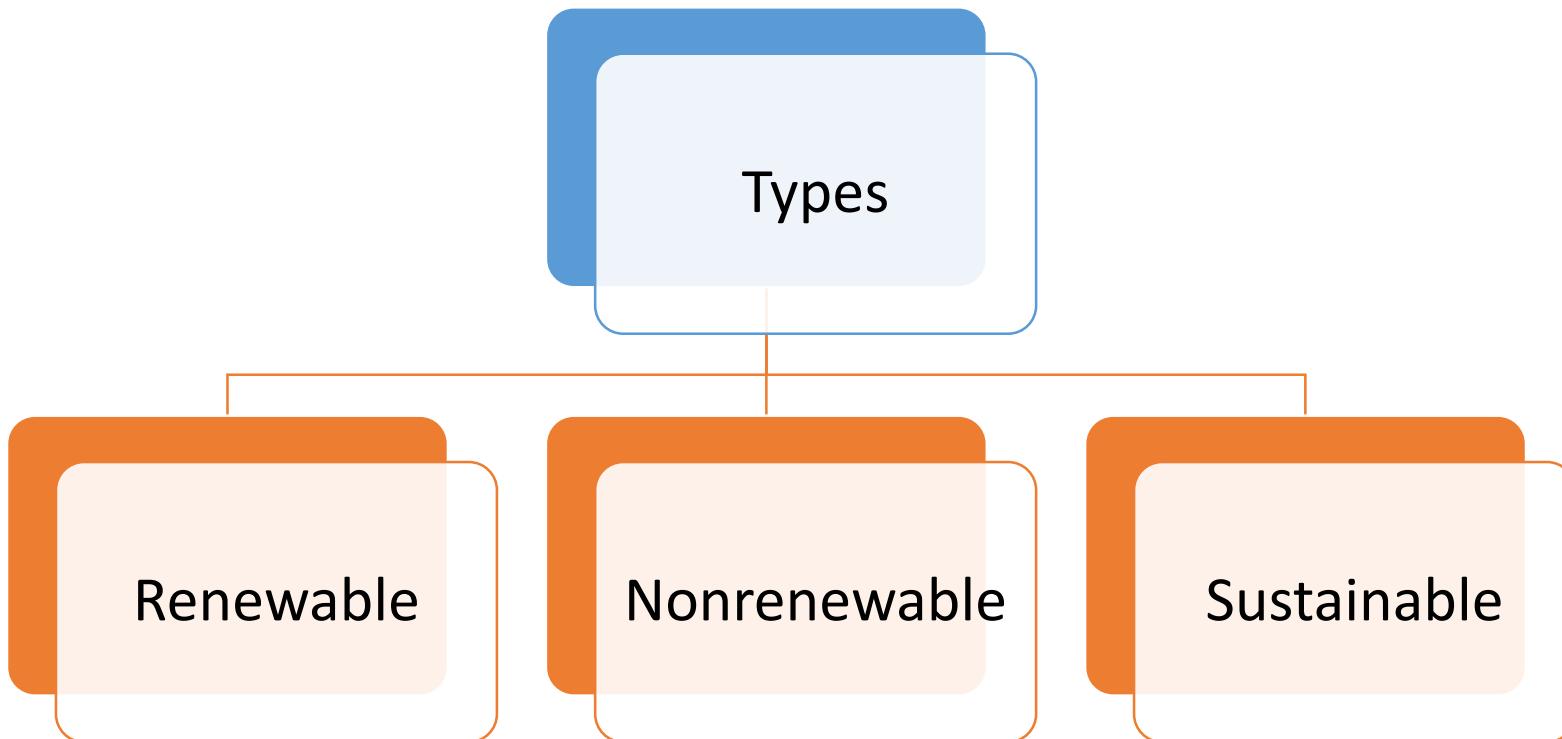


- Agro-forestry.
- Development of national parks and sanctuaries.
- Development of botanical gardens.
- Development of seed banks.
- Forest management.
- Proper role of government in forest conservation

Energy Resources



Classification



Types of energy sources

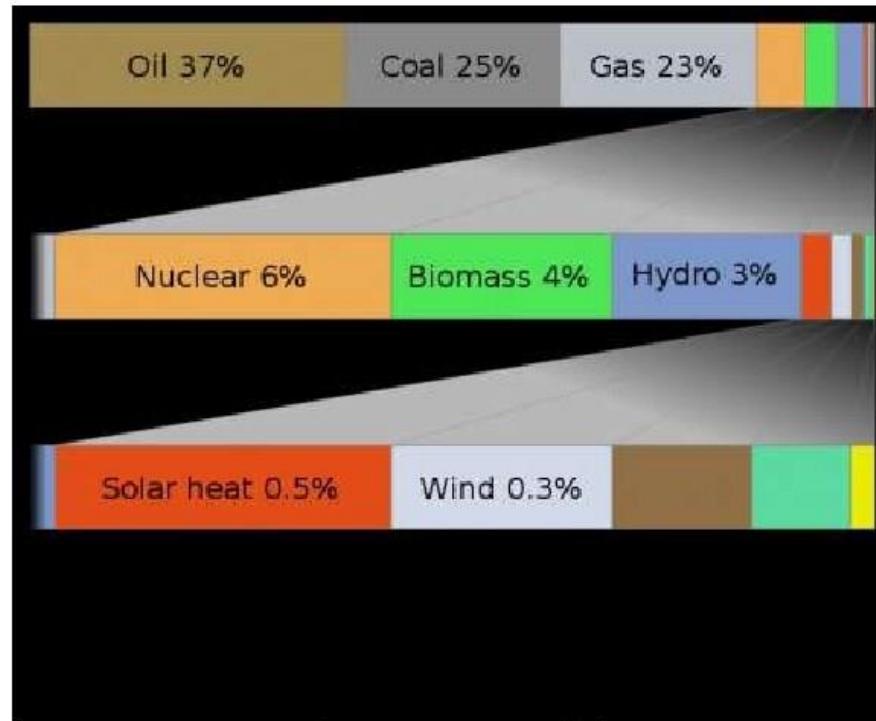
- Non-renewable
 - Fossil fuels : petroleum, coal, gas
- Renewable
 - Wind
 - Wave [Tidal energy]
 - OTEC [Ocean thermal exchange capacitors]
 - Solar
 - Hydro-power
 - Hydrogen energy - Fuel-cells
 - Biofuels: biomass energy
- Sustainable
 - Nuclear power

Non – renewable



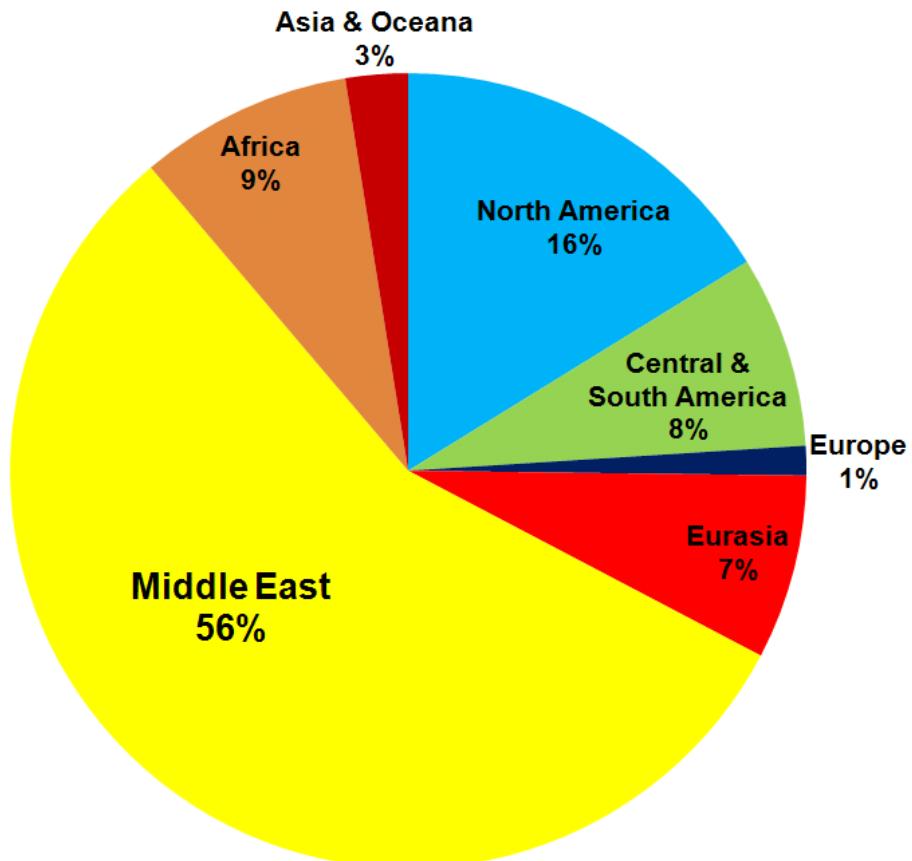
Non – renewable resources

- A natural resource that is available only in limited amounts
- Cannot be replaced quickly by natural processes
- Examples: topsoil, fossil fuels for energy

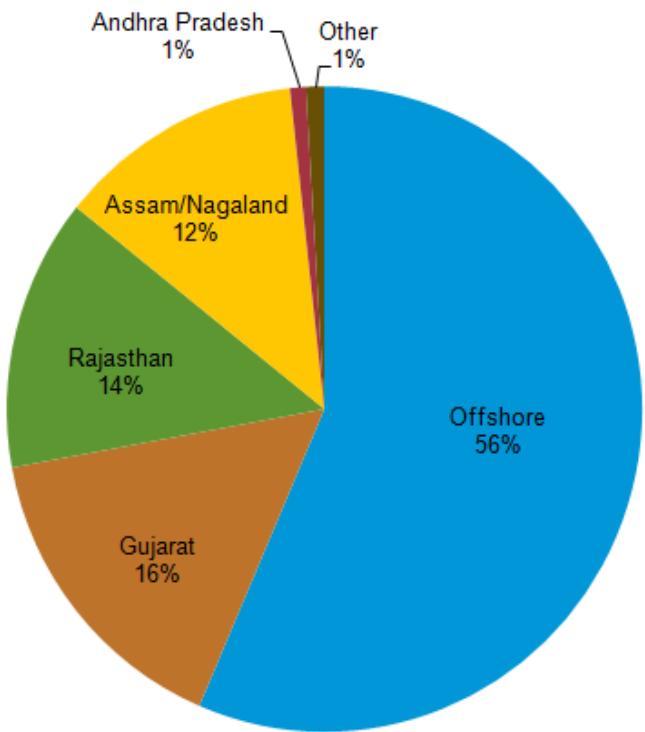


Approximate world usage
of fossil fuels

World Oil Reserves by Region



India crude oil production by region, 2010



Sources: U.S. Energy Information Administration, ONGC, OIL, DGH

Advantages:

- Widely and easily distributed all over world
- Easy to store and transport
- Cleaner and easier to burn than coal
- Reliable electricity

Disadvantages:

- Growing demand
- Non-renewable and fast depleting(used up fast)
- Burning produces carbon dioxide which is major cause for global warming\leaves harmful products when combusting
- Increasing prices

Non –renewable : Coal

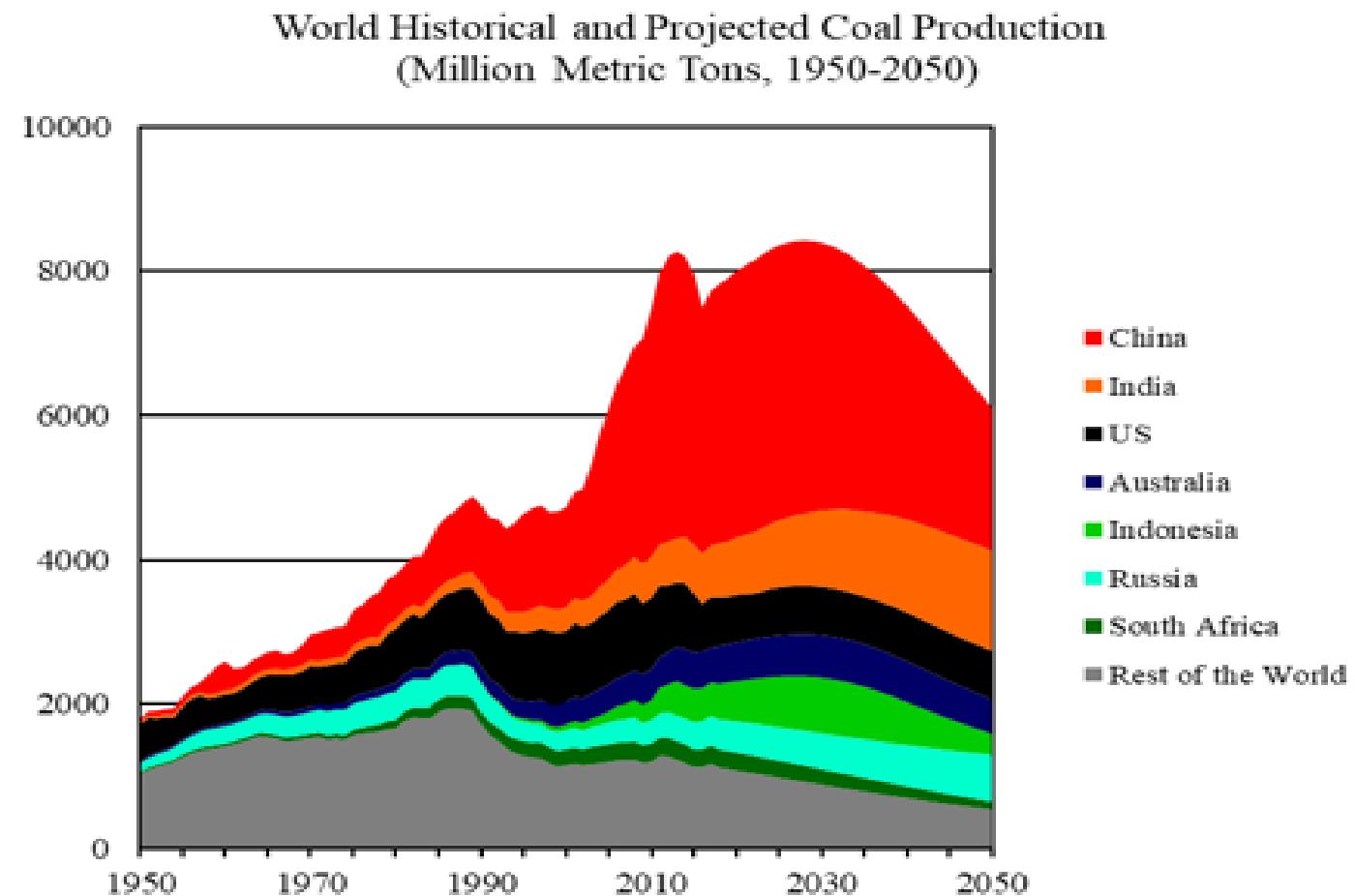
- Was the first fossil fuel to be used on an industrial scale.
- Remains a major force in world energy.
- Economically recoverable reserves exist in about 70 countries.
- At the current rate of production, global coal reserves are estimated to last for almost another 150 years.





IMPACT OF COAL MINING ON ENVIRONMENT

- Impact of mining on Air
- Co2 emission
- Ozone depletion
- Global warming and climate change
- Mine fires
- Impact on water
- Impact on land
- Mining waste



Data Sources : World Coal 2018-2050, World Energy Annual Report (Part 4)

Fossil fuels: Environmental Impact

- Burning fossil fuels releases chemicals and substances that contaminate the air and water
- A common product made from fossil fuels (oils) is plastic
- While we continue to use fossil fuels, how can we try and reduce our environmental impact?
- 3Rs!: Reduce, reuse and recycle



Renewable - Wind Energy

Source: wikipedia



So how do wind turbines make electricity?

Simply stated, a wind turbine works the opposite of a fan.

Instead of using electricity to produce wind, like a fan, wind turbines use wind to produce electricity.

The wind turns the blades, which spin a shaft, which connects to a generator and produces electricity.

Wind Energy

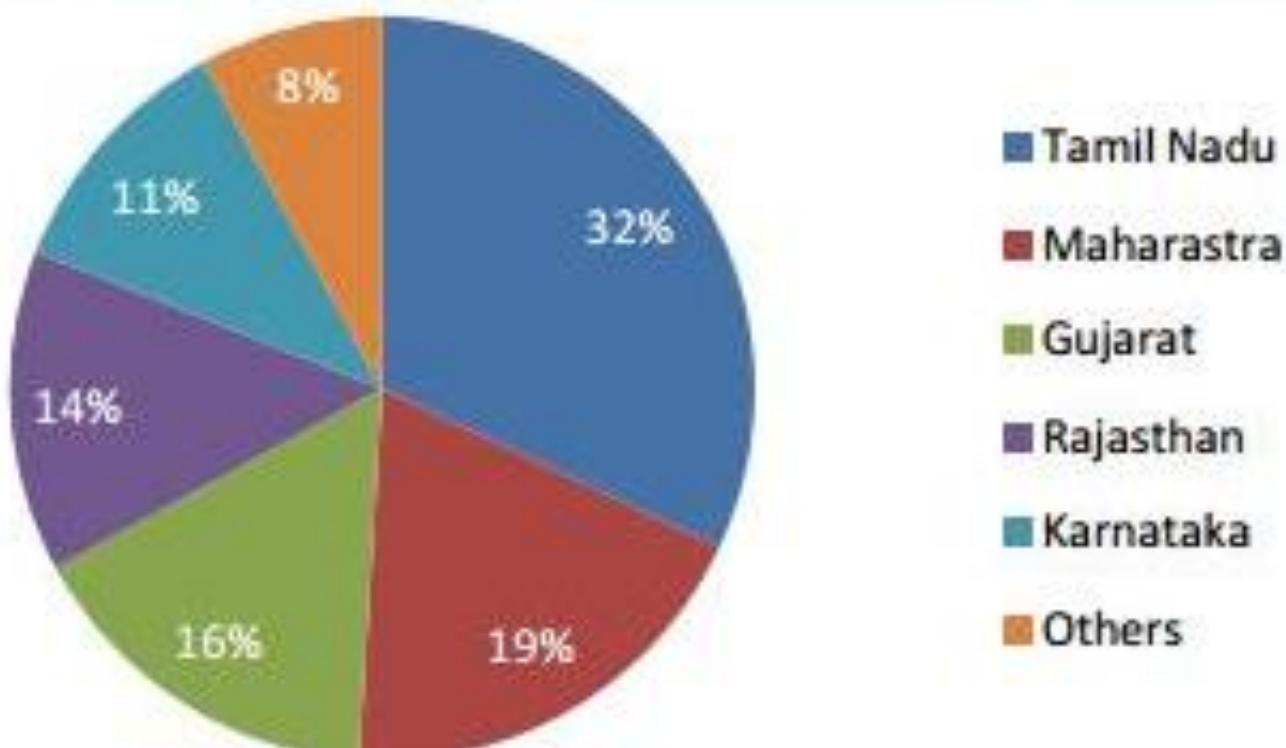


Source: *wikimedia*

State-wise electricity produced from wind

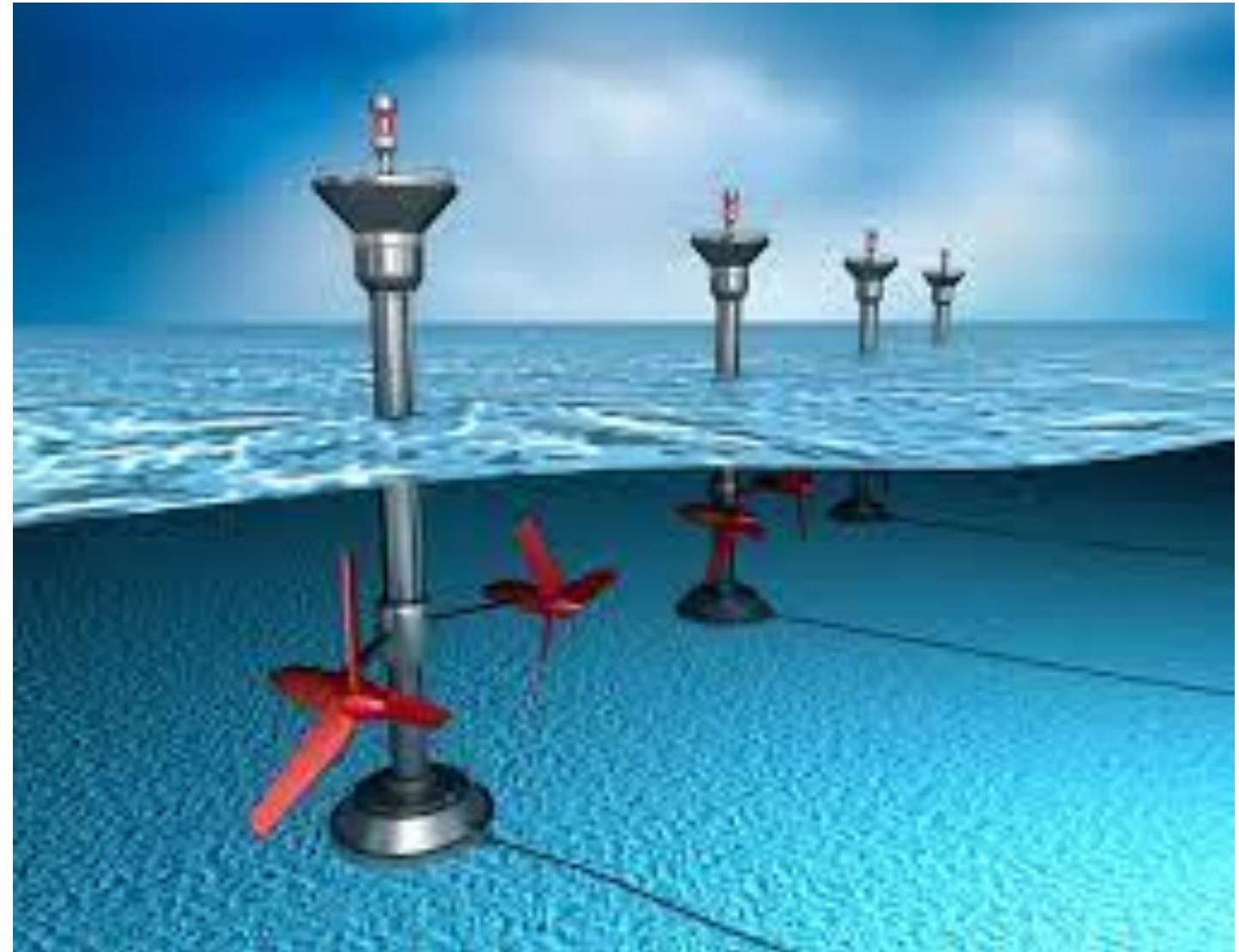


% of contribution of total installed capacity across states in wind power



Source: Central Electricity Authority

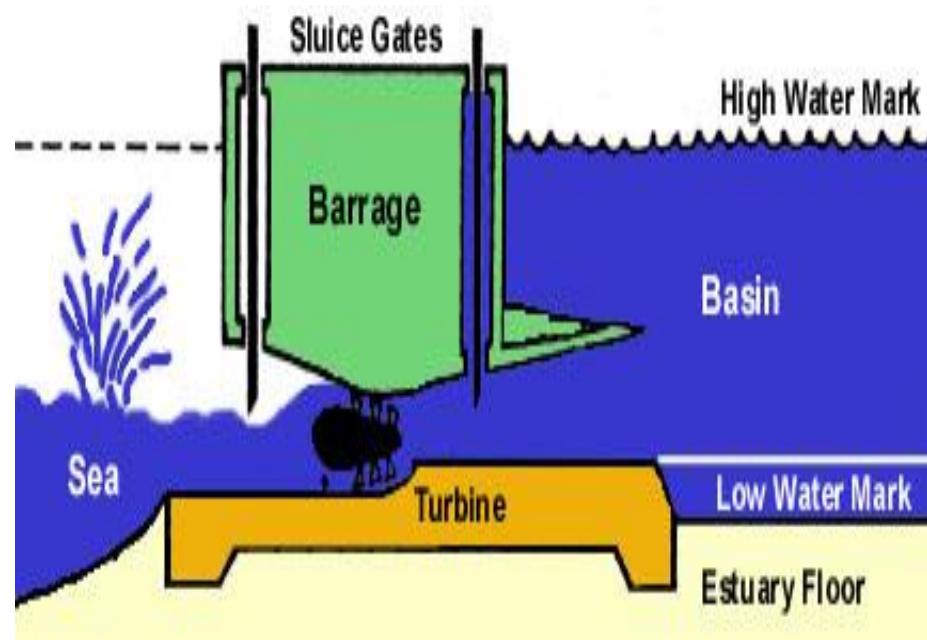
Wave -Tidal
energy



Turning Tides into Usable Energy

- A dam (barrage) is built across the mouth of an estuary.
- Sluice gates allow incoming tides to fill the basin.
- As the tide ebbs(receding tide),

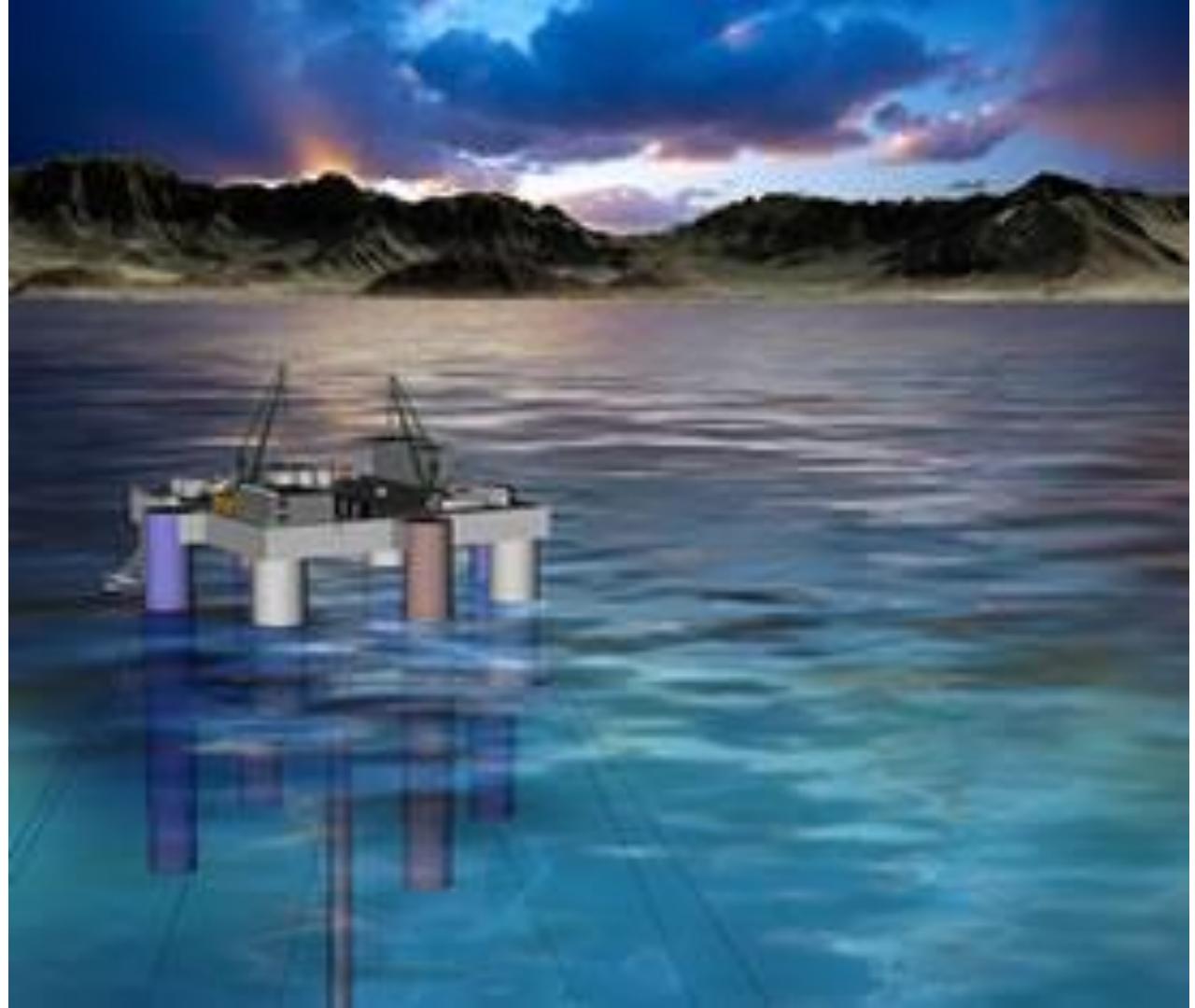
the water is forced through a turbine system to generate electricity.



Source: *wikimedia*

Ocean Thermal Energy Conversion (OTEC)

- *Source: wikimedia*



Three basic ways to tap ocean for its energy

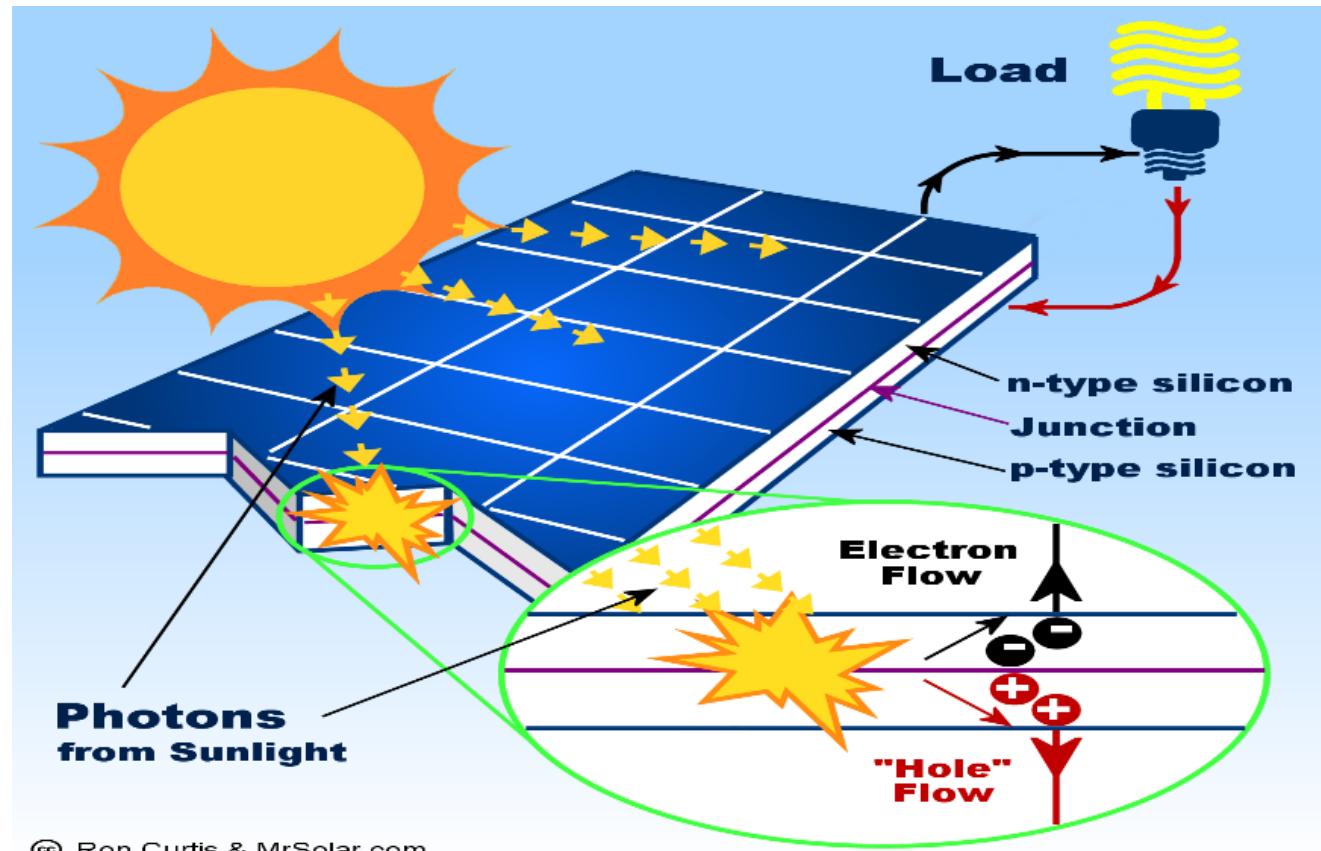
- Waves : Kinetic energy of the moving waves in the ocean can be used to power a turbine.
- Tidal energy (Renewable resource) : A difference of atleast 5m height between high and low tides is required for generating power.
- Temperature difference in water.

Solar energy



Devices

- There are two basic types of device currently used to capture and utilize solar radiation:
 - Solar thermal collectors, which are used to heat air, water or other liquids, depending on the application
 - Photovoltaic (PV) collectors, which convert sunlight directly into electricity.



Solar thermal collector



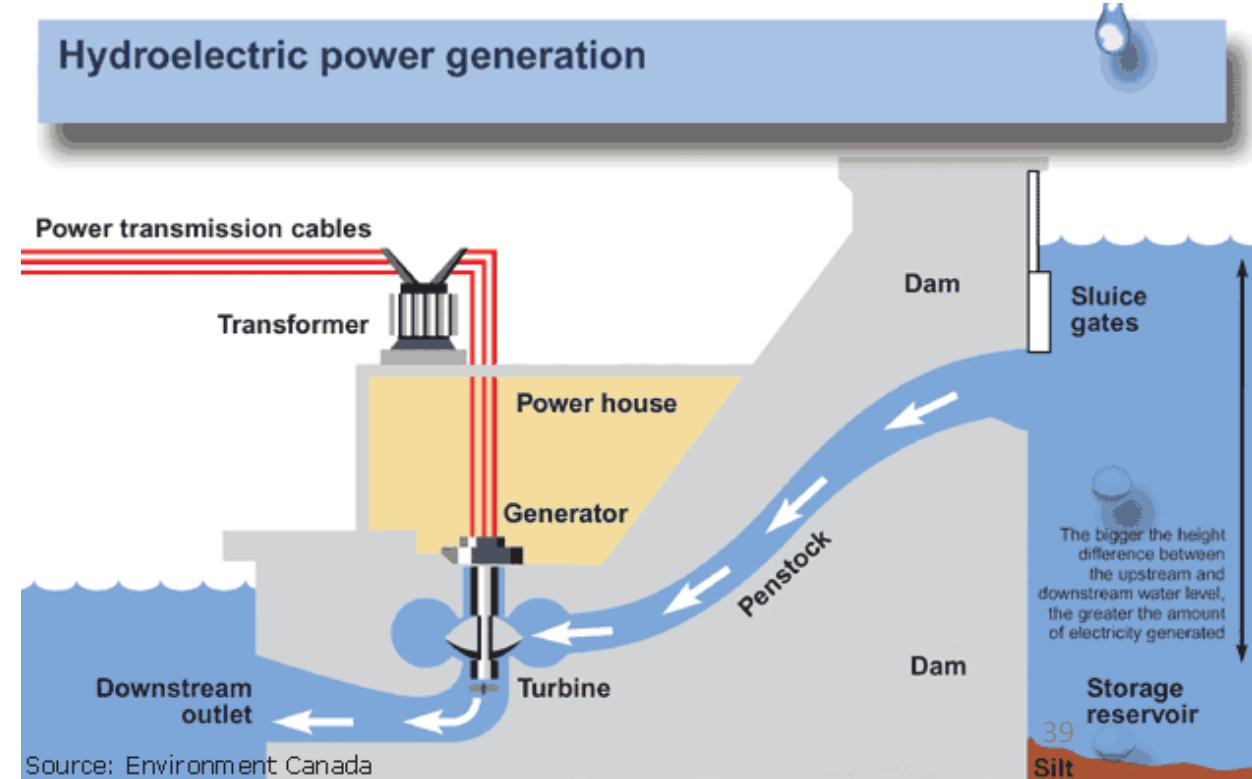
Source: wikimedia

PV cell- roof top solar panels



Hydropower...

- Hydro helps power generation in 160 countries.
- Five countries make up more than half of the world's hydropower production: Brazil, Canada, China, Russia and the USA.



The Changing Role of Hydropower

- There are 45,000 large dams in the world and the majority do not have a hydro component. Need to use it for power generation
- Long-term economic advantage. Operating costs minimal-autonomy from the fuel price is a distinct advantage.
- Water management- multipurpose hydro reservoirs can bring security of water supply as well as power.

Disadvantages

- Water logging
- Salinity of lands
- Siltation of reservoirs
- Submergence of forest lands and villages
- Displacement and rehabilitation of people affected
- Possibility of earthquakes



Hydrogen energy

Hydrogen - Today

Production



Steam Reforming
of Petroleum

Use



Space Programme

Storage



Cryogenic Liquid

Hydrogen - Tomorrow

Production

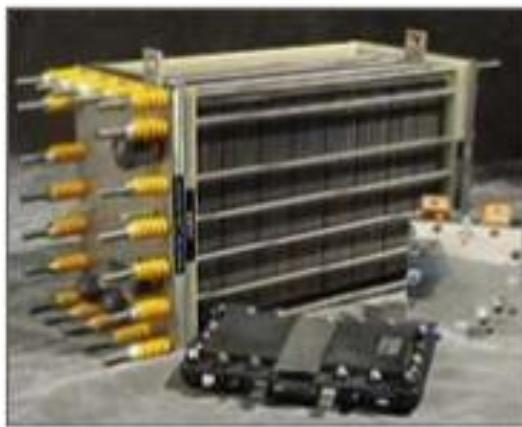


Bio-mass &
Electrolysis

Storage



Innovative Tank
Designs



Fuel for FUEL CELLS

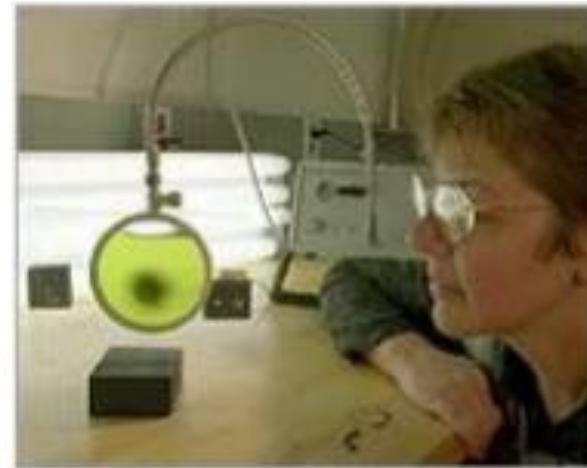
Hydrogen Production For Future



Photo-
electrochemical



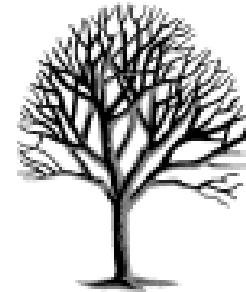
Solar powered
Electrolysis



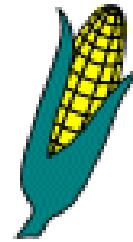
Algal Production

Biomass
energy

Types of Biomass



Wood



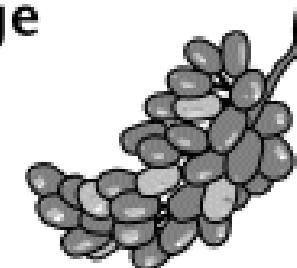
Crops



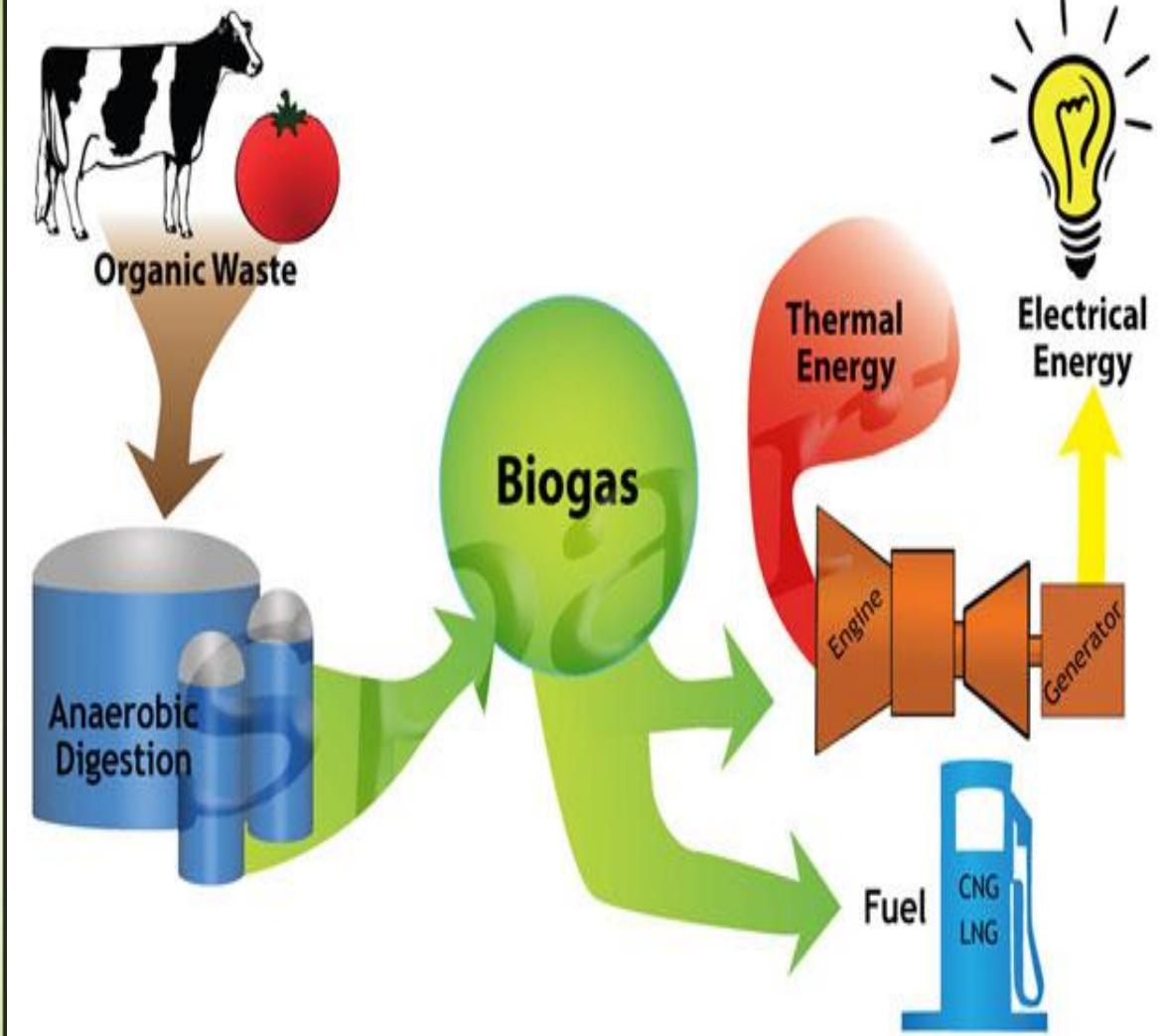
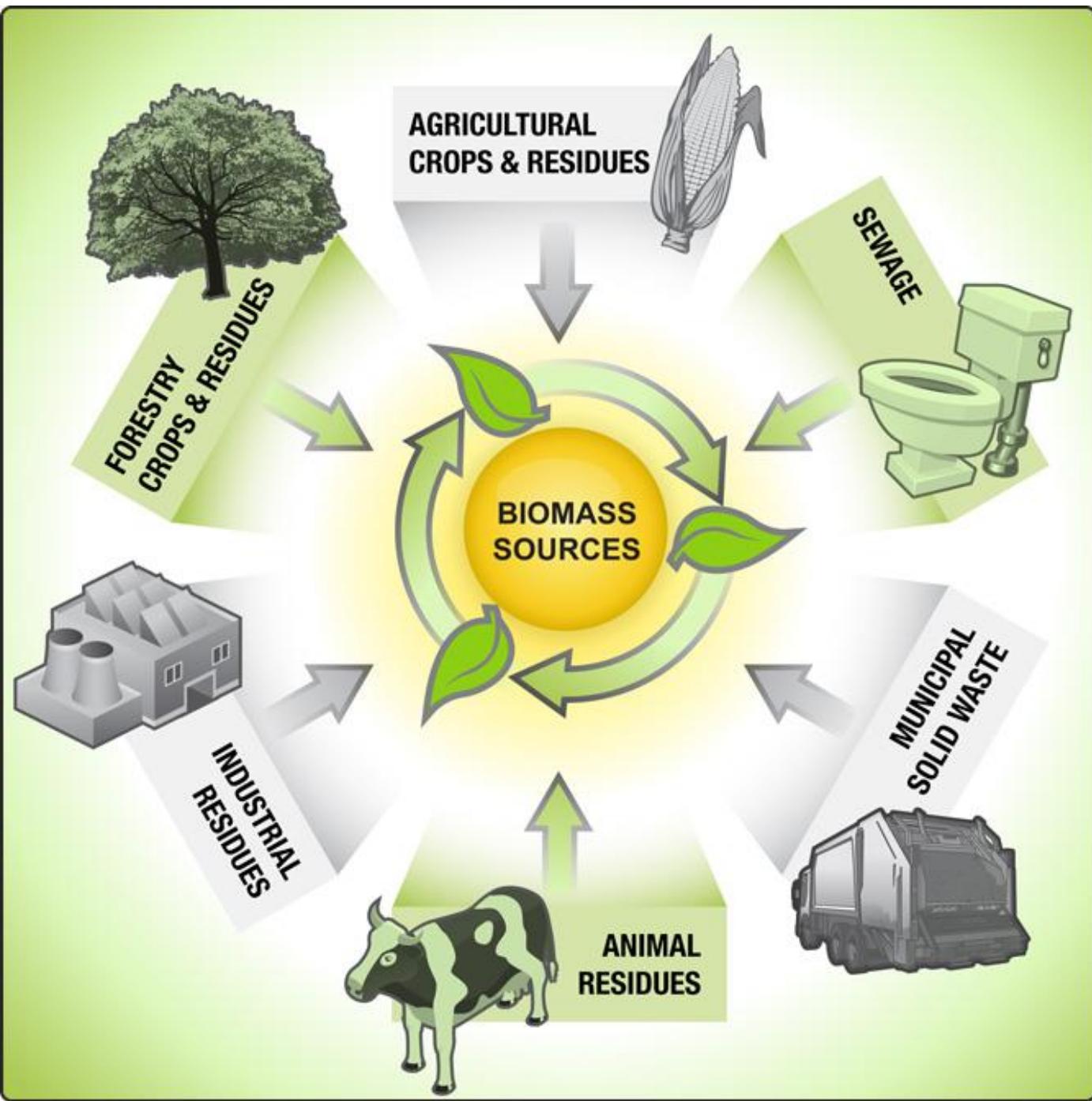
Garbage



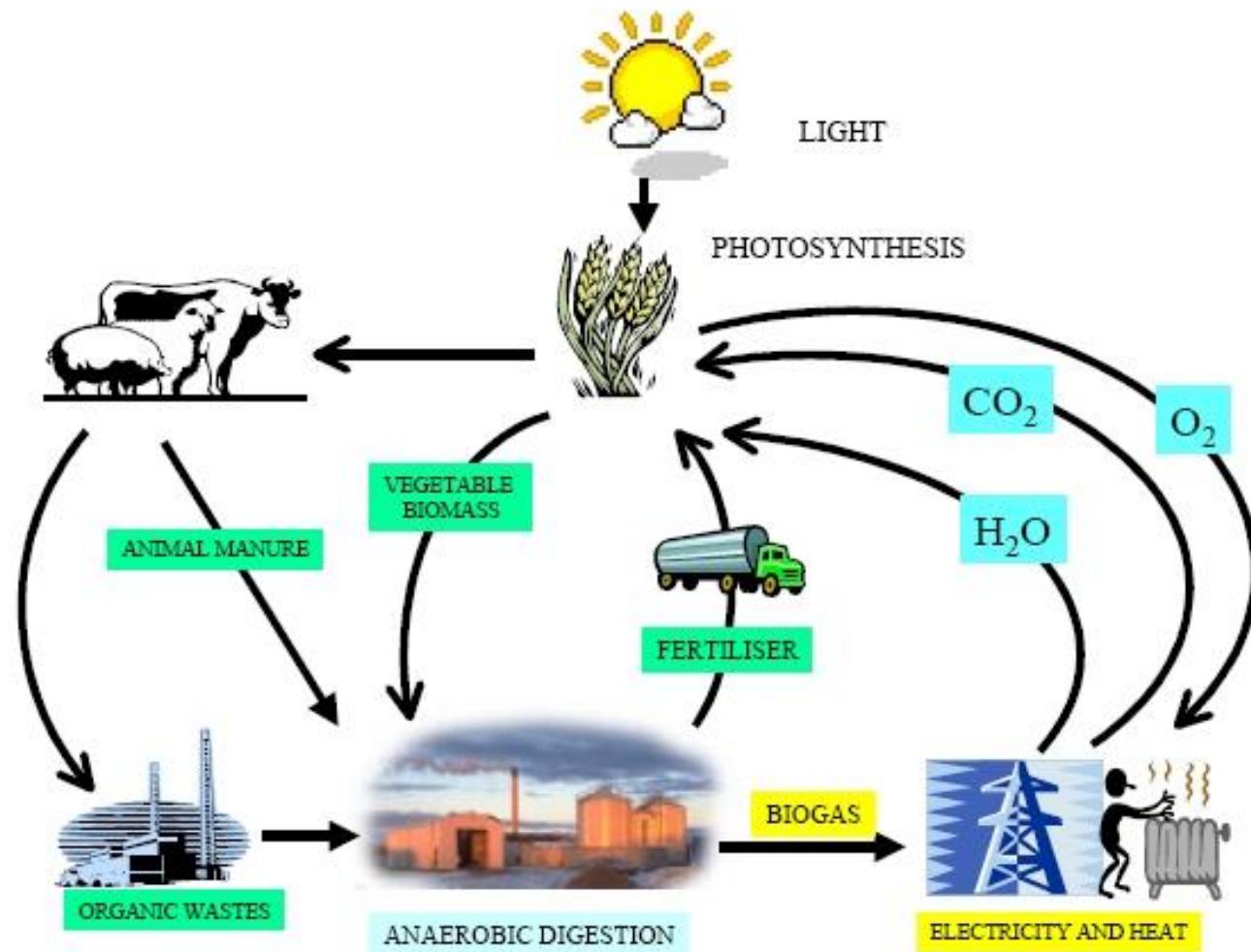
Landfill Gas



Alcohol Fuels

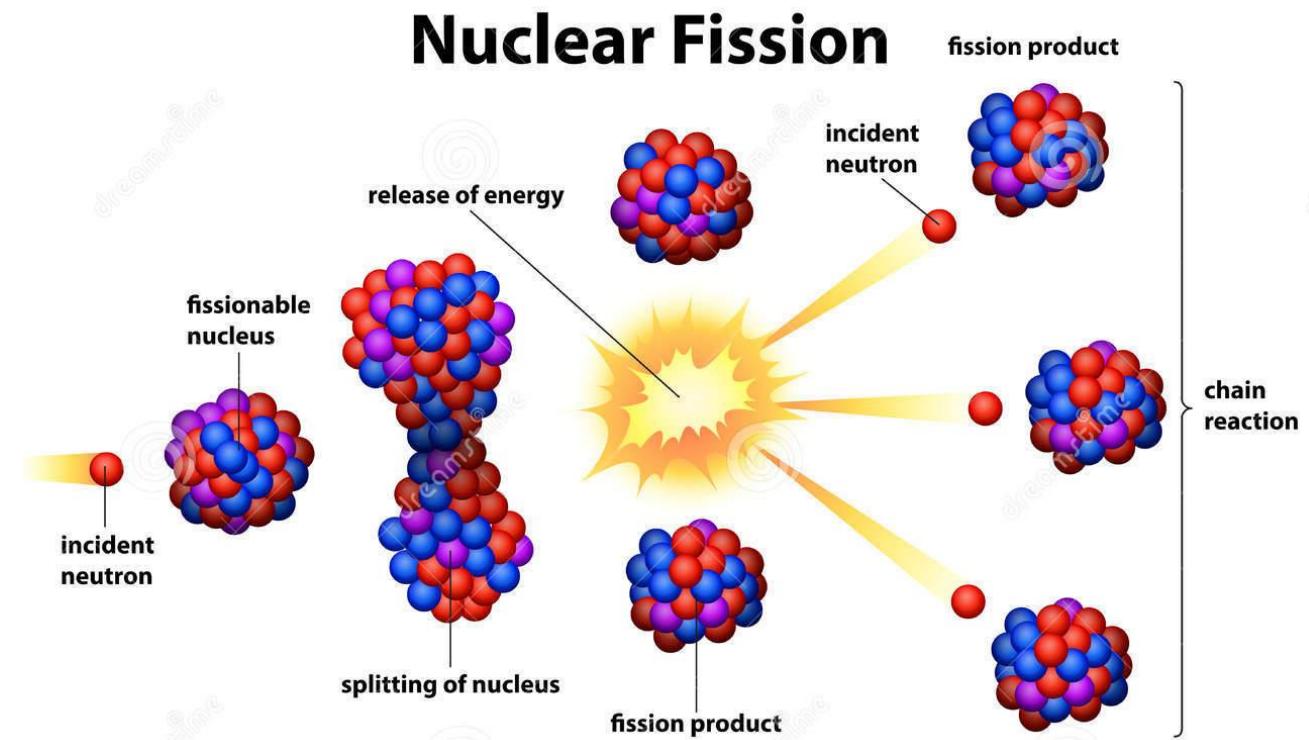


Biomass to
Biogas
(65% methane,
30% carbon
dioxide)



Sustainable - Nuclear Energy...

- Nuclear energy is renewable and economic alternative for coal.
- Alternative to fossil fuels.



Nuclear
reactor



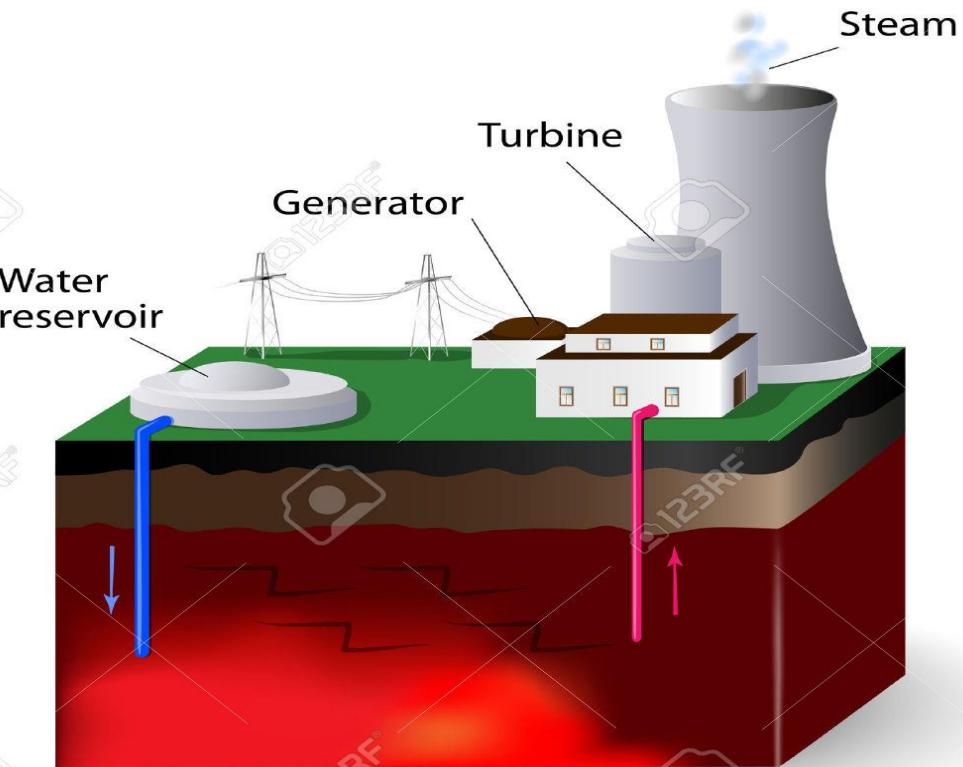
Source : World nuclear association

Planned Nuclear Power Plants in India

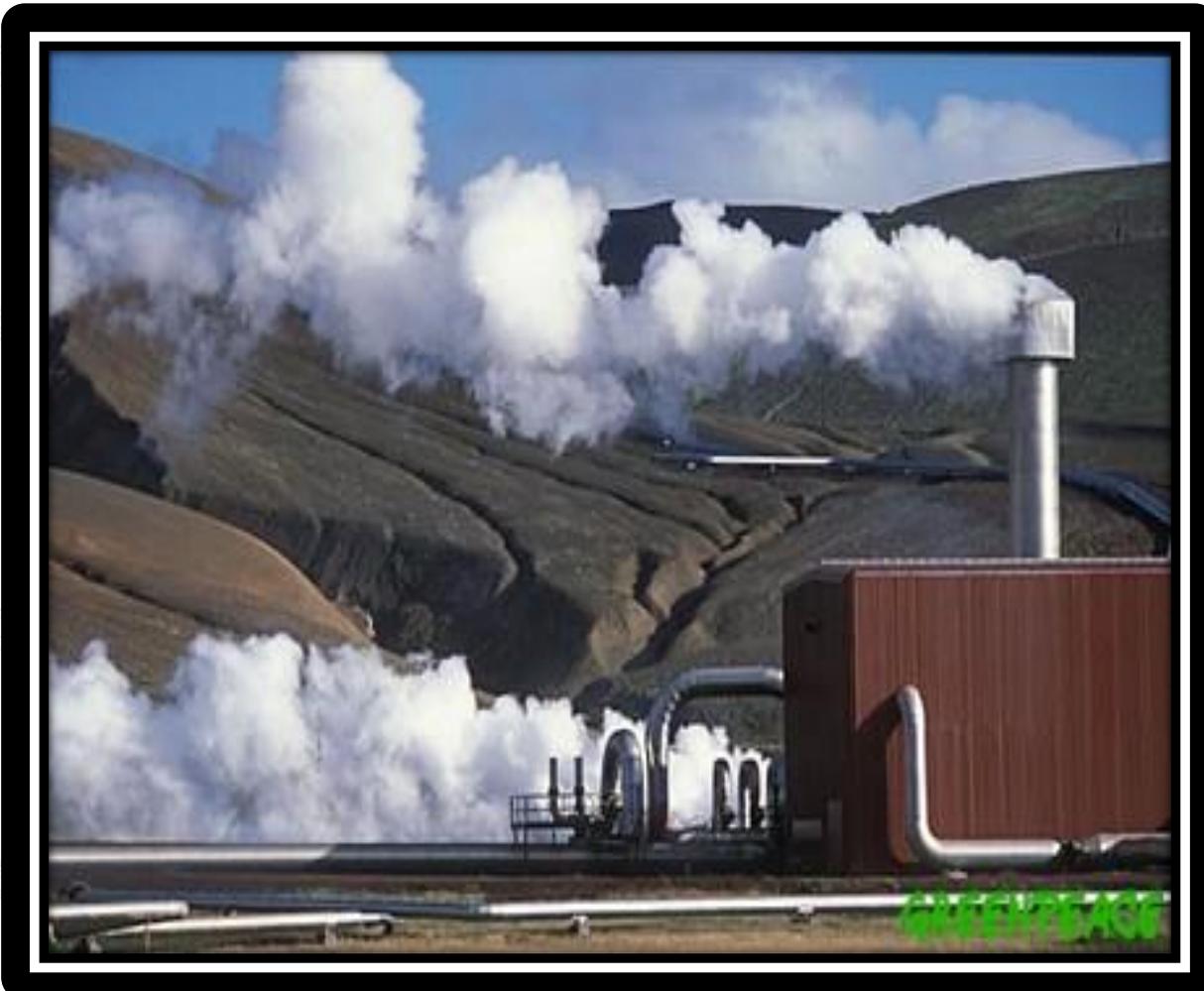


Geothermal energy

GEOTHERMAL ELECTRICITY

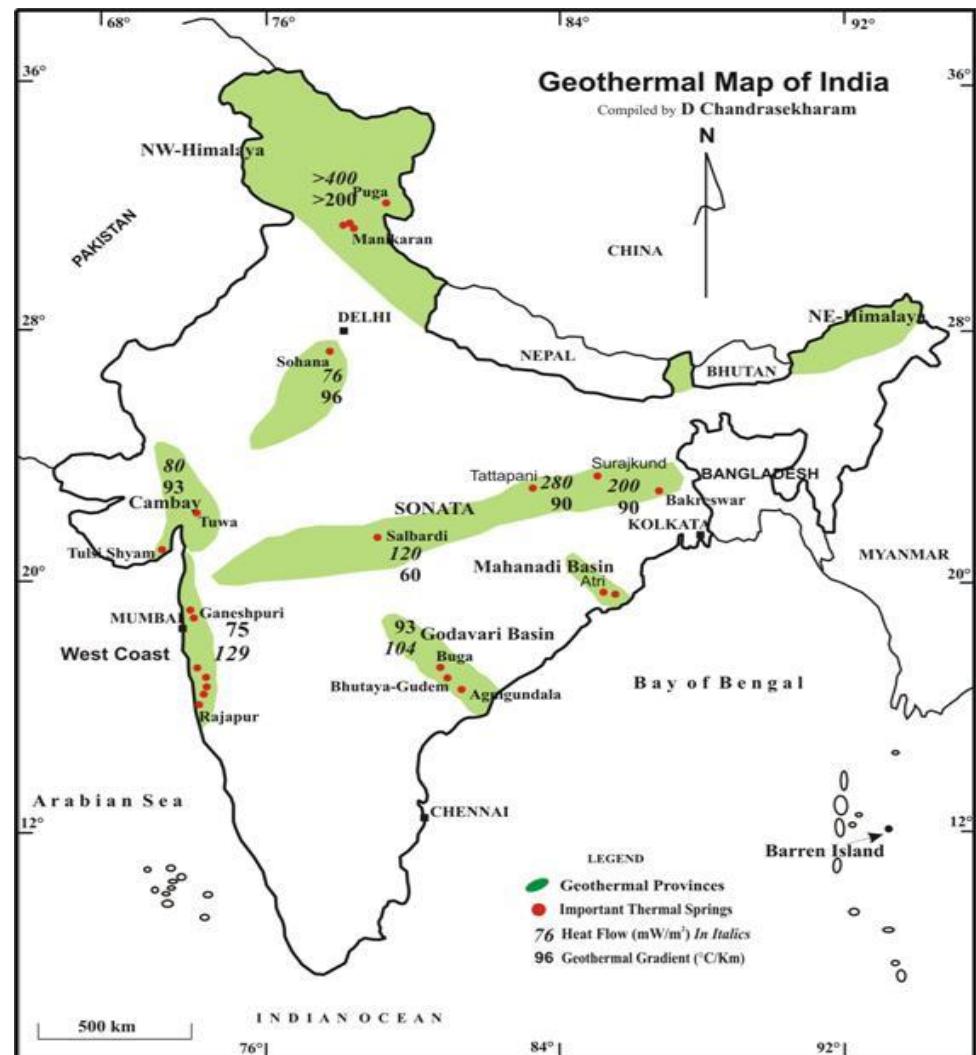


Source: wikipedia



Geothermal plant

Source: <http://www.geosyndicate.com/dchandra/geoenrgyresource.html>



Water Resources

While 67% of Earth's surface is covered by water, only less than 2.7% of global water is freshwater. Most of the freshwater (2.05%) are locked in ice caps and glaciers. Only less than 0.7% is available for human use.



Overutilization and pollution of surface and ground water

- With the growth of human population there is an increasing need for larger amounts of water to fulfil a variety of basic needs. Today in many areas this requirement cannot be met.
- Overutilization of water occurs at various levels. Most people use more water than really needed. Most of us waste water during a bath by using shower or during washing of clothes. Many agriculturists use more water than necessary to grow crops. There are many ways in which farmers can use less water without reducing the yields such as the use of drip irrigation systems.
- Agriculture also pollutes surface water and underground water stores by the excessive use of chemical fertilizers and pesticides. Methods such as the use of biomass as fertilizers and non toxic pesticides such as neem products reduces the agricultural pollution of surface and ground water.
- Industry tends to maximise short-term economic gains by not bothering about its liquid waste and releasing it into the streams, rivers, sea.

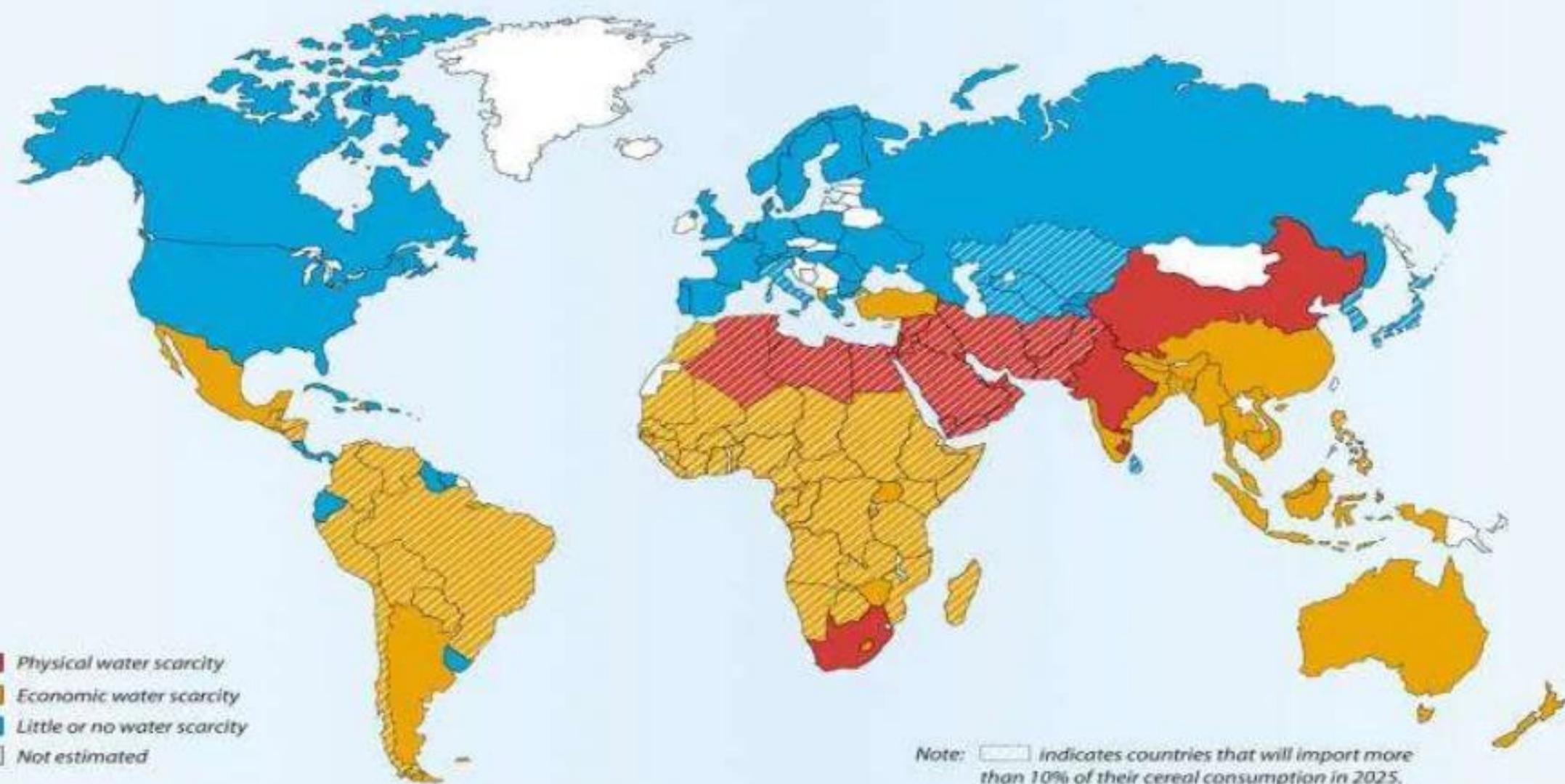
Water Resources

- Any disturbance to the flow of the rivers causes ***drought or floods.***
- Floods are the result of peculiar rainfall pattern. Of the total annual rainfall, 75% occurs over 3-4 months. This leads to very heavy discharge from rivers which floods large areas.
- Drought occur when rainfall is less than 400mm /year
- Ganga-Brahmaputra-Meghna, which carry about 60% of total river flow is the most flood prone region of India. States of Assam, Bihar, Uttar Pradesh (about 19 million hectares of land) get affected almost every year by floods.
- Similarly, 16% of the land area spread over 16 states is drought prone in India.

Distribution of population and water resources



Projected Water Scarcity in 2025



DTP Unit, IWMI – January 2000

Watershed management

What Is a Watershed?



Water Management

- Building several small reservoirs instead of few mega projects.
- Develop few catchment dams.
- Afforestation permits recharging of underground water.
- Treatment and recycling municipal waste water for agricultural use.
- Preventing leakages from dams and canals.
- Preventing loss in municipal pipes.
- Effective rain water harvesting in urban environments.
- Water conservation measures in agriculture such as using drip irrigation.
- Pricing the water at its real value makes people use it more responsibly and efficiently and reduce the water wasting.

What is Rainwater Harvesting?

Rainwater harvesting is the process of augmenting the natural filtration of rainwater into the underground formation by some artificial methods.

"Conscious collection and storage of rainwater to cater to demands of water, for drinking, domestic purpose & irrigation is termed as **Rainwater Harvesting**".

Why Rainwater Harvesting?

- To arrest ground water, decline and augment ground water table
- To beneficiate water quality in aquifers
- To conserve surface water runoff during monsoon
- To reduce soil erosion
- To inculcate a culture of water conservation

There are two ways of harvesting rainwater:

- (i) Surface runoff harvesting
- (ii) Roof top rainwater harvesting

Surface runoff harvesting:

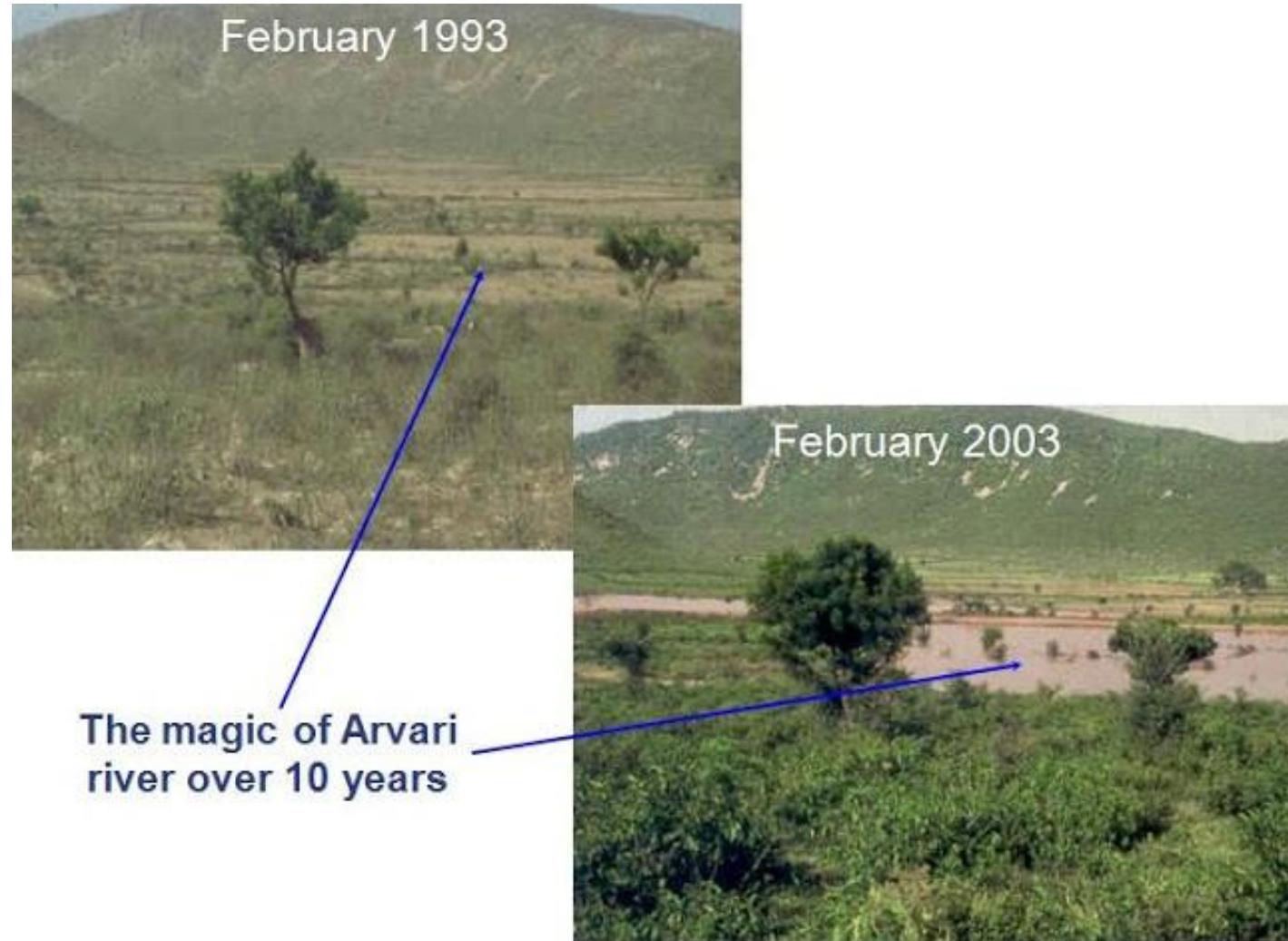
In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

Waterman of India

Rajendra Singh



Arvari river,
Rajasthan

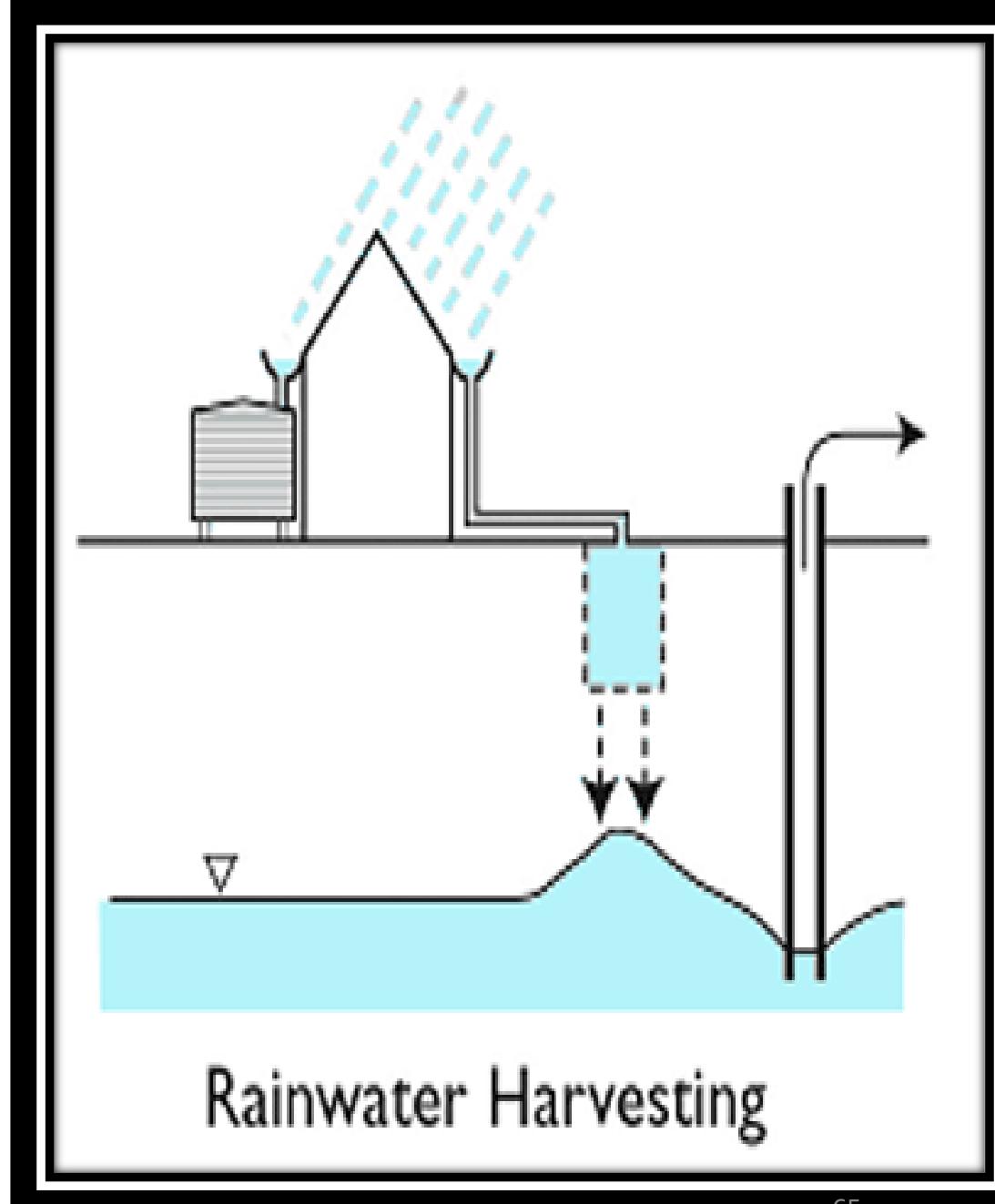


Manipal lake



Roof top rainwater harvesting

- Harvesting rainwater from roof-tops is an easy and eco-friendly method of augmenting household-level water availability.
- Roof-top rainwater harvesting (RRH) involves diverting and recharging (or) storing part of the rainwater that falls on the roof of a house.
- RRH for recharging groundwater is a common practice implemented in individual houses as well as apartment complexes.



What is the inter-linking river project?

- It aims to Transfer water from surplus to water deficit areas in the country.
- Inter-Linking River Program will help saving the people living in drought-prone zones from hunger and people living in flood-prone areas from the destruction caused by floods

What are the benefits?

- Irrigating 35 million hectares;
- Enabling full use of existing irrigation projects;
- Generating power to the tune of 34,000 MW with added benefits, including flood control.

What is the cost?

- Cost of the project was estimated at 5,60,000 crore.
- The true cost can be known only when the detailed project reports of the 30 river link projects are drawn up

What is the problem?

- Environmental problems
- Exotic species
- Inter-state disputes



Mineral Resources



Mineral Resources

- A mineral is a naturally occurring substances of definite chemical composition and identifiable physical properties.
- Minerals are formed over a period of millions of years in the earths crust.
- Iron, aluminium, zinc, manganese and copper are the important raw materials for the industrial use.
- Important non-metal resources includes coal, salt, clay, cement and silica.
- Stone used for building materials, such as granite, marble, limestone, constitute another category of the minerals.
- Minerals with special properties that humans values such as diamonds, emeralds, rubies. The luster of gold, silver, and platinum are used for the ornaments.
- Minerals in the form of the oil, gas, and coal were formed when ancient plants and animals were converted into underground fossil fuels.

India's contribution to world mineral production

- India is the world's largest producer of mica blocks and mica splitting's.
- With the recent spurt in world demand for chromite, India has stepped up its production to reach the third rank among the chromite producers of the world.
- Besides, India ranks
 - 2nd in production of coal
 - 4th in iron ore,
 - 6th in bauxite and manganese ore,
 - 2nd in crude steel in the World.



Types of mining

- Broadly there are two types:
 - Surface mining
 - Underground mining
- Environmentally surface mining creates more harm than underground mining.

Open Mining



Underground mining



Mining

- The extraction of the minerals and their ores from the earth's interior so that they can be used. This process is known as mining.
- Mines are of two types surface or deep or shaft mines.
- Mining is hazardous occupation, and the safety of the mine workers is an important.
- Surface mining is less hazardous than underground mining.
- Metal mining is less hazardous than coal mining.
- Mining poses several long term occupational hazards to the miners. Dust produced during mining operations is injurious to health and causes a lung disease known as black lung.
- Fumes generated by incomplete dynamite explosions are extremely poisonous.
- Radiation is hazardous in uranium mines.

Environmental impacts of mining

- Direct impact of the mine
- Disposal of mine wastes
- Transport of ores
- Ore treatment or refining
- Special impacts in coastal areas
- Long-term problems

Direct impact of the mine

- Land degradation- landslides, erosion, siltation
- Disturbing landscape, forests and wildlife
- Water, air, noise pollution

Special impacts in coastal areas

- Corals and other forms of life on the bottom generally require clear water for growth.
- Dredging and other forms of coastal mining destroy the immediate site and affect a much larger area through the sediment stirred up in the water.
- Removing sand and gravel from the beach can also cause beach disappearance and serious coastal erosion.
- Copper and other toxic materials from mines may kill most marine life in the vicinity of treatment and shipping facilities.

Long-term problems

Many islands have mining ghost towns and rusting equipment that are the only remaining signs of brief periods of prosperity (Kudremukh and Kolar).

Environmental protection

Government has initiated following measures to protect the environment before commencing and during any mining activity:

- Detailed EIA report has to be prepared and submitted to ecological & environment dept. of GOI for clearance of mining project to safeguard the public interest.
- Indian Bureau of Mines has to over see safe mining practices.
- Forest dept. has to clear the mining project.

Environment protection during mining

- Soil erosion has to be prevented by constructing suitable check-dams & planting suitable species of shrubs and trees.
- Dust has to be suppressed.
- The mined area has to be back-filled with excavated materials & restored to the original condition.
- A green-belt has to be created.
- If houses & villages are to be displaced, adequate rehabilitation and welfare measures need to be taken.

Land Resources

- “Land” means the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system.
- Land is More valuable when :
 - Climate is pleasant,
 - Availability of plenty of potable water,
 - Clean-fresh air, flora & fauna,
 - Good communication facility in the form of roads and railways etc.
 - Scenic, educational/research value of the landscape
- Similarly, if the climate is bad, full of desert conditions this resource is less valuable.

Soil formation

Definition of soil:

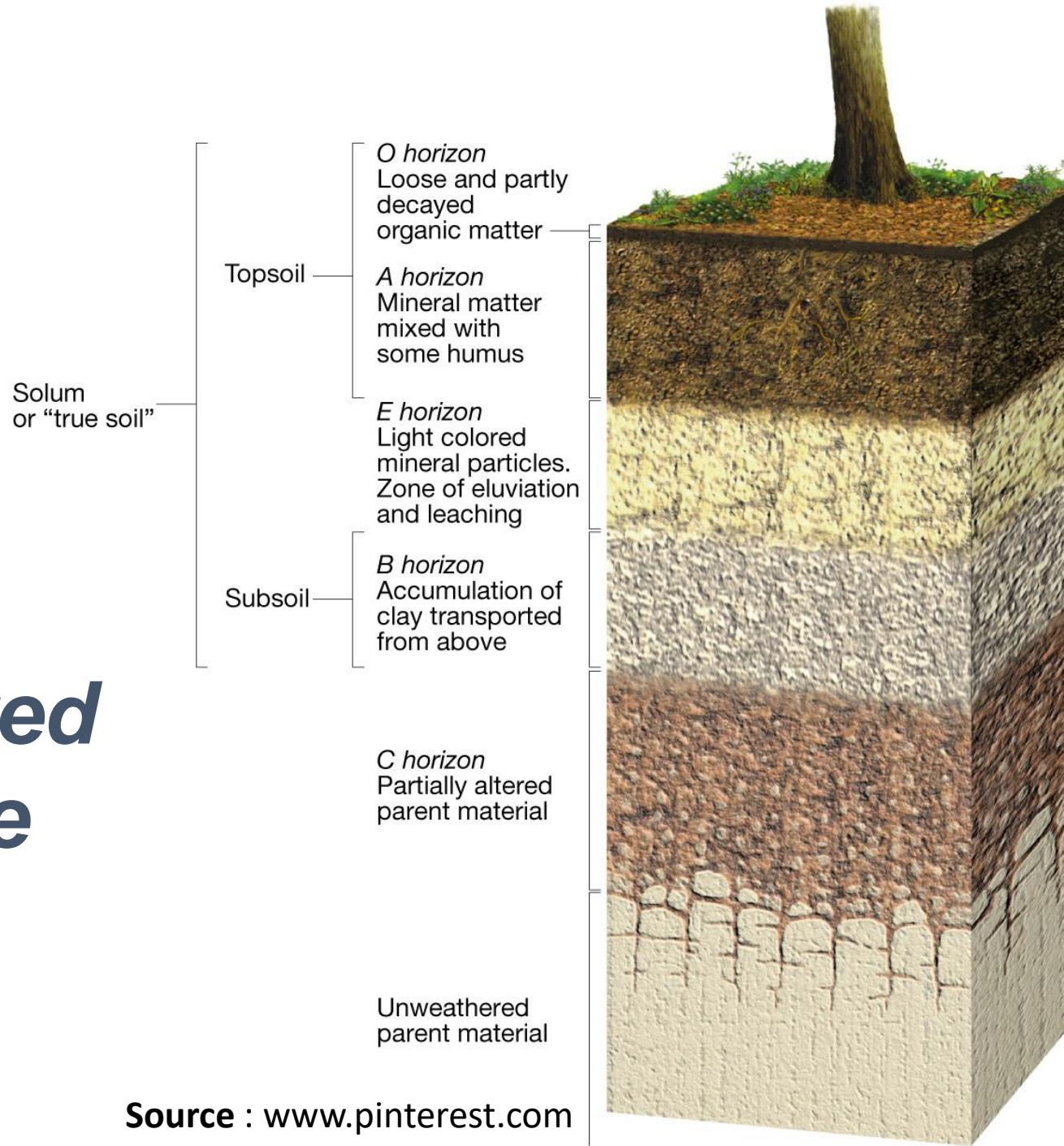
The upper layer of the ground made of unconsolidated material produced due to weathering agencies from the rocks and generally modified subsequently by a variety of mechanical, chemical and organic processes all operating constantly in a complex manner.



Factors controlling soil formation

- Parent material
 - parent material is the underlying bedrock - composition affects soil types
- Time
 - Soils get better developed (Thicker, with greater differences between layers)
 - with more time
- Climate
 - Biggest control on soil formation (Key factors are temperature and precipitation)
- Plants and animals
 - Organisms influence soil properties
 - Also furnish organic matter to the soil (especially plants)
- Slope
 - Steep slopes have poorly developed soils (due to faster erosion and downslope transport)
 - Flatter terrain accumulates soil faster

An idealized soil profile with horizons



Soil Profile

- Vertical differences are called **horizons** – zones or layers of soil

O horizon – organic matter

A horizon – organic and mineral matter

High biological activity (animals live here)

Together the O and A horizons make up topsoil

E horizon – little organic matter

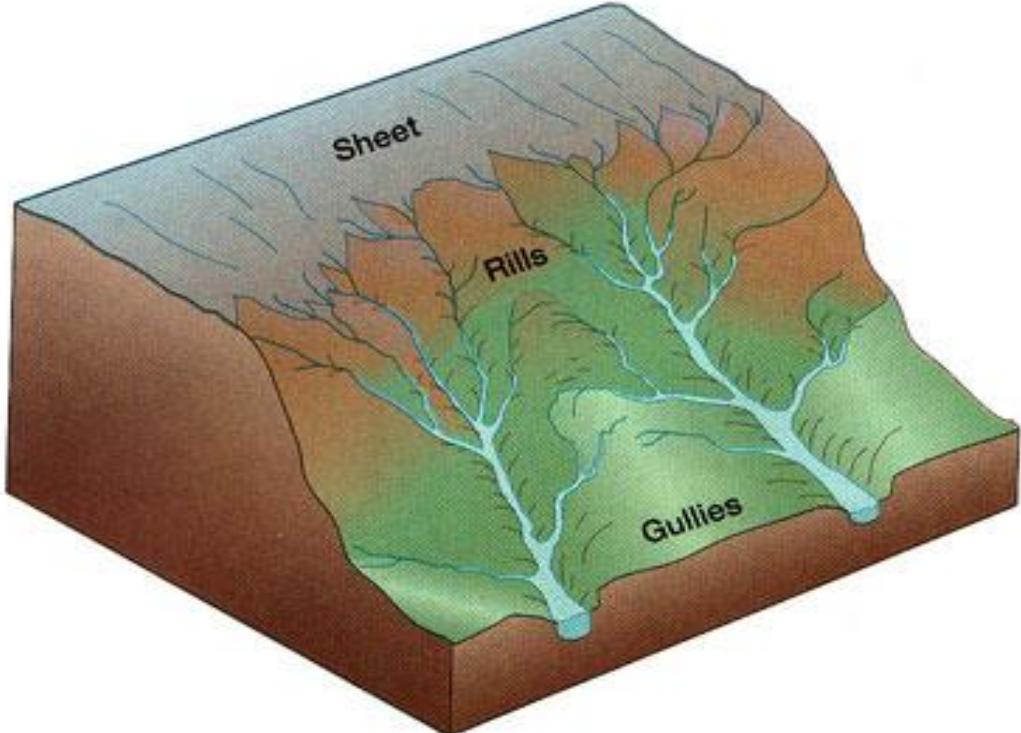
Zone of leaching (loss of nutrients from soil)

B horizon – zone of accumulation

C horizon – partly altered parent material

Eluviation : The movement of various dissolved or suspended chemicals, minerals, etc. downward through the soil due to the movement of ground water.

Soil erosion



Sheet erosion

Sheet erosion is the transport of loosened soil particles by overland flow.

Rill erosion

When sheet flows begin to concentrate on the land surface, rill erosion occurs. This type of erosion occurs when the duration or intensity of rain increases, and runoff volumes accelerate.

Gully erosion

Gully erosion occurs when runoff water accumulates, and then rapidly flows in narrow channels during or immediately after heavy rains or melting snow, removing soil to a considerable depth

Causes of soil erosion

- Deforestation- Wind and water are the main agents
- Intensive agriculture
- Over grazing

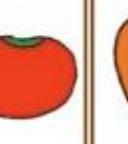
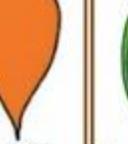


Source: wikimedia

Prevention and control

Agricultural practices of controlling land degradation:

- a) Crop rotation
- b) Strip farming (*Strip cropping* or *strip farming* is defined as alternating crop rows between heavy-rooted plants and loosely-rooted plants to minimize erosion)
- c) Ridge and furrow type of irrigation (*Furrows* are small, parallel channels, made to carry water in order to irrigate the crop. The crop is usually grown on the *ridges* between the *furrows*)
- d) Cultivation of grassland
- e) Mulches [protective layer of plants]

	Area 1	Area 2	Area 3	Area 4
Year 1				
Year 2				
Year 3				

3-year crop rotation



Strip farming



Ridge and furrow



Terrace construction



Source: wikipedia

Mulches

Wasteland reclamation

- Encourage social forestry.
- Less chemicals in agricultural practices.
- Construct water harvesting structures.
- No crop for one season such that land recovers mineral loss.
- Practice bioremediation to restore land. (*Bioremediation* is a waste management technique that involves the use of organisms to remove or neutralize pollutants from a contaminated site)

Ecosystem and Biodiversity

Ecology

The word ecology is derived from Greek word ‘Oekologic’. Oikos means ‘habitation’ or ‘house’ and logos means study.

It was first coined by the German biologist Ernst Hoeckl in 1886, who defined it as “The comprehensive science of the relationship of the organism to the environment”.

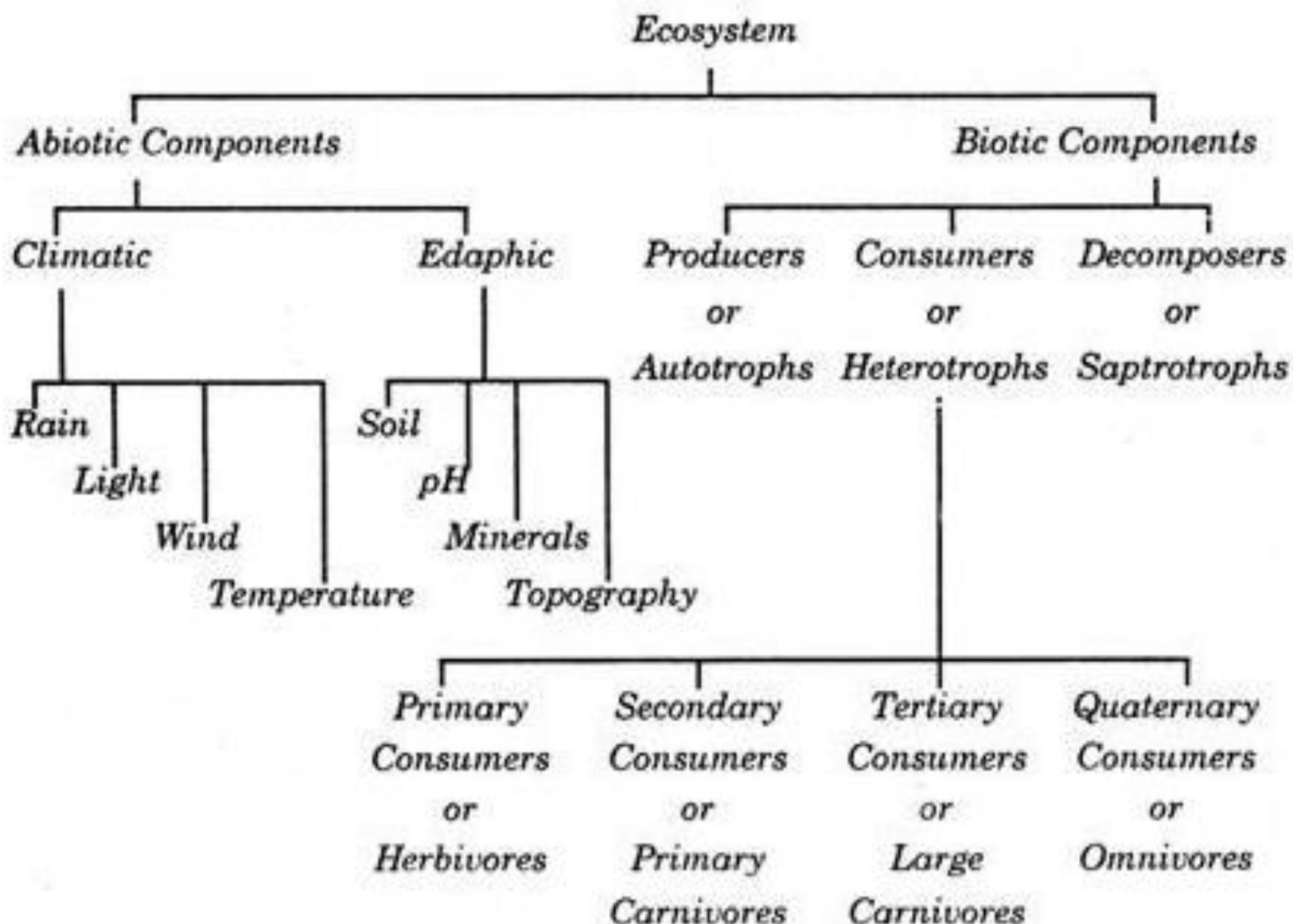
It can also be defined as “ The scientific study of the relationship of living organism with each other and with their environment”.

Ecosystem

Definition: The living community of plants and animals (Biotic) in any area together with the non-living components of the environment such as soil, air and water (Abiotic) constitute the ecosystem

It is also defined as a Natural unit of living organisms and their non-living environment that interact to form a stable system.

STRUCTURE OF AN ECOSYSTEM



Schematic Representation of the Structure of an Ecosystem.

Functions of an ecosystem

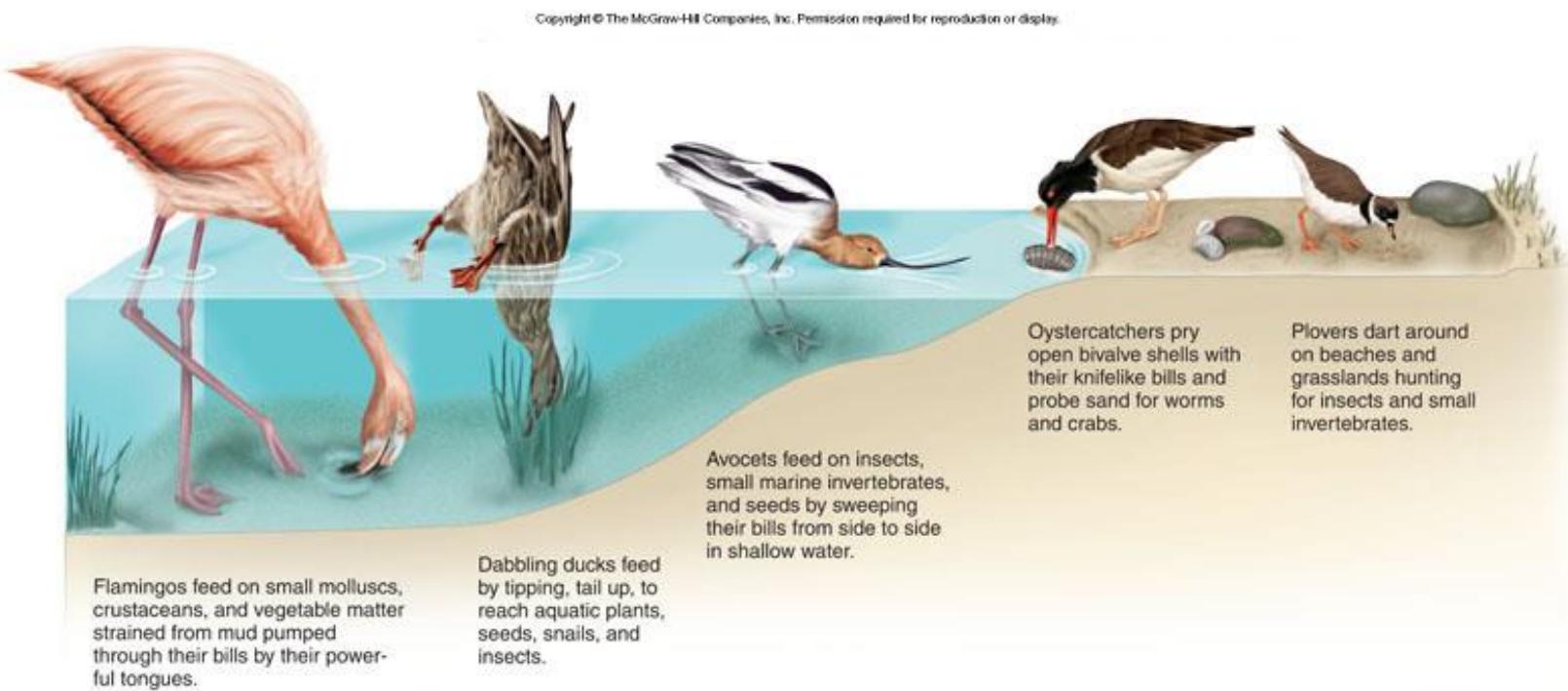
Major functional attributes of ecosystem are

- Energy Flow
- Nutrients cycling
- Productivity and decomposition
- Development and stabilization

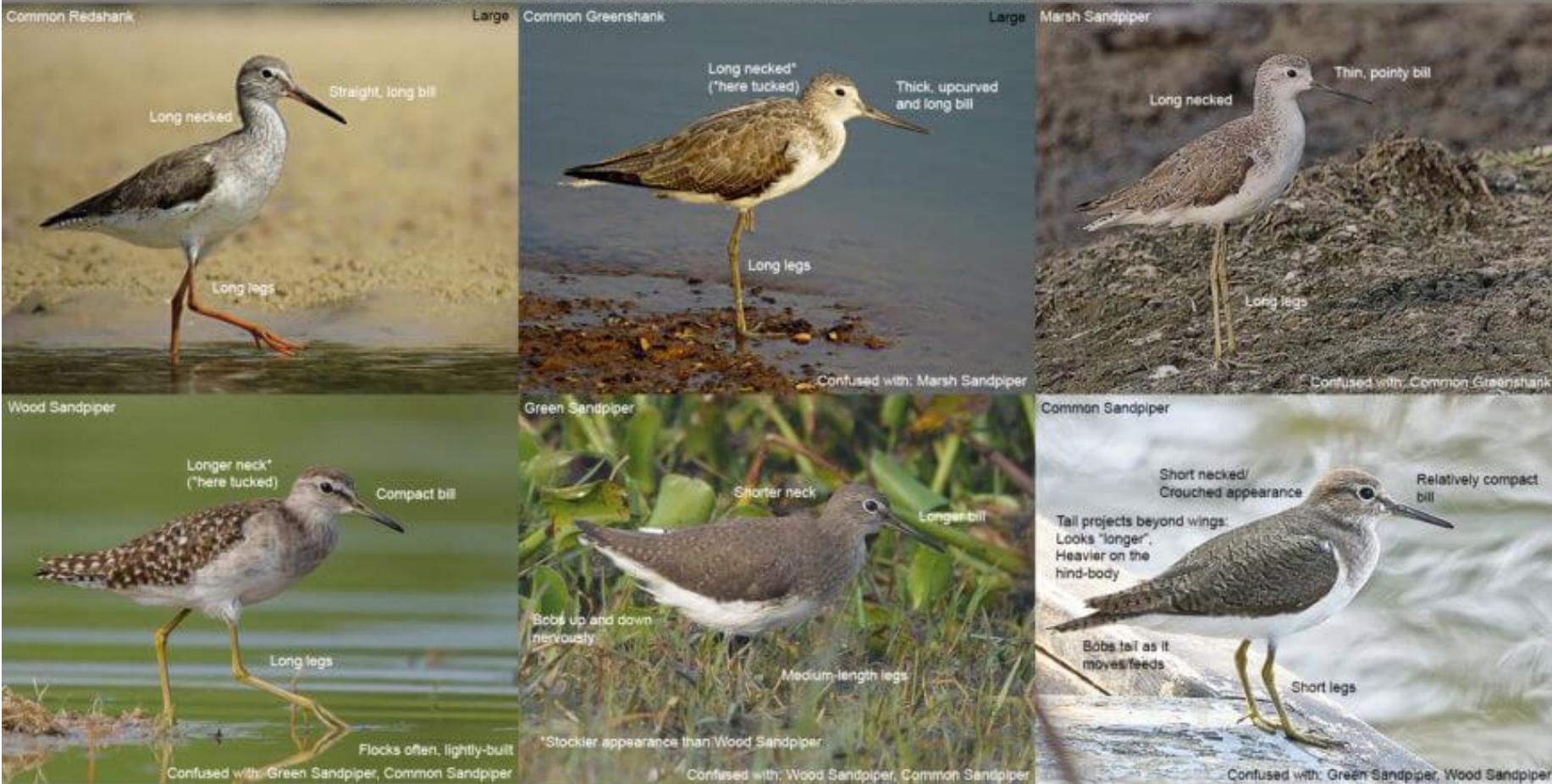
Ecological Niche

An Ecological niche is the match of a species to a specific environmental condition

Ecological Niche- Wading Birds



Identifying Waders: Part 1 (Common tringa and actitis species) - Structure



For more: <https://birdcount.in/waders-identification-1/>

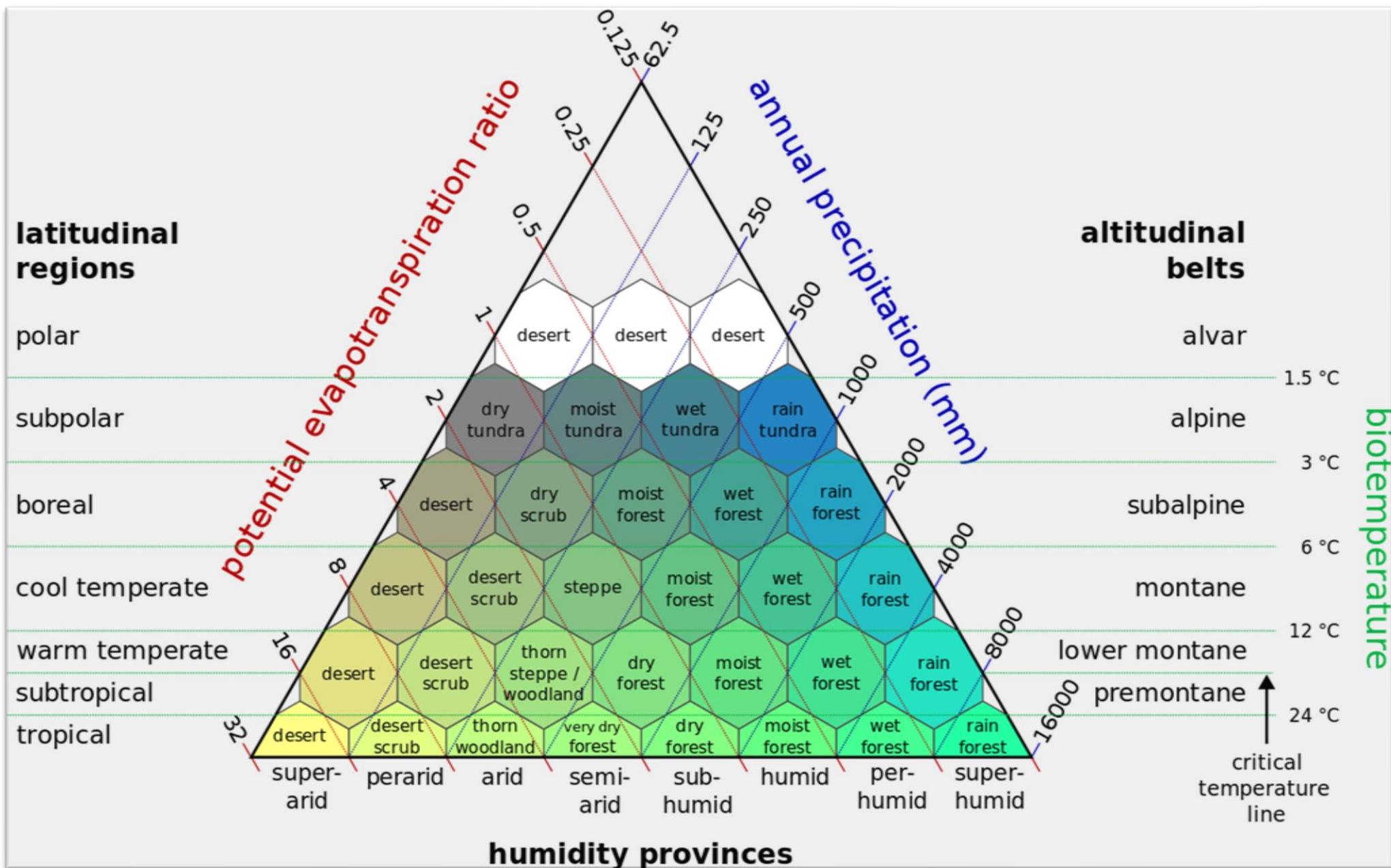
Images: Ramit Singal, Mukundan Kizhakkemadham, Palani Andavan Balasubramanian, Sanjay Malik, Arun Prabhu

PC: Ramit Singal

Niche partitioning among five species of coexisting warblers



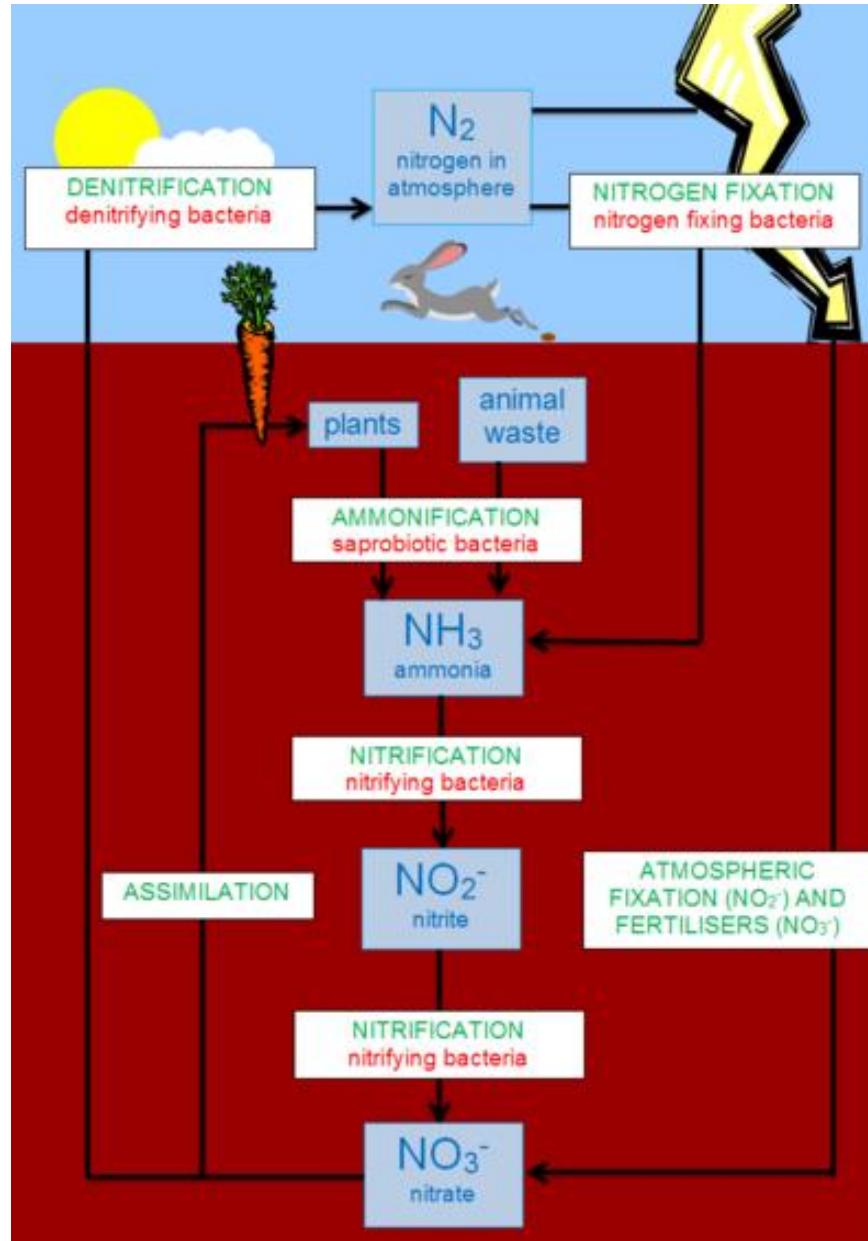
Holdridge life zones- Terrestrial Ecosystems



Energy and Nutrient Flow in an Ecosystem

- Energy flows through the ecosystem in one direction.
- On the other hand, matter moves through ecosystem in numerous cycles. The nutrients that organisms needs to grow, live, and reproduce are continuously taken from the abiotic environment, consumed, and then recycled back to the environment.
- There are several such *biogeochemical cycles*(with biological, geological and chemical interaction), powered directly or indirectly by solar energy. They include *Water cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Phosphorous cycle*.
- Earth is essentially closed system- matter can not escape from its boundaries.

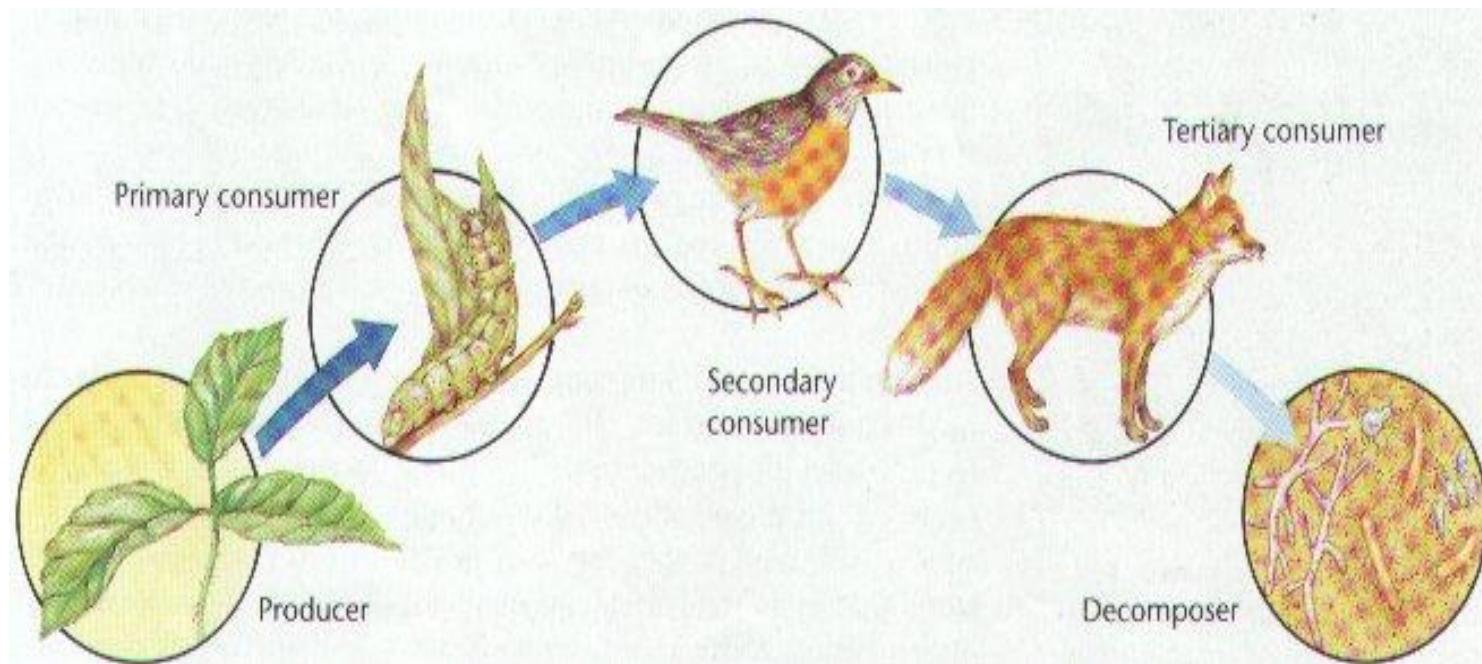
Biogeochemical cycle



Food Chains

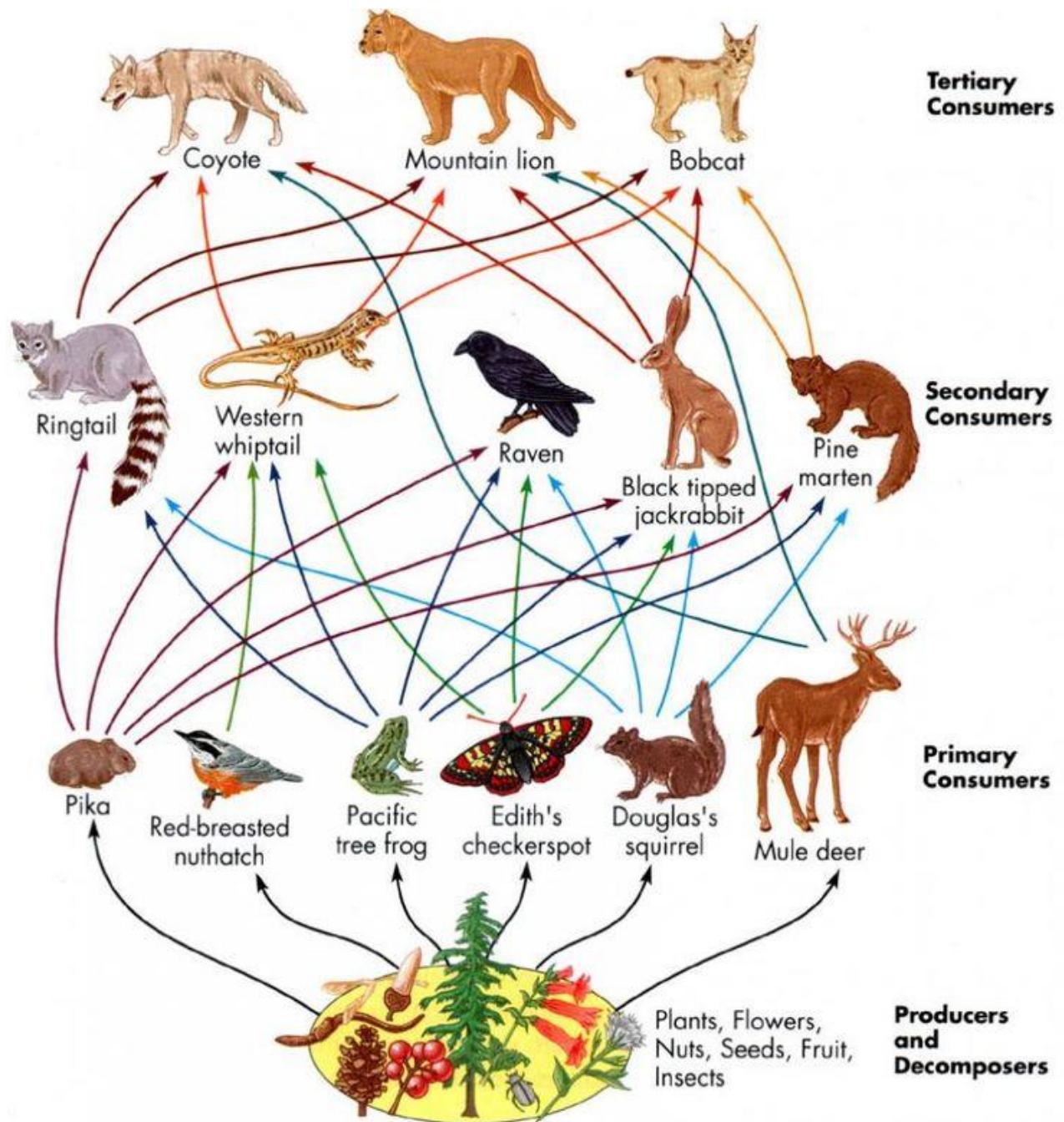
- The producers, consumers, and decomposers of each ecosystem make up a food chain.
- There are many food chains in an ecosystem.
- Food chains show how energy is transferred and not who eats who.

Example of a Food Chain



Food Web

Many food chains overlap, since most organisms have more than one item on their menu. Again an organism can be found on the menus of many other organisms. Thus we have a complex network of interconnected food chains, which is called as Food Web.



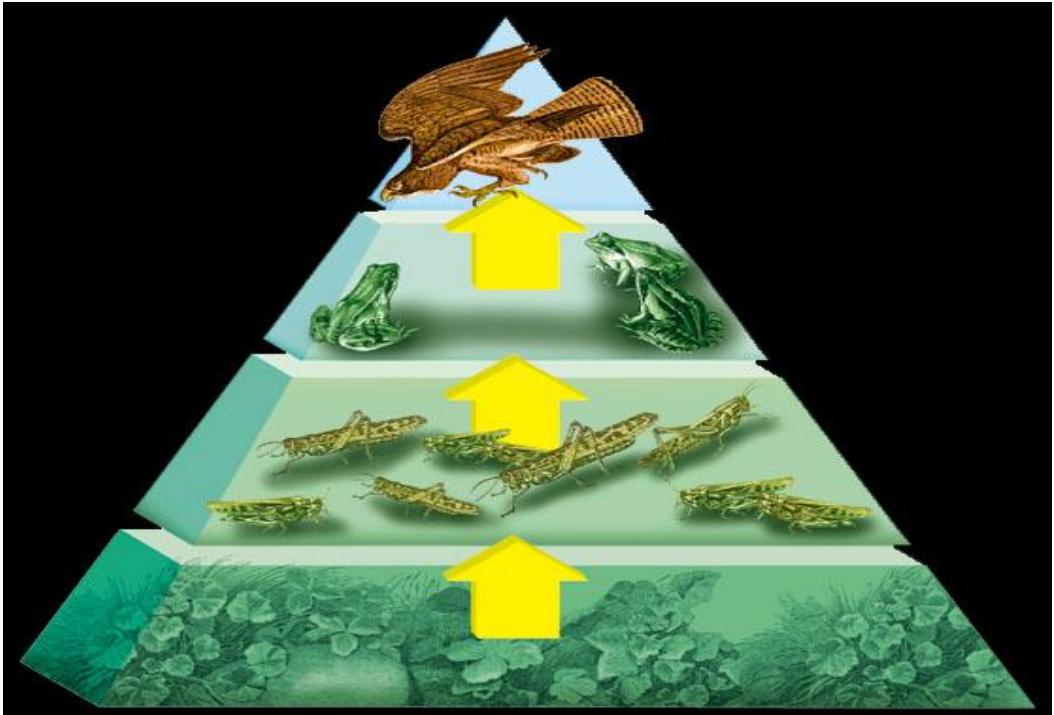
Understanding Food webs-Trophic Levels

- A trophic level is the position occupied by an organism in a food chain.
- Trophic levels can be analyzed on an energy pyramid.
- **Producers** are found at the base of the pyramid and compromise the **first trophic level**.
- **Primary consumers** make up the **second trophic level**.
- **Secondary consumers** make up the **third trophic level**.
- Finally **tertiary consumers** make up the **top trophic level**.

Biomass

- Energy is sometimes considered in terms of biomass, the mass of all the organisms and organic material in an area.
- There is **more** biomass at the trophic level of **producers** and **fewer** at the trophic level of tertiary **consumers**.
- **Bio=life Mass=weight**
- **Bio + Mass = Weight of living things within an ecosystem.**

Energy/Biomass Pyramids

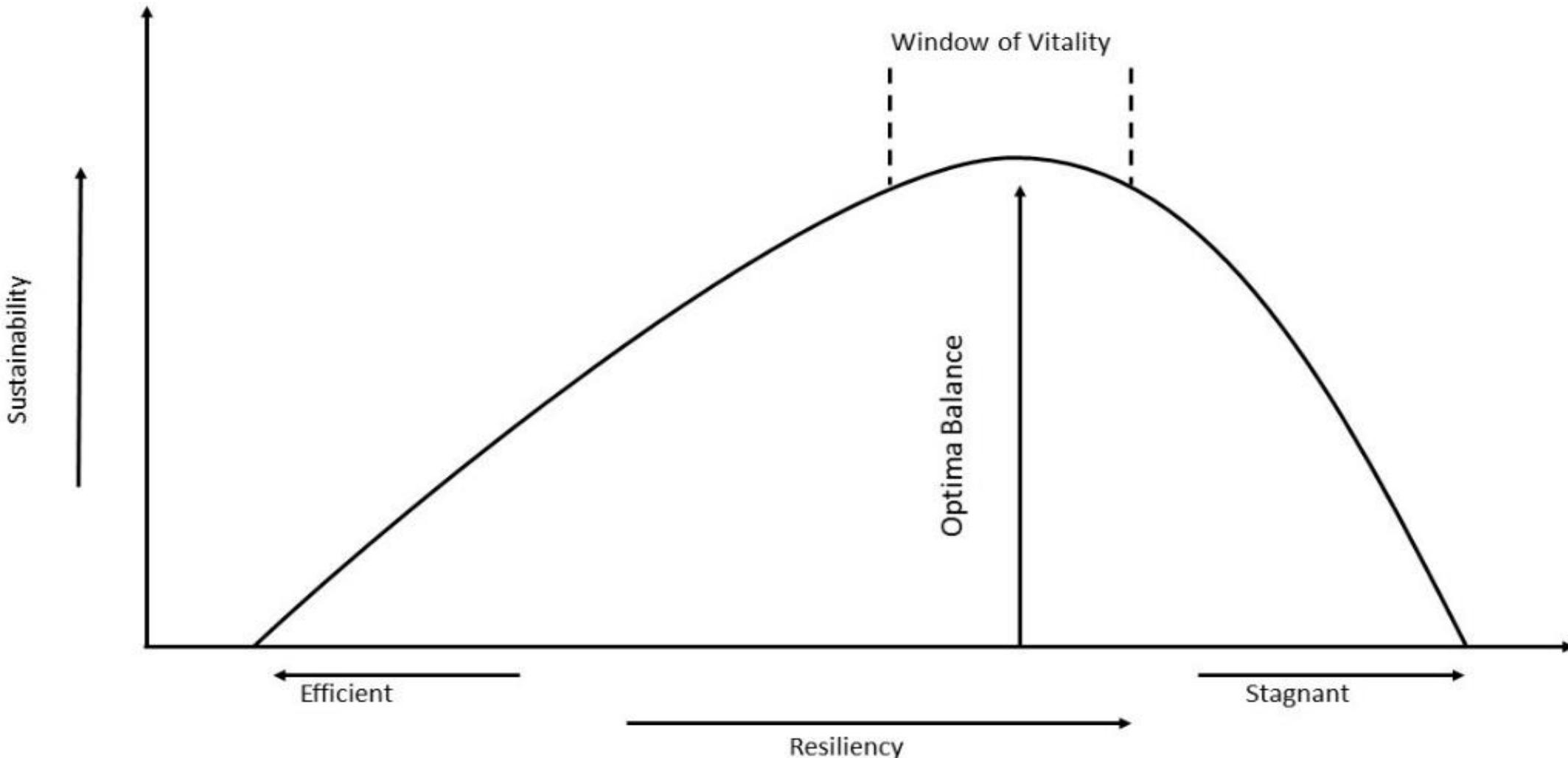


- The greatest amount of energy/biomass is found at the base of the pyramid.
- The least amount of energy/biomass is found at top of the pyramid.

Assessing Health of Ecosystems Through Energy/Biomass Pyramids

- The slope and the trophic levels of the pyramid can be approximated for a healthy ecosystem (different ecosystems will have different constituent in each trophic level and slope in the energy/biomass pyramid).
- A significant deviation from the approximated norm can point to serious problems in an ecosystem

Health of Ecosystems: A complex systems perspective



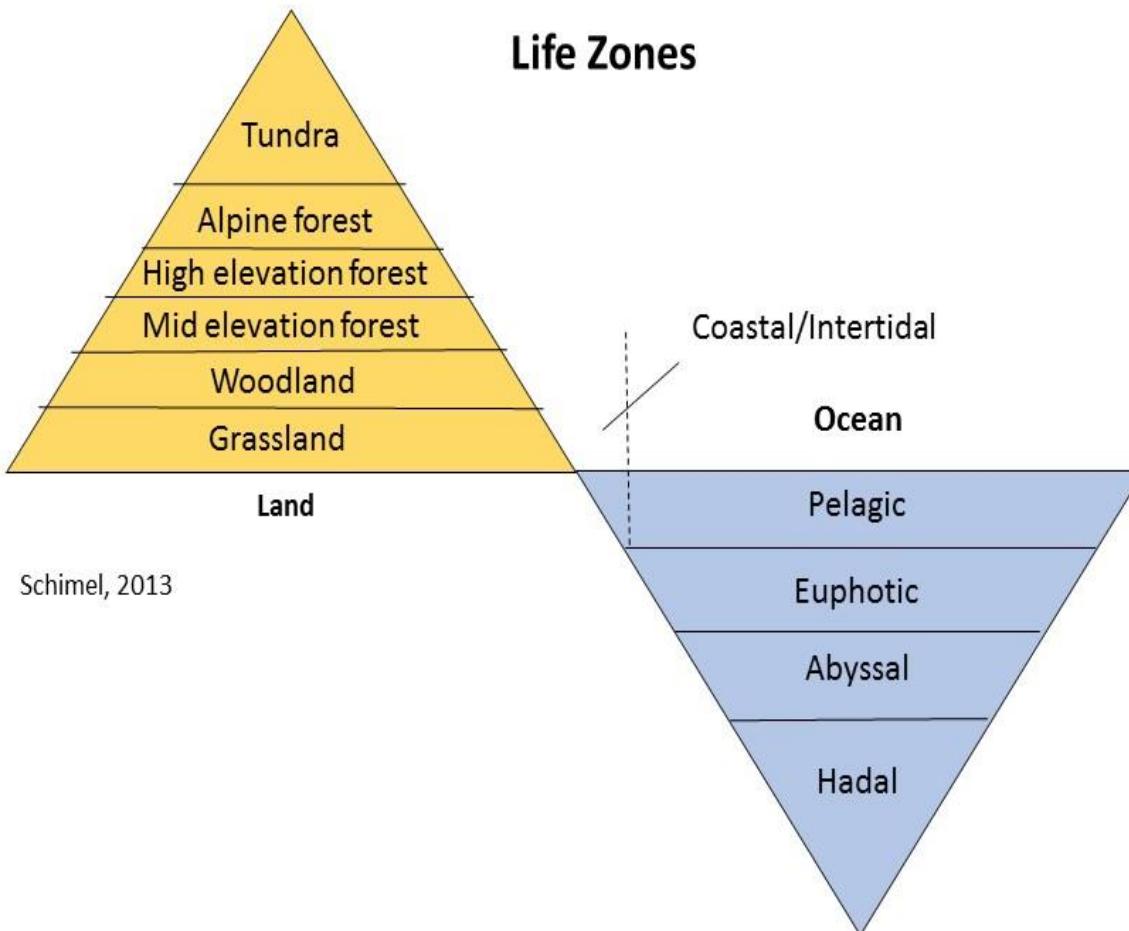
Adapted from Goerner et al., 2009

BIODIVERSITY

The term biodiversity refers to the totality of species, populations, communities and ecosystems, both wild and domesticated that constitute the life of any one area or of the entire planet.

Degree of variety in life in an ecosystem

Relationship between altitude, ecosystem and biodiversity- Holdridge Life zones





INDIA'S BIODIVERSITY

- India is home to 33% of the life forms found in the world, 2 % of the world landmass 8% of the biodiversity of the world.
 - More than 18000 plants
 - 1337 birds
 - More than 400 mammals
 - More than 600 reptiles and amphibians
- 60% of this wealth can be found in the Western Ghats

Natural systems provide society with many goods and services: **ecosystem services**



Pollination



Flood control



Non-timber forest products



Raw materials



Recreation

Earth has entered sixth mass extinction, warn scientists

Humans are responsible for so many species dying out that we are now in a sixth mass extinction, Stanford University has warned

50K 2K 98 218 61K



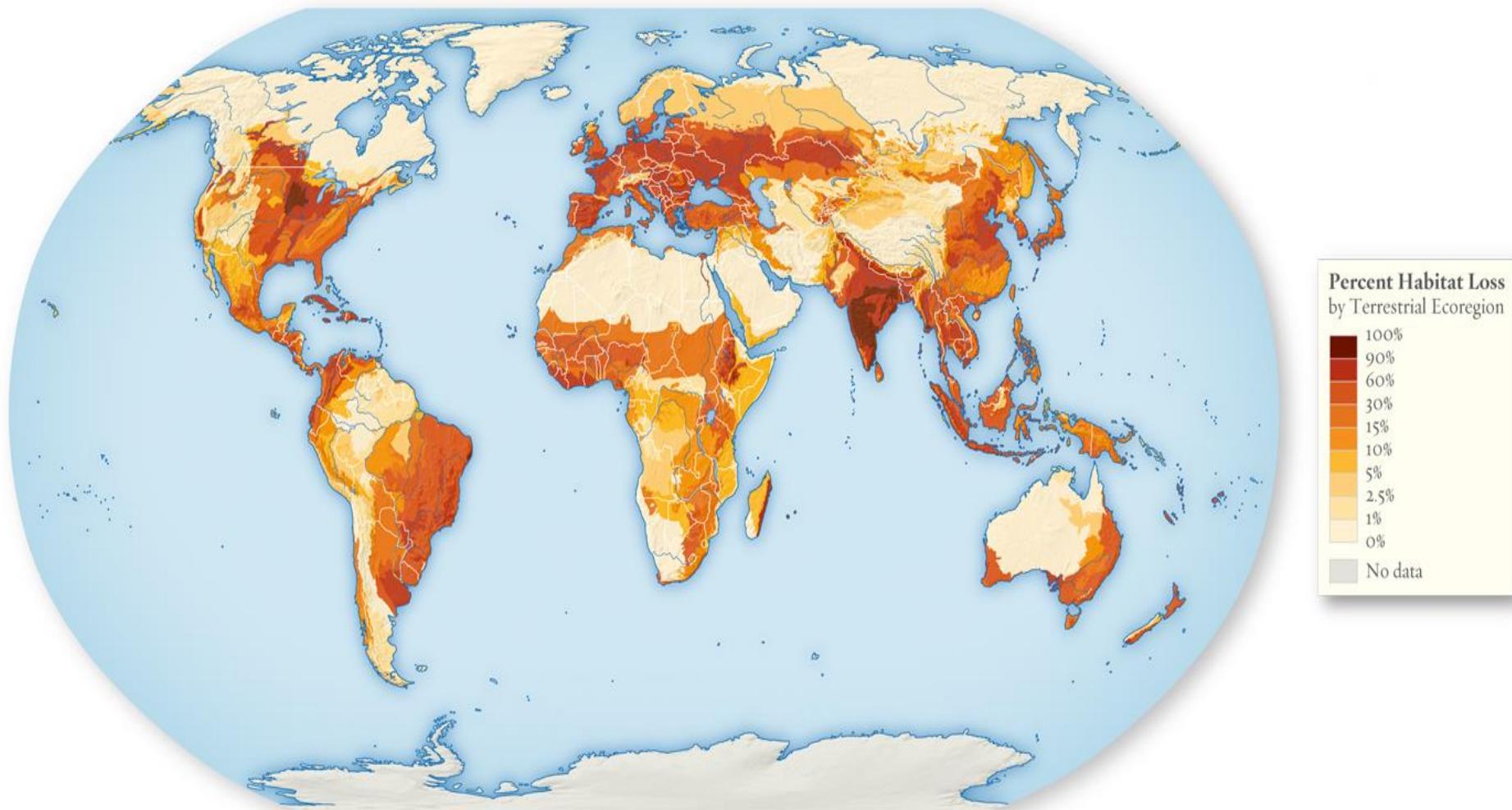
The last mass extinction saw the dinosaurs wiped out. Photo: Alamy

 By Sarah Knapton, Science Editor
7:00PM BST 19 Jun 2015
[Follow](#) 5,956 followers

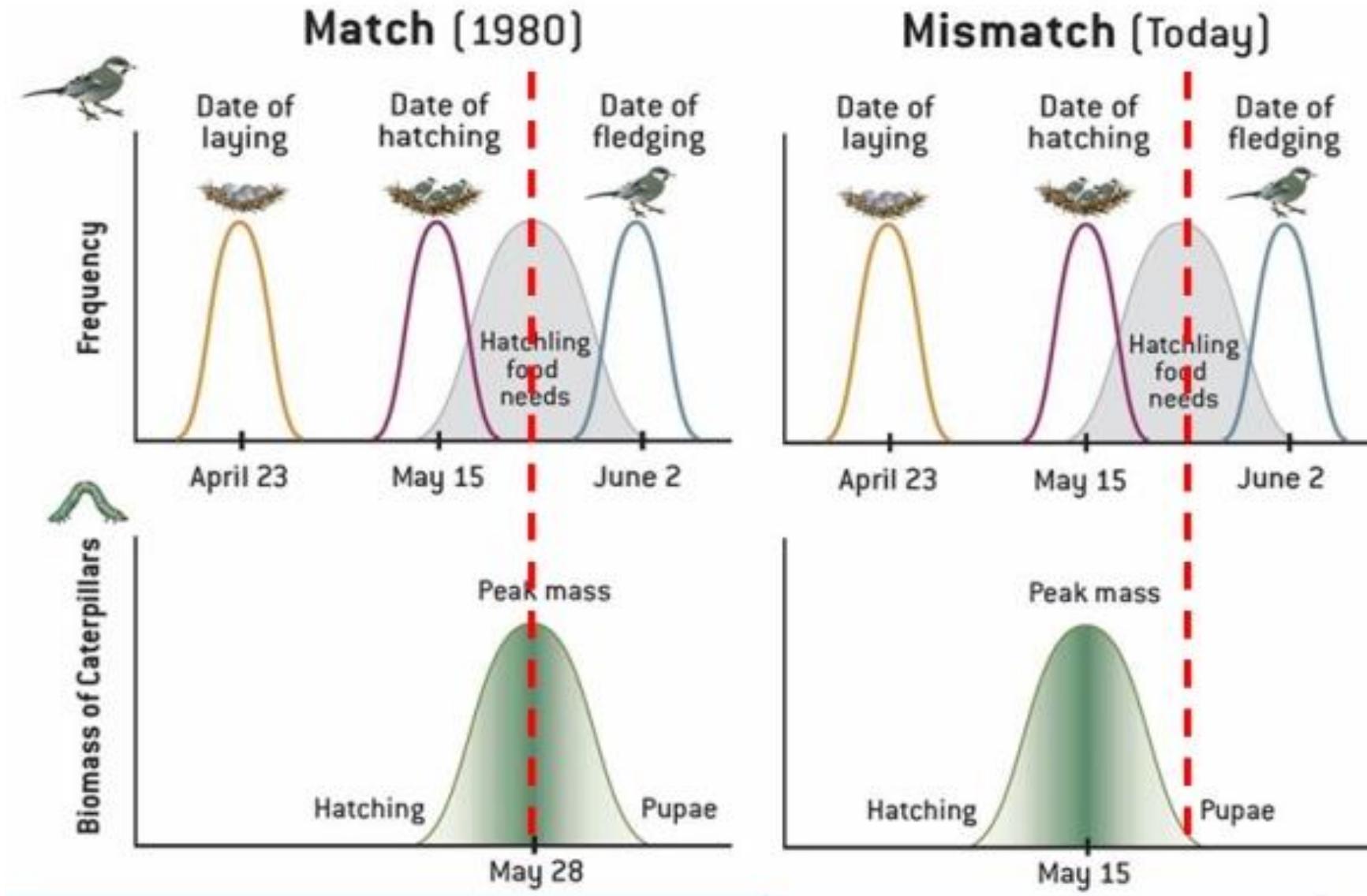
Earth has entered its sixth mass extinction with an



Extinction



Effect of climate change- Trophic Mismatch



Biodiversity Conservation

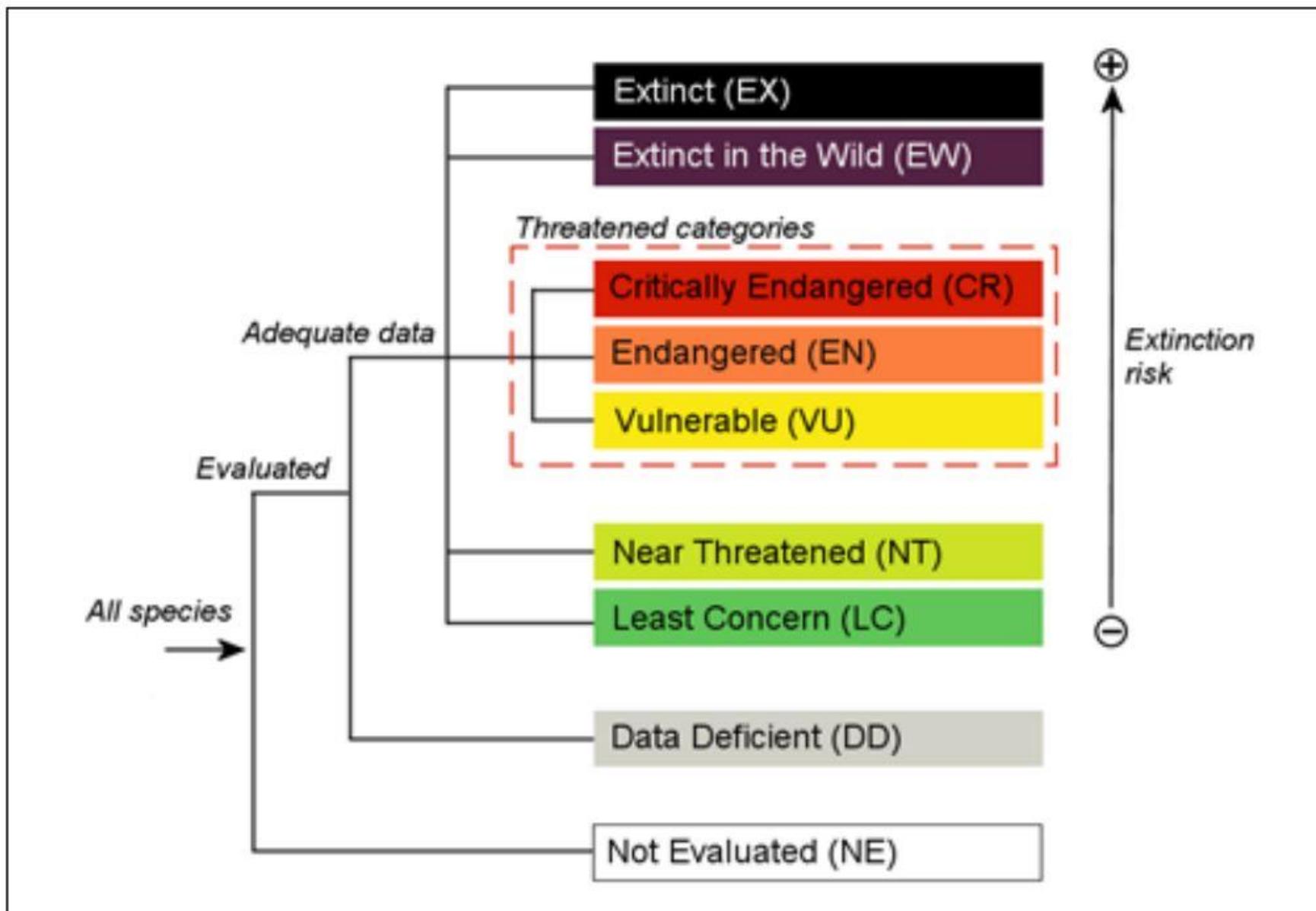


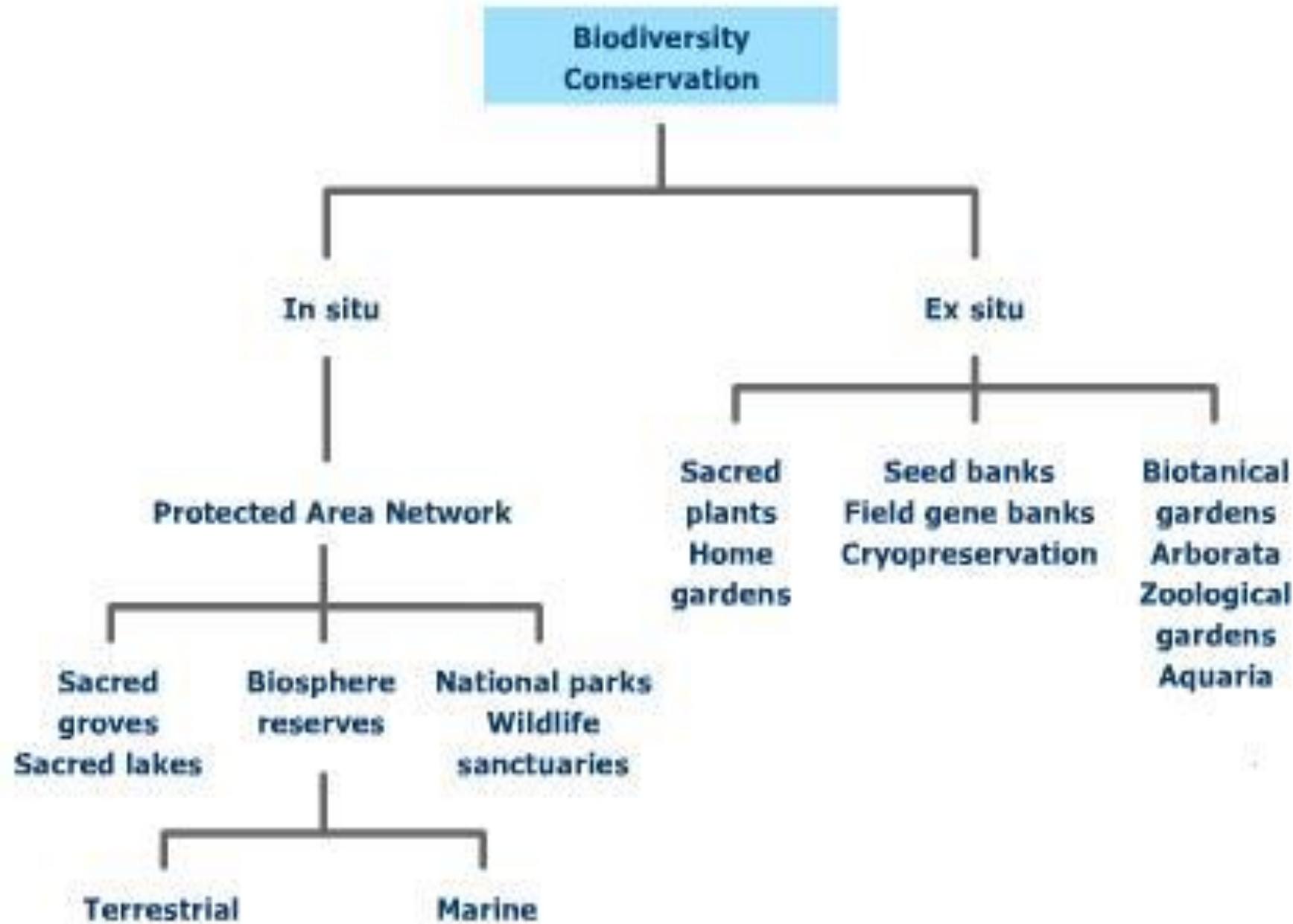
Source: Wikimedia



Source: Wikimedia

IUCN Red List Categories





In situ Conservation Strategies

- It means the conservation of ecosystems, natural habitats and the maintenance and recovery of viable populations of species in their natural surrounding and in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

Protected areas:

These are the areas of land and/or sea, especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources.

- Maintaining viable populations of all native species and subspecies.
- Maintaining the number and distribution of communities and habitats and conserving the genetic diversity of all the existing species.
- Preventing man created introduction of exotic species.
- Making it possible for species to shift in response to environmental changes.

Ex situ conservation strategies :

- It is defines as the conservation of components of biological diversity outside their natural habitat.
- Eg:- Botanical gardens, zoos, aquaria, gene banks, seed banks, use of biotechnology and DNA preservation.

Botanical gardens and zoos:-

There are more than 1500 botanical gardens and arboreta in the world with more than 80000 species.

Similarly there are more than 800 professionally managed zoos around the world with about 3000 species.

Biotechnological methods:-

It has provided many new conservation tools in agriculture, animal husbandry, fisheries, forestry and medicine.

1. **Gene banks:-** It provides a method of conservation of diverse genetic resources, particularly of threatened species and those seeds which are not viable for longer periods under natural conditions.

2. **Conservation of DNA:-** An emerging and promising technique in preserving biodiversity is isolation and conservation of DNA. It can be used for endangered or even extinct species by taking samples of material from hair, bones and herbarium specimens of the target species.

SVALBARD GLOBAL SEED VAULT



Chang-la Gene bank, Leh

India commissioned its own seed bank called the Chang-la Gene Banks for long-term storage of crops germplasm at a permanently frozen mountain in Leh. It's the second seed bank in the world after Svalbard.



Problems in Conservation:-

1. Very little understanding of what is to be conserved, especially with regard to complex natural ecosystems like tropical rain forests.
2. Limited Financial resources to protect and manage ecosystems.
3. Alienation of people from their natural resources bring in resentment among local people and no protected area.



ENVIRONMENTAL POLLUTION



Environmental Pollution

- **Environmental pollution** can be defined as any undesirable change in physical, chemical and biological characteristics of any component of the environment like air, water, soil which can cause harmful effects on various forms of life or property.
- **Pollution** : The term pollution can be defined as the influence of any substance causing nuisance, harmful effects and uneasiness to the environment.
- **Pollutants** : The pollutant may be physical, chemical, bacteriological, suspended, colloidal, dissolved, organic, inorganic, mineral salts, toxic chemicals etc.

Causes of Pollution

Man has spoiled and polluted the environment by:

- Uncontrolled growth
- Rapid industrialization
- Rapid urbanization
- Exploitation of nature

Besides man, contributors to pollution are:

- Volcanic eruptions
- Radio activities
- Strong wind
- Forest fires
- Sandstorms etc.

Types of Pollution

Air pollution

Land pollution

Nuclear pollution

Water pollution

Noise pollution

AIR POLLUTION

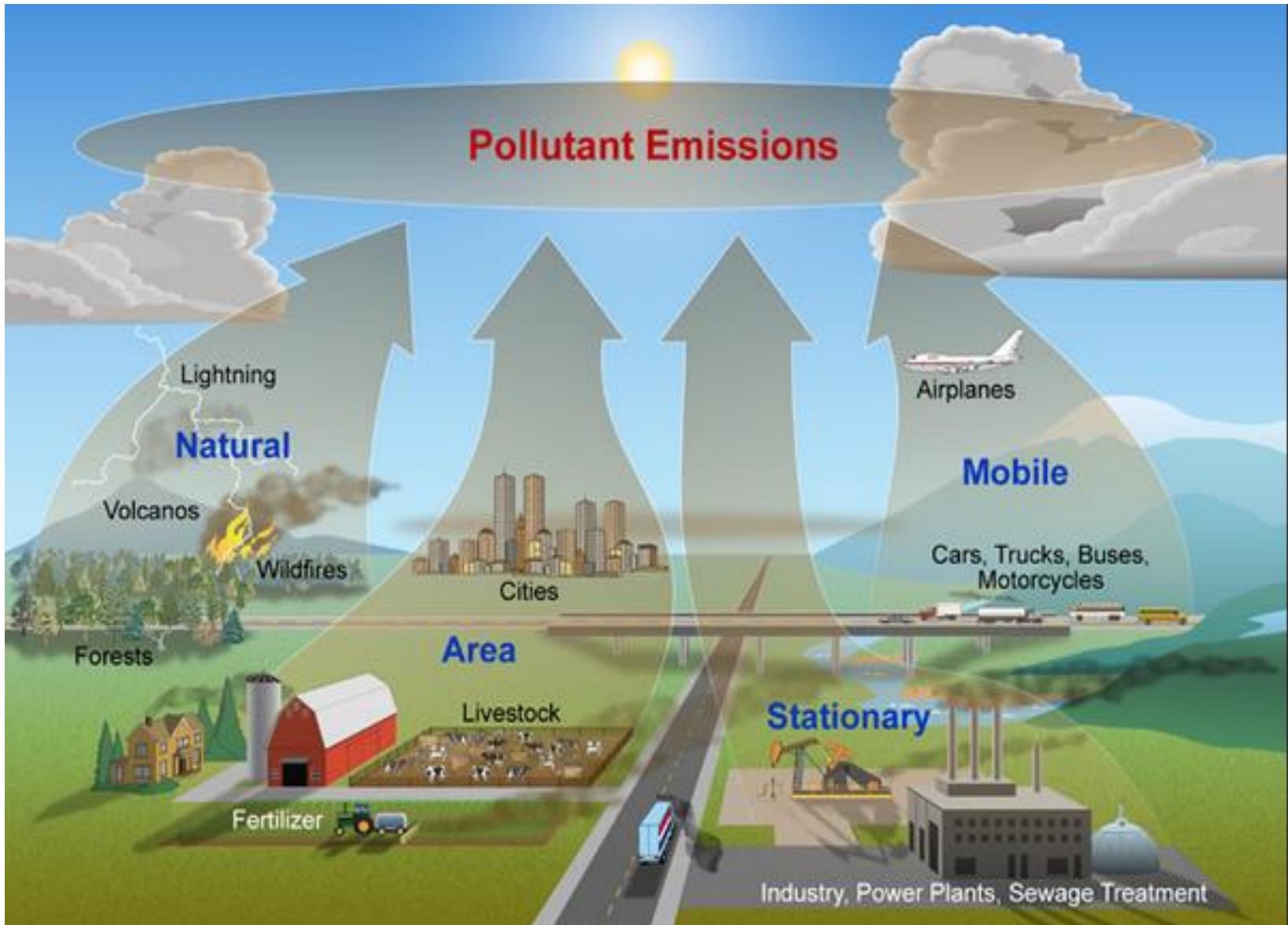
- **Air pollution** is a chemical, particulate matter, or biological agent that modifies the natural characteristics of the atmosphere.
- Air pollution is said to exist if the level of harmful gases, solids or liquids present in the atmosphere are high enough to affect humans, other organisms, buildings, monuments, etc.
- Air pollution is measured in terms concentrated suspended particulate matter (SPM), nitrogen-oxide & sulphur dioxide.

Source of Pollutants

Natural sources

- sand/dust storms
- volcanoes
- forest fires
- gases produced by decaying organisms

Human activity



Human Activity



Source : Wikipedia.org

Result: Hazy Horizon



Source : Wikipedia.org

Particulate matter

- Solid particles generated by handling, crushing, grinding, spraying and other operations are known as particulate matter.
- Particle's size vary from 2.5 microns to 100 microns in the atmosphere.
- Small and light particles suspend whereas bigger sized particles settle by their own weight.
- Fine particles reach human lungs and cause respiratory diseases.

Classification of Pollutants

Primary Pollutant:

- Primary pollutants are substances directly emitted from source; such as ash from a volcanic eruption or the carbon monoxide gas from a motor vehicle exhaust.

Secondary Pollutant:

- Secondary pollutants not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone - one of the many secondary pollutants that make up photochemical smog.

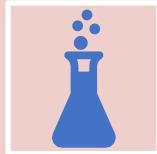
Major Primary Pollutants

- Sulfur oxides (SO_x) especially sulfur dioxide are emitted from burning of coal and oil.
- Nitrogen oxides (NO_x) especially nitrogen dioxide are emitted from high temperature combustion. Can be seen as the brown haze dome above or plume downwind of cities.
- Carbon monoxide is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.
- Carbon dioxide (CO_2), emitted from combustion and respiration.

Major Primary Pollutants.....

- Particulate matter (PM), measured as smoke and dust.
- Volatile organic compounds (VOC), such as hydrocarbon fuel vapors and solvents.
- Chlorofluorocarbons (CFCs), harmful to the ozone layer emitted from products currently banned from use.
- Ammonia (NH₃) emitted from agricultural processes.
- Toxic metals, such as lead, cadmium and copper.
- Odors, such as from garbage, sewage, and industrial processes
- Radioactive pollutants produced by nuclear explosions and war explosives, and natural processes such as radiation.

Secondary pollutants



Particulate matter formed from gaseous primary pollutants and compounds in photochemical smog, such as nitrogen dioxide.



Ground level ozone (O_3) formed from NOx and VOCs.



Peroxyacetyl nitrate (PAN) similarly formed from NOx and VOCs.

Control measures of Air pollution

Using low sulphur coal in industries

Removing NOx during the combustion process

Using mass transportation system

Removing particulate from stack exhaust gases by employing electrostatic precipitator, bag filters, cyclone separators, scrubbers etc.

Shifting to less pollution fuels (Hydrogen gas)

Installing catalytic converters by engine modification to have fuel efficient to reduce CO and hydrocarbon emissions

By planting trees

LAND POLLUTION

- **Land pollution** is the degradation of Earth's land surfaces often caused by human activities and their misuse of land resources.
- It occurs when waste is not disposed properly. Disposal of urban and industrial wastes, exploitation of minerals, and improper use of soil by inadequate agricultural practices are a few factors.
- Urbanization and industrialization are major causes of land pollution.

Land pollution comprises of :

- Solid Waste
- Soil Pollution

Solid waste

Wastes from Agriculture: This comprises of waste matter produced by crop, animal manure, and farm residues.

Wastes from Mining: Piles of coal refuse and heaps of slag.

Wastes from Industries: Industrial waste matter that can cause land pollution can include paints, chemicals, and so on.

Solids from Sewage Treatment: Wastes that are left over after sewage has been treated, biomass sludge, and settled solids.

Ashes: The residual matter that remains after solid fuels are burned.

Garbage: This comprises of waste matter from food that are decomposable and other waste matter that are not decomposable such as glass, metal, cloth, plastic, wood, paper, and so on.

Soil pollution

It is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment.

Caused due to :

- underground storage tanks,
- application of pesticides,
- percolation of contaminated surface water to subsurface strata
- oil and fuel dumping

Control measures

Use the following guide for each product:

- **Glass**: Bottles or jars can be reused or taken to a bottle bank for recycling. Broken glass can be repeatedly recycled with no reduction in quality, saving energy and raw materials.
- **Metals**: Used aluminum and steel cans can be collected as scrap and smelted for re-use.
- **Textiles**: Old clothes may be given to charity shops or jumble sales or used as rags. Some textiles can be re-used for blankets and cloths.
- **Vegetable Waste**: A bucket with a lid makes a good container for vegetable waste that can be regularly added to the compost heap for use in the garden.

Nuclear pollution

- Nuclear waste is the radioactive waste produced by nuclear reactors, or left over from research projects, medical uses, and the manufacture of nuclear weapons.



Nuclear wastes

Two categories

- High-level waste (HLW)
- Low-level waste (LLW)

These are generally recognized, based on radioactivity, source and hazard.

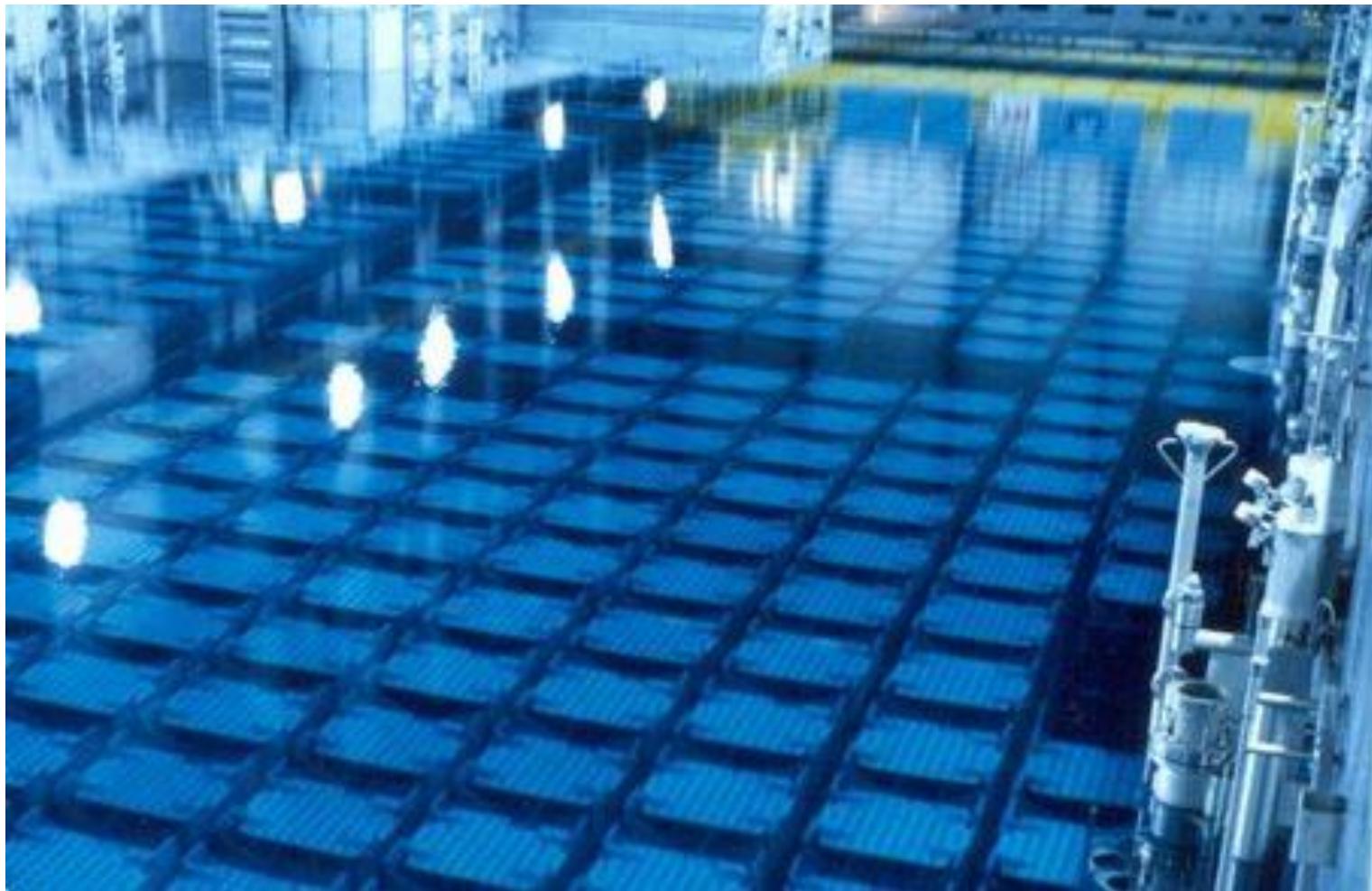
High Level Waste

- High-level waste consists mainly of spent fuel rods from nuclear reactors.
- These power plants rely on nuclear fission to generate heat.
- These elements decay at different rates.

Low Level wastes

- It comes from a wide variety of sources.
- Examples are items of protective clothing worn by staff who work with radioactive materials, and syringes and needles used for the injection of radioisotopes for medical purposes. It typically remains potentially hazardous for between a few tens and a few hundreds of years.

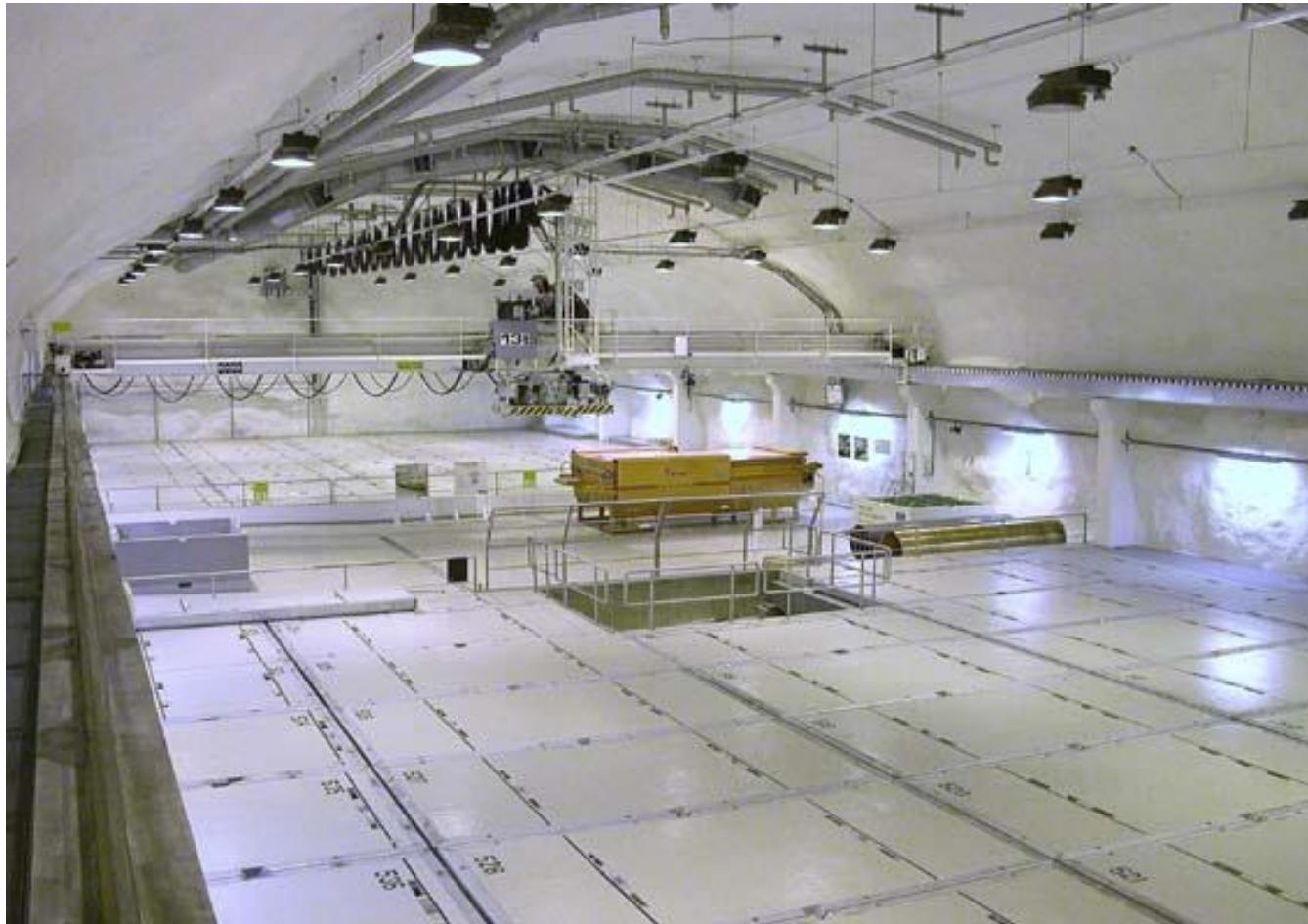
Nuclear fuel storage pool



Source : www.pinterest.com

- Pool is 12m deep
- Bottom 4.3 m is equipped with storage racks designed to hold fuel assemblies removed from reactors.
- Such pools are used for immediate "cooling" of the fuel rods, which allows short-lived isotopes to decay and thus reduce the ionizing radiation emanating from the rods.
- The water cools the fuel and provides radiological protection shielding from their radiation.

Low-level waste repository in Finland



Source : cienciaensocietat.org

- Low-level waste is compressed with a hydraulic press to half its original volume and packed in barrels. Liquid radioactive waste is dried and mixed with a solid agent, such as bitumen, and then cemented in barrels.

Control of Radioactive Pollution

The following preventive measures should be followed to control radioactive pollution :

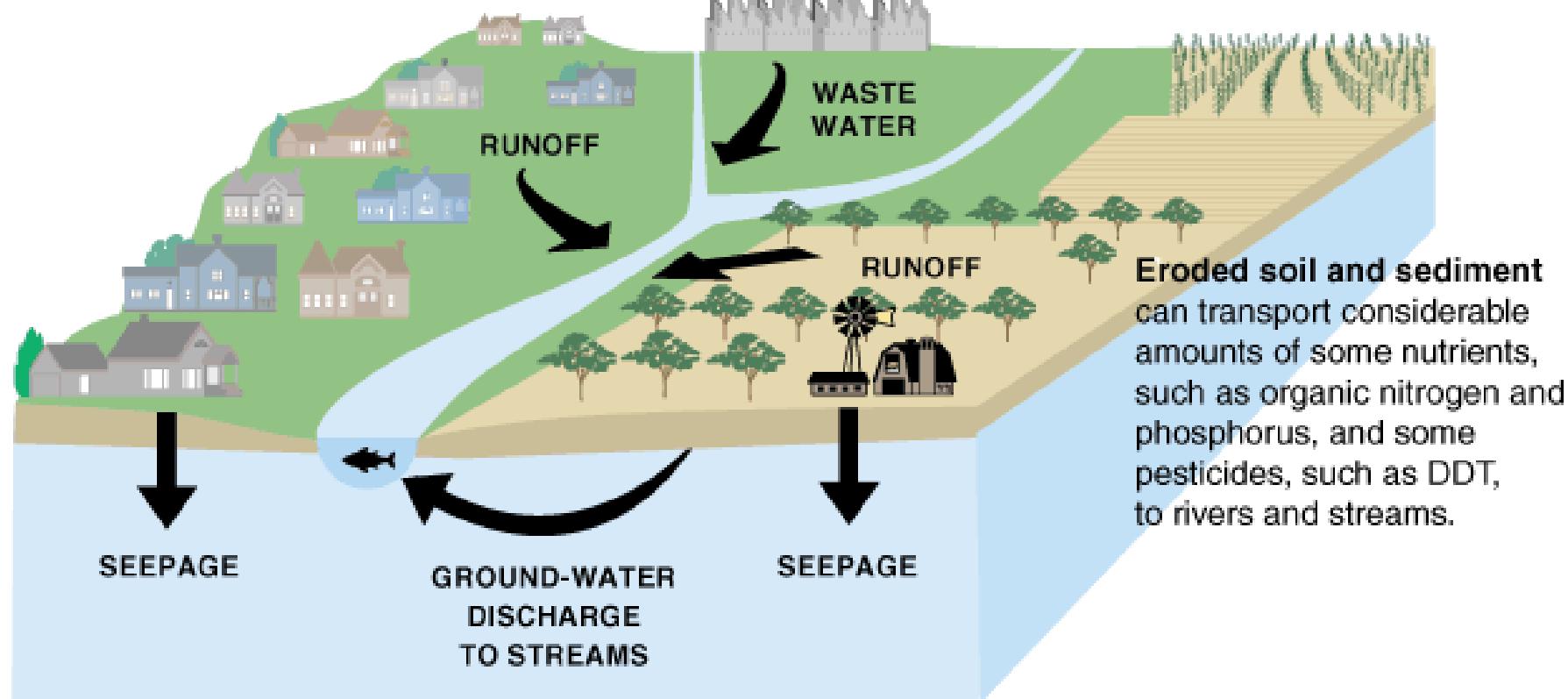
- (i) Leakage of radioactive materials.
- (ii) Radioactive wastes disposal must be safe.
- (iii) Preventive measures should be taken so that natural radiation level does not rise above the permissible limits.
- (iv) Safety measures should be taken against accidents in nuclear power plants.

Water Pollution

- Water pollution can be defined as alteration in physical, chemical or biological characteristics of water through natural or human activities and making it unsuitable for its designated use.
- Water is used for drinking, domestic, agricultural, irrigation, industries, navigation and recreation.

Point-source contamination can be traced to specific points of discharge from wastewater treatment plants and factories or from combined sewers.

Air pollution spreads across the landscape and is often overlooked as a major nonpoint source of pollution. Airborne nutrients and pesticides can be transported far from their area of origin.



Test parameter	Acceptable limit	Permissible limit (In the absence of alternate source of water)
pH value	6.5-8.5	No relaxation
Turbidity	1	5
Total hardness as CaCo ₃ , mg/l, Max	200	600
E.coli presence/absence	Shall not be detectable in any 100ml sample	Shall not be detectable in any 100ml sample
Total iron as Fe, mg/l, Max	0.3	No relaxation
Taste	Agreeable	Agreeable
Odour	Agreeable	Agreeable

As Per BIS – For Indian scenario

12/15/2021

Consequences



Toxic green algae in Copco Reservoir, northern California

Sources of water pollution are :

- Municipal wastewater
- Industrial waste
- Inorganic pollutants
- Organic pollutants
- Agricultural wastes
- Marine pollution
- Thermal pollution

Municipal wastewater

- Municipal wastewater is defined as wastewater from households or a mixture of wastewater from households and of industrial origin as well as precipitation water.
- It is comparatively easy to almost completely break down these pollutants with the help of micro organisms used in wastewater treatment plants.



Industrial wastewater

- The major source of water pollution is the wastewater discharged from industries such as chemical, metallurgical, food processing industries, textile, paper industries.
- They discharge several organic and inorganic pollutants that prove to be highly toxic.



Inorganic pollutants

- They include fine particles of different metals, chlorides, sulphates, oxides of iron, cadmium, acids and alkalies.

Organic pollutants

- They include fats, oils, phenols, organic acids, grease and several other organic compounds

Agricultural wastes



Chemical fertilizers and pesticides have become essential for the present-day high yielding crops.



Consequently, they have become a potential source of water pollution.



They contain major plant nutrients such as nitrogen, phosphorous and potassium.



Excess fertilizers may reach the ground water by leaching or may be mixed with surface waters of rivers, lakes and ponds by runoff and drainage.

Marine Pollution

- Oceans are the final sink of all natural and manmade pollutants.
- Rivers discharge their pollutants into the sea.
- The sewage and garbage of the coastal cities are also dumped into the sea.
- The others sources include discharge of oil, grease, plastics, detergents and radioactive wastes from ships.



92%

of people are concerned about the negative impact that plastic pollution in the oceans will have on future generations



78%

of people want to reduce their use of single use plastic



NEW RESEARCH REVEALS CONCERN OVER MARINE POLLUTION

71%

of people want a **wider choice of plastic-free products** on offer where they shop

72%

of people are concerned about the impact of **increasing levels of acidification in the oceans on marine life**



89%

of people are concerned about **plastic pollution spoiling the world's beaches**



81%

of people are concerned about the **potential health implications of consuming seafood that contains microplastics**





Marine Pollution Abatement

- Identify load & type of pollutants and cut it at the source.
- Political commitment and enforce legislation.
- Coastal and marine planning & management.
- Create less waste.
- Reduce/Eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water etc.
- Pretreatment before disposal to sea.
- Use of equipment to reduce water content and volume in the chemical process.

Thermal Pollution

- **Thermal pollution** is the degradation of water quality by any process that changes ambient water temperature.
- A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature, the change in temperature decreases oxygen supply and affects ecosystem composition.
- Fish and other organisms adapted to particular temperature range can be killed by an abrupt change in water temperature (either a rapid increase or decrease) known as "thermal shock."

Effects of Water Pollution

- It damages the food chain. The toxins from water travel to the body of human and animals.
- The water pollution is responsible for spreading some deadly diseases like cholera, typhoid, diarrhea, and other communicable diseases. This is called microbial water pollution and the pathogens are responsible for it.
- Polluted water can also adversely affect the human heart and kidneys. The toxins in the human body can create problems like poor blood circulation, vomiting, skin lesions, damage to nervous system and others.

- Ground water level gets contaminated by carcinogenic elements like lead, cadmium and others which when consumed with drinking water increases the risk of having cancer.
- Acid rain is another worry to water pollution. Sulfate particles present in water creates problem for marine life. It pollutes the water and also affects the food chain of marine life.
- Lots of pollutants in water can be responsible for changing the acidity, temperature, and conductivity of water.

How to prevent water pollution?

Educating the public about its harmful effects to human and environment.

Enforcing stringent environmental laws.

Do not dispose household chemicals to the sink or to the toilets.

Avoid over dosage of pesticides and fertilizers.

Don't throw any non degradable substances to rivers, lakes and oceans.

Pretreatment of industrial wastewater before discharging to water bodies.

Noise pollution

- Sound that is unwanted or disrupts one's quality of life is called as noise. When there is lot of noise in the environment, it is termed as noise pollution.

Sources of Noise Pollution



CONSTRUCTION
WORK



NEIGHBOURHOOD
NOISE



TRAFFIC

Health Effects



BLOOD PRESSURE
PROBLEMS



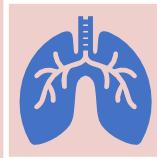
ANXIETY



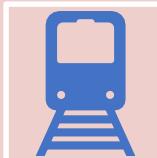
HEARING LOSS



SLEEP LOSS



Noise pollution is the disturbing or excessive noise that may harm the activity or balance of human or animal life.

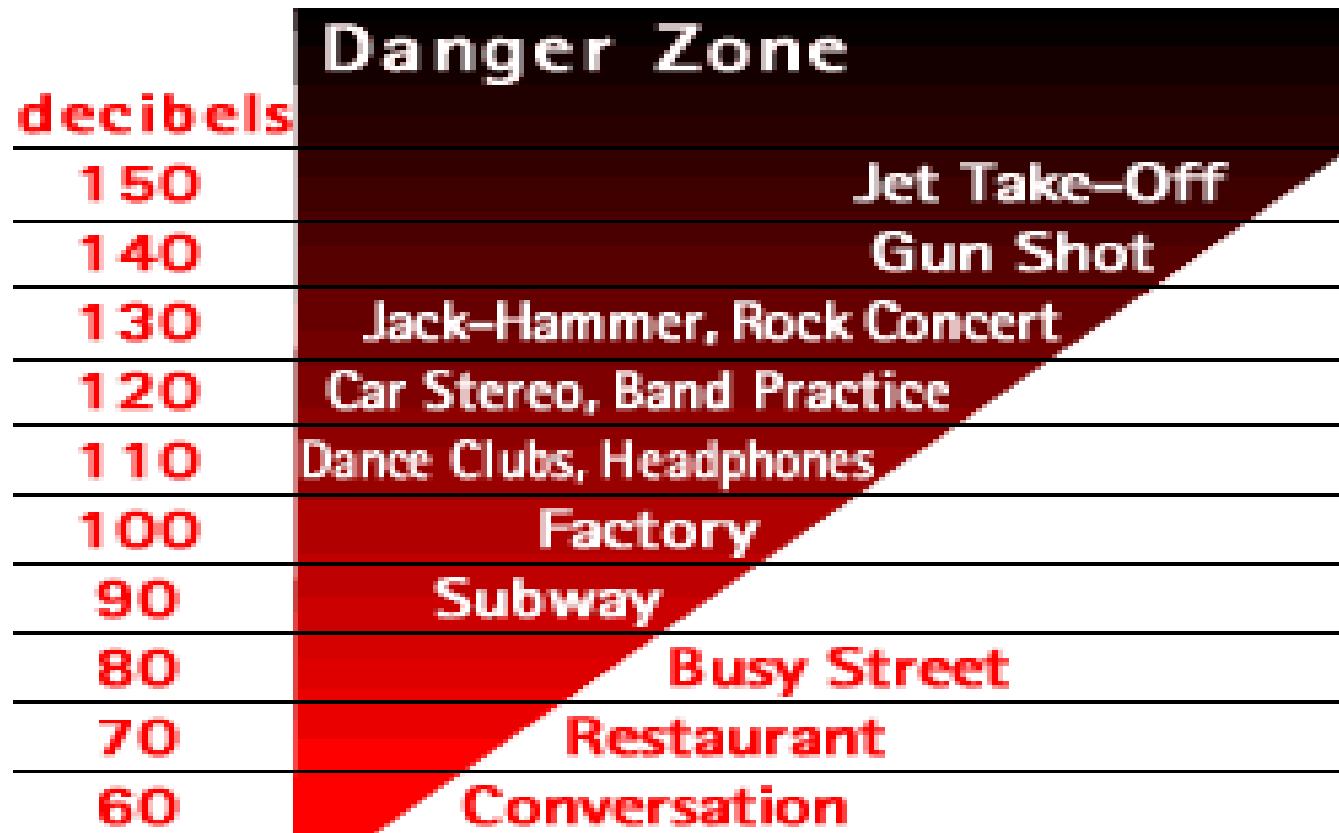


The source of most outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles, aircraft and trains.



Indoor noise can be caused by machines, building activities, and music performances, especially in some workplaces. There is no great difference whether noise-induced hearing loss is brought about by outside (e.g., trains) or inside (e.g., music) noise.

Noise level chart



Causes

- **Transportation sector**:- aircrafts, trains, trucks, tractors, cars, three-wheelers, motorcycles etc. contribute maximum noise.
- **Industrial & construction machinery**:-factory equipment's, generators, pile-drivers, pneumatic drills, road rollers etc. make lot of noise.
- **Special events** :- high volume sound speakers during festivals , marriage celebrations, public meetings etc. create unbearable noise.

Effects of noise

- Noise is generally harmful and can create serious health hazard.
- Noise can lead to physiological & psychological damage if the volume is very high, or the exposure is prolonged.
- Vibrations of high pitches create permanent hearing impairment.
- Noise can also have other ill effects like heart problem, pupil dilation or muscle contraction.
- Migraine headache, nausea, dizziness, gastric ulcers and constriction of blood vessels are some of the other possible bad effects of noise.

Noise control measures

- Producing less noise is the best method of reducing type of pollution. All machinery should be so designed that the noise produced is minimum.
- All the persons working in noisy areas should wear noise shield like ear-plugs and such areas should be isolated by having noise absorbing materials.
- Proper lubrication and better maintenance of machines will reduce noise while running.
- By using:
 - silencers to control noise from automobiles, ducts, exhausts etc. noise levels can be reduced;
 - glass wool or mineral wool covered with a sheet of perforated metal plates ; mechanical vibration isolation can be partly achieved.

Applications



THE SION FLYOVER
THE SOUND BARRIERS ARE
ATTACHED TO AVOID THE
SOUND OF THE TRAFFICE
TO ENTER THE HOSPITAL



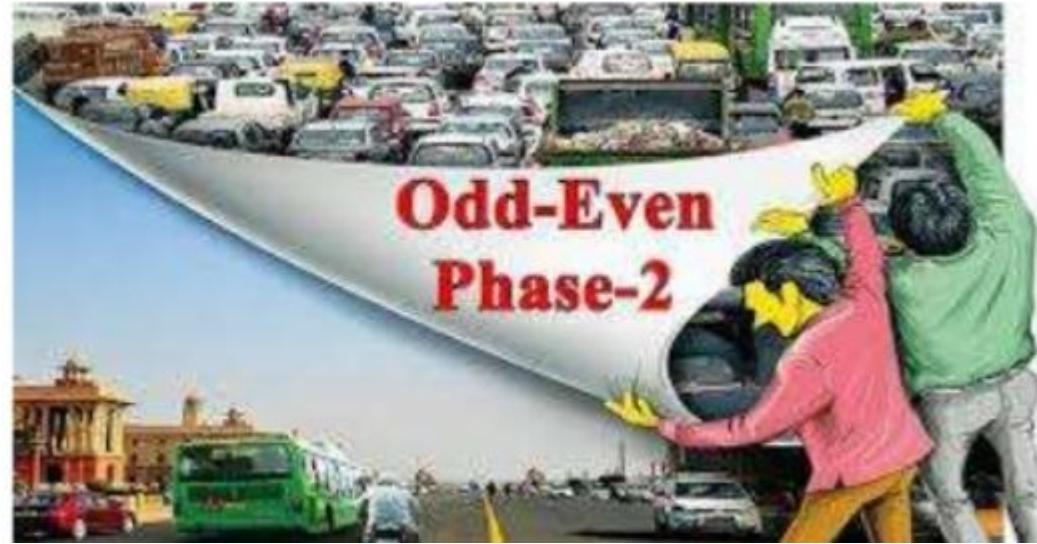


BIG NOISE OF THE MACHINES
HAVE LOT OF NOISE . TO
AVOID THE LOUD NOISE THE
COMPANIES USE SOUND
BARRIERS



THE TRAIN SYSTEM IN MANY COUNTRIES IS ACCEPTING THE SOUND BARRIER SYSTEM TO OVERCOME THE NOISE PROBLEMS







EFFECT ON BEACHED WHALE

One of the best known damage caused by noise pollution is the death of certain species of beached whales, brought on by the loud sound of military sonar.



Environmental laws and legislations



Introduction

2

- The Constitution of India clearly states that it is the duty of the state to *'protect and improve the environment and to safeguard the forests and wildlife of the country'*.
- The Department of Environment was established in India in 1980. This later became the Ministry of Environment and Forests in 1985.

Introduction (Contd..)

3

- **The EPA (Environment Protection Act), 1986** came into force soon after the Bhopal Gas Tragedy and is considered an umbrella legislation as it fills many gaps in the existing laws.
- Thereafter a large number of laws came into existence as the problems began arising, for example, Handling and Management of Hazardous Waste Rules in 1989.

Environmental Governance in India

- Article 51 A (g) in a new chapter entitled “Fundamental Duties”, impose a similar responsibility on every citizen to protect and improve the natural environment including the forest, lakes, rivers, and wildlife, and to have a compassion for living creatures”
- Together, the provisions highlight the national consensus on the importance of environmental protection and improvement.





Article 21. Protection of life and personal liberty

No person shall be deprived of his life or personal liberty except according to procedure established by law.





Environmental Protection Activities of the Department.

- Environmental protection activities undertaken by the department have the following objectives:
- To play the role of a “**Watch Dog**” to study and **bring to the attention of government and the Parliament instances**, causes, and consequences of environmental degradation in all sectors
- To serve as a **nodal agency for environmental protection and eco development in a coordinated manner**.
- To **Carry out environmental appraisal** of the development projects.
- To have **administrative responsibility for, pollution monitoring and regulations**, conservation of ecosystems as biosphere reserves.



Environmental Protection Activities of the Department.

The 42nd Amendment Act

- The 42nd Amendment Act has certain changes in the seventh schedule of the constitution.** In the Concurrent list after 17, entry 17A was inserted, which provides **for “forest”**. Originally, forest was a state subject and as there was no uniform policy followed by the state government in respect of protection of forest, this subject was transferred to list III.
- The legal sections to protect different segments of the environment in India has been provided by successive enactment of certain laws.**



The Indian Forest Act, 1927





The Indian Forest Act, 1927.

- Although it embodies the colonial policies of the pre-independence era, the forest Act of 1927 remain in force.
- The 1927, Act deals with four categories of forests, namely, reserved forest, village forests, protected forests and non government (private) forests.
- A state may declare forestland or waste lands as reserved forests and may sell the produce from these forests. Any unauthorized felling of trees, quarrying, grazing and hunting in reserved forests is punishable with a fine or imprisonment, or both.
- The preservation of protected forests is enforced through rules, licenses and criminal prosecutions.



The Factories Act of 1948





The Factories Act of 1948

- Passed shortly after the Bhopal gas tragedy, the 1987 **Amendment empowers the states to appoint site Appraisal Committees to advise on the initial location of factories using hazardous processes.**
- **The factory inspector and the local authority have to keep a close watch on all particulars regarding health hazards at the factory,** and the preventive measure taken. These preventive measures must be published among the workers and nearby residents. Every ‘**Occupier**’ must also draw up an emergency disaster



- **Control plan**, which must be approved by chief Inspector.
- The **permissible limits of exposure to toxic substances** are prescribed in the second schedule of the act.
- **Safety committee consisting of workers and managers** are required to review periodically the factor's safety measures.
- The Factories Act after its 1987 Amendment defines "**Occupier**" as a very senior level manager. Such Person is held responsible for compliance with the Acts provision to Hazardous processes. Non-Compliance exposes the occupier to stiff penalties.

The Atomic Energy Act, 1962





The Atomic Energy Act, 1962

- **The Atomic Energy Act of 1962 and the Radiation Protection Rules of 1971 governs the regulation of nuclear energy and radioactive substances in India.** Under the Act, the central Government is required to prevent radiation hazards, guarantees public safety and safety of workers handling radioactive substances, and ensure the disposal of radioactive substances, and the production and supply of atomic energy and nuclear generated electricity also fall within the Centre's authority.



The Insecticides Act, 1968



Insecticides Act, 1968





The Insecticides Act 1968

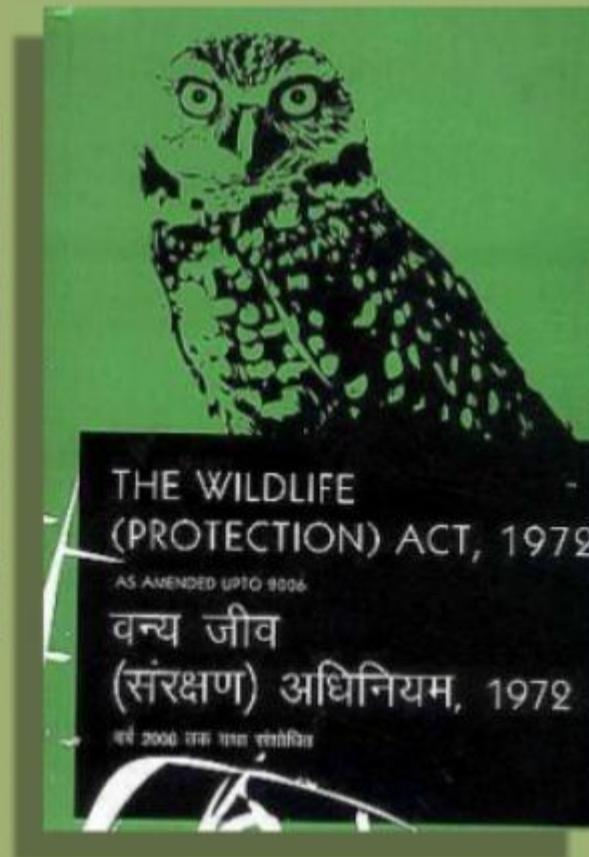
- In Insecticides Act was designed to implement the recommendations of the Kerala and Madras Food-Poisoning Cases Inquiry Commission, which inquired into several death from insecticide-contaminated food in April and May 1958.
- The Act established a Central Insecticide board to advise the Centre and states on technical aspects of the Act. A committee of this board registers insecticides after examining their formulas and verifying claims regarding their safety and efficacy.
- A violation of this act can lead to prosecution and penalties.



The Insecticides Act 1968

- The implementation of the provisions of this act for monitoring pesticides residue in the environment is totally inadequate. It is hence not surprising that increasing levels of pesticide residue are being recorded in food stuffs, animal tissues and even human fats.
- The Insecticides Rules of 1971 prescribe the procedures for licensing, packaging, labeling and transporting insecticides. They also provides for workers safety during manufacture and handling of insecticides through protective clothing, respiratory devices and medical facilities.

The Wildlife (Protection), 1972





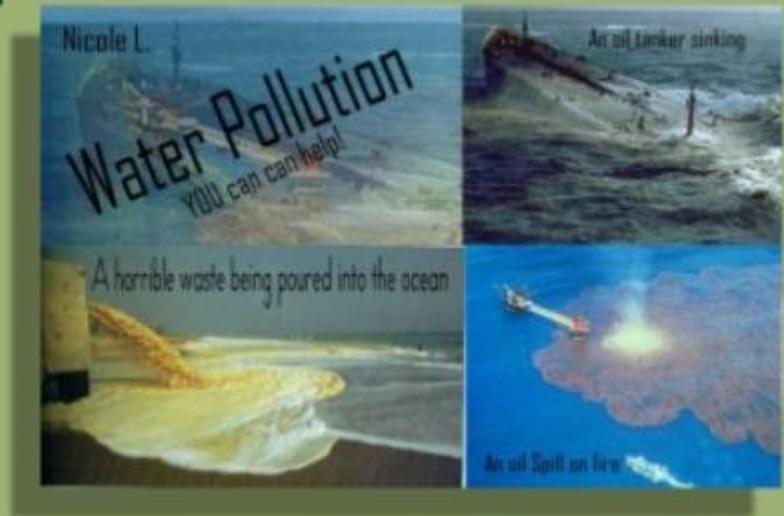
The Wildlife (Protection) Act of 1972

- In 1972, Parliament enacted the wildlife Act Pursuant to enabling resolutions of 11 states under Article 252 (1) of the constitution. **The wild life act provides for state wildlife advisory boards, regulations for hunting wild animals and birds, established of sanctuaries and national parks, regulations for trade in wild animals, animal products and judiciously impose penalties for violating the Act.** Harming endangered species listed in Schedule I of the Act is prohibited throughout India.
- Wildlife wardens and their staff administer the Act.

The Water (Prevention and Control of pollution) Act, 1974



Water Act, 1974





The Water (Prevention and Control of pollution) Act,1974

- The water Act was the culmination of over a decade of discussion and deliberation between Centres and states.
- The history and the preamble of the water Act suggest that only state government can enact water pollution legislation. **The Act vests regulatory authority in state boards and empowers these boards to establish and enforce effluent standards for factories discharging pollutants into bodies of water. A central Board performs the same functions for union territories and coordinate activities among the states.**



The Water (Prevention and Control of pollution) Act,1974

- Prior to its amendment in 1988, **enforcement under the water Act was achieved through criminal prosecutions initiated by the board.** The 1988 Amendment strengthened implementation provisions of the Act.
- **Now a board may close a defaulting industrial plant or withdraw its supply of power or water by an administrative order; the penalties more stringent, and citizens, suit provisions bolsters the enforcement machinery.**



The Water (Prevention and Control of Pollution) Cess Act of 1977

Water Cess Act

- The Water Cess Act was passed to help meet the expanses of the central and State Water Boards. **The Act creates economic incentives for pollution control and requires local authorities and certain designated industries to pay a cess (tax) for water consumption.**
- **The revenue are used to implement the water Act.** The Central Board and the states such sums as it deems necessary to enforce the provisions of the water Act. **To encourage capital investment in pollution control, the act gives a polluter a 70 % rebate of the applicable cess upon installing effluent treatment equipment.**



The Forest (Conservation) Act of 1980





The Forest (Conservation) Act of 1980

- Alarmed at India's rapid deforestation and the resulting environment degradation, the central Government enacted the Forest (Conservation) Act in 1980. AS amendment in 1988, The Act requires the approval of the Central Government before a state "deserves" a reserved forest, uses forest land for non-forest purposes, assigns forest land to private person or corporation, or clears forest land for the purpose of reforestation.



The Air (Preservation and Control of pollution) Act of 1981

THE AIR(PREVENTION AND
CONTROL OF POLLUTION), ACT
1981





The Air (Preservation and Control of pollution) Act of 1981

- The Air Act's framework is similar to the one created by its predecessor the water Act of 1974.
- **To enable an integrated approach to environmental problem. The Air Act expanded the authority of the Central and State boards established under the water Act, to include air pollution Control.** States not having air pollution were required to set up air pollution boards.



The Air (Preservation and Control of pollution) Act of 1981

- Under the Air Act, all industries operating within designated air pollution control area must obtain a “consent” from the state boards. The states are required to prescribe emission standards for industry and automobiles after consulting the Central Board and noting its ambient air quality standards.
- The 1987 amendment strengthened the enforcement machinery.

The Environment Protection Act, 1986

**THE ENVIRONMENT PROTECTION
ACT (1986)**





The Environment Protection Act of 1986

- In the wake of the **Bhopal Gas Tragedy**, The government of India enacted the **Environment (Protection) Act of 1986 under Article 253 of the Constitution**.
- The purpose of the act is to implement the decisions of the United Nations. **The Act is an “Umbrella” legislation designed to provide a framework for central government coordination of the activities of various Central and State authorities established under previous laws, such as the Water Act and the Air Act.**



The Environment Protection Act of 1986

The Scope of the Act

- The potential scope of the Act is broad, with “environment” defined to include water, air, land and the **inter-relationships which exist among these, and human beings, and other living creatures, plants, microorganisms and property.**
- **The Section 3 (1) of the act empowers the Centre “to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environment pollution”.**



The Environment Protection Act, 1986

- Specifically, the **Central Government** is authorized to set new nation standards for the quality of the environment as well as standards for controlling emissions and effluent discharges, to regulate industrial safeguards for preventing accidents, and to collect and disseminate information regarding environmental pollution.



Other Environmental legislations that have come into effect:





- The Manufacture, Storage, and Import of Hazardous Chemicals, 1989
 - ✓ Defines the terms used in this context, and sets up an authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities.
- The Public Liability Insurance Act and Rules and Amendment, 1992
 - ✓ Drawn up for the purpose of providing immediate relief to the persons affected by accident while handling any hazardous substance.



35



MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)



- The National Environmental Tribunal Act, 1995
 - ✓ Created to award compensation for damages to persons, property, and the environment arising from any activity involving hazardous substances.
- The Biomedical waste (Management and Handling) Rules, 1998
 - ✓ Legal binding on the health care institutions to streamline the process of proper handling of hospital waste.



- The Environment (Siting for Industrial Projects) Rules, 1999
 - ✓ Lays down detailed provisions relating to areas to be avoided for siting of industries & precautionary measures to be taken for site selection.
- The Municipal Solid Wastes (Management and Handling) Rules, 2000
 - ✓ Apply to every municipal authority responsible for the collection, transportation, processing, and disposal of municipal solid wastes.



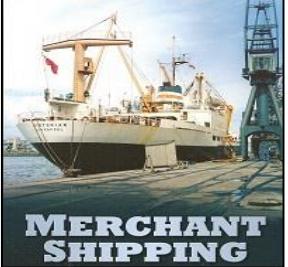
- The Ozone Depleting Substances (Regulation and Control), 2000
 - ✓ Rules have been laid down for the regulation of production and consumption of ozone depleting substances.
- The Batteries (Management and Handling) Rules, 2001
 - ✓ Rules shall apply to every person involved in the manufacture, processing, sale, purchase, and use of batteries or components to regulate and ensure the environmentally safe disposal of used batteries.



- The Noise Pollution (Regulation and Control) (Amendment), 2002
 - ✓ Lay down terms and conditions as are necessary to reduce noise pollution such as use of loud speakers or public address systems during night hours (from 10.00 p.m. to 6.00 a.m.) on or during any cultural or religious festive occasion.
- The Biological Diversity Act, 2002
 - ✓ Is an act to provide for the sustainable use & conservation of biological diversity.



- The Easement Act, 1882
 - ✓ Allows private rights to use a resource that is, groundwater, by viewing it as an attachment to the land. It also states that all surface water belongs to the state and is a state property.
- The Indian Fisheries Act, 1897
 - ✓ Establishes two sets of penal offences whereby the government can sue any person who uses dynamite or other explosive substance in any way (whether coastal or inland) with intent to catch or destroy any fish or poisonous fish in order to kill.



MERCHANT
SHIPPING

40



MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)



- The River Boards Act, 1956
 - ✓ Enables the states to enroll the central government in setting up an Advisory River Board to resolve issues in inter-state cooperation.
- The Merchant Shipping Act, 1970
 - ✓ Aims to deal with waste arising from ships along the coastal areas within a specified radius.



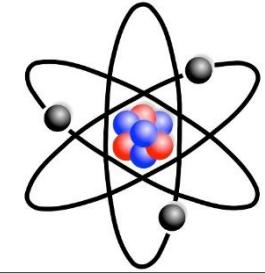
41



MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)



- The Coastal Regulation Zone Notification, 1991
 - ✓ Puts regulations on various activities, including construction.
 - ✓ It gives some protection to the backwaters and estuaries.



- The Motor Vehicles Act, 1988
 - ✓ States that all hazardous waste is to be properly packaged, labelled , and transported.
- The National Green Tribunal Act, 2010
 - ✓ The Act envisages establishment of NGT in order to deal with all environmental laws relating to air and water pollution, the Environment Protection Act, the Forest Conservation Act and the Biodiversity.



Violation of Penalties Under the Act





Violation of Penalties Under the Act

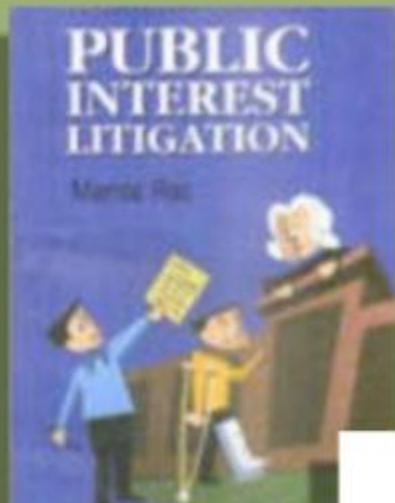
- The Act provides for several penalties. Any person who fails to comply with or contravenes any of the provisions of the Act, rules, order or directions issued under the **Act shall be punished for each failure or contravention, with a prison term of up to 5 years or a fine of up to Rs 1 lakh or both. The Act imposes an addition fine of up to Rs 5000 for every day continuing violation.**



MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

45

Public Interest Litigation





Public Interest Litigation

- Public Interest litigation has successfully demonstrated that responsible non-government organizations and public spirited individuals about significant pressure on polluting units for adopting abatements measures.
- As the present system of jurisprudence does provide for compensation to individuals for environmental damage, including effect on health and environmental damage caused by pollution, it is proposed to set up special legal institutions to redress this deficiency and also make adequate arrangement for interim relief.



Public Interest Litigation

Regulatory Measures

- The regulatory Control Measures include **physical as well as fiscal measure**. Physical control Include the imposition of a legal ceiling for pollution emission and directions to industrial units to install control equipment to reduce emission or discharge of waste water.

Fiscal Measures

- Fiscal measures **Include the imposition of taxes, pollution permits, and the allocation of property rights**. The imposition of financial liabilities and tax burdens are the weapon of the mechanism



Public Interest Litigation

Promotional Measures

- Includes Subsidies and voluntary programmes which have a moral and social responsible impact on potential polluters. The voluntary programmes include moral education and popularization of social responsibility and ethical considerations

Participatory Measures

- Include Direct Investment by the government in Waste Management, effluent Treatment and slum clearance, and increasing forest cover programmes. Direct Participation will yield quick results.

Environmental Impact Assessment

49

- EIA is a management tool for ensuring optimal use of natural resources for sustainable development.
- The MoEF notified new EIA legislation in September 2006.
- The notification makes it mandatory for various projects such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports) and industries including very small electroplating or foundry units to get environment clearance.
- Certain activities permissible under the Coastal Regulation Zone Act, 1991 also require similar clearance.

Steps involved in EIA

- ✓ Screening
- ✓ Scoping
- ✓ Public Consultation
- ✓ Appraisal
- ✓ Post monitoring

Steps involved in EIA

Screening: First stage of EIA, which determines whether the proposed project, requires an EIA and if it does, then the level of assessment required. Categorization of projects.

Scoping: This stage identifies the key issues and impacts that should be further investigated. This stage also defines the boundary and time limit of the study.

Public Consultation: This stage of EIA identifies and predicts the likely environmental and social impact of the proposed project and evaluates the significance.

Steps involved in EIA

52

Appraisal: The detailed scrutiny by the Expert Appraisal Committee or State Level Expert Appraisal Committee of the application and other documents like the Final EIA report, outcome of the public consultations including public hearing proceedings, submitted by the applicant to the regulatory authority concerned for grant of environmental clearance.

Post monitoring: This stage comes into play once the project is commissioned. It checks to ensure that the impacts of the project do not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report.

Pollution control boards

53

The Central Pollution Control Board (CPCB), was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974.

Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.



Principal Functions of the Pollution Control Board

54

- To promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution.
- To improve the quality of air and to prevent, control or abate air pollution in the country.

Functions of the Central Pollution Control Board

55

- Advice the Central Government, on any matter concerning the improvement of the quality of air and prevention control or abatement of air pollution/water pollution
- Provide technical assistance and guidance to the state boards carry out and sponsor investigations and research relating to problems of air pollution/water pollution and its control and abatement.
- Plan and cause to be execute a nation-wide programme through mass media for the provision, control or abatement of air/water pollution.

Functions of the Central Pollution Control Board

56

- Organize through mass media a comprehensive programme towards prevention, control and abatement of air pollution or water pollution.
- Collect, compile and publish technical and statistical data relating to air pollution/water pollution and the measures devised for its effective prevention, control and abatement and prepared manuals.
- Collect and disseminate information in respect of matters relating to air/water pollution.

Functions of the State Pollution Control Board

57

- To collect information relating water/air pollution and to encourage, conduct, participate in investigations and research relating to problems of water pollutions.
- To plan a comprehensive programme through mass media for prevention, control or abatement of air / water pollution.
- To advise the Central and State Government, in any matter concerning the prevention, control or abatement of air/water pollution.
- To inspect sewage or trade effluents, works and plants for the treatment of sewage or trade effluent.



Functions of the State Pollution Control Board

58

- To evolve economical and reliable methods of effluents of sewage and trade effluents.
- To evolve methods of utilization of sewage and suitable trade effluents in agriculture.
- To evolve efficient methods of disposal of sewage and trade effluents on land
- To lay down standards of treatment of sewage and trade effluents, to be discharged into any particular stream (prevention, control, abatement of discharged of wastes into stream or wells).



The environment is
everything that isn't me.

Albert Einstein

-Thank You!

DISASTER MANAGEMENT

Disaster Management Act, 2005 defines disaster as “*a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area*”.

Disaster Management means a coordination and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for: [According to DM act 2005]

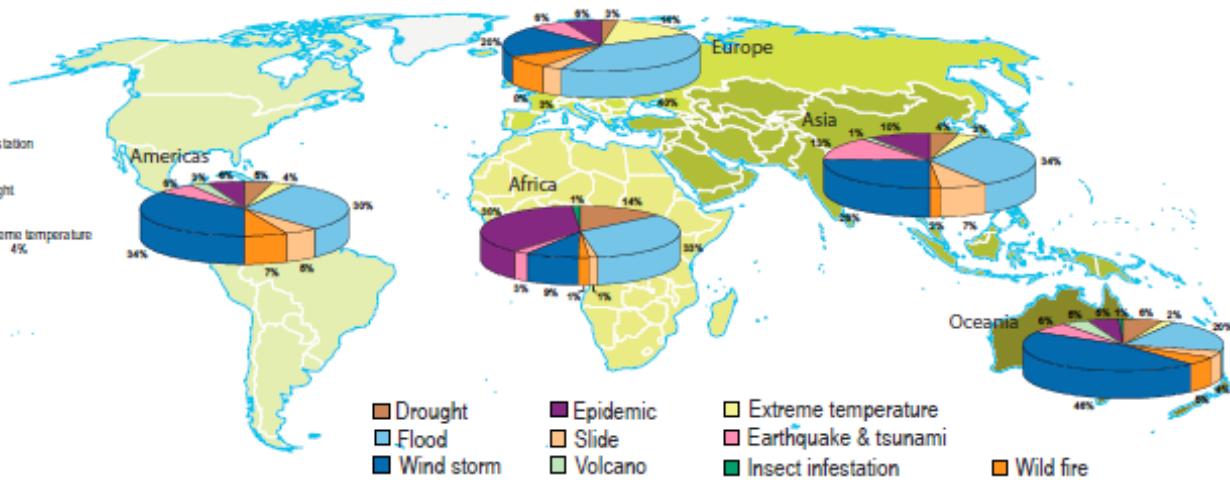
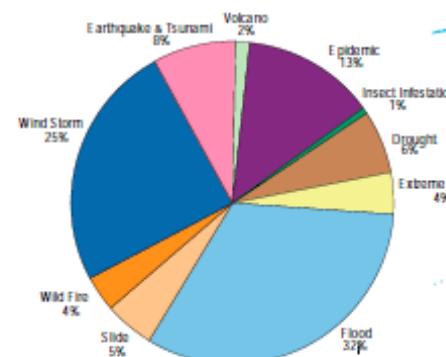
- (i) Prevention of danger or threat of any disaster
- (ii) Mitigation or reduction of risk of any disaster or its severity or its consequences
- (iii) Capacity building
- (iv) Preparedness to deal with any disaster
- (v) Prompt response to any threatening disaster situation or disaster
- (vi) Assessing the severity or magnitude of effects of any disaster
- (vii) Evacuation, rescue and relief
- (viii) Rehabilitation and reconstruction

TYPES OF DISASTERS

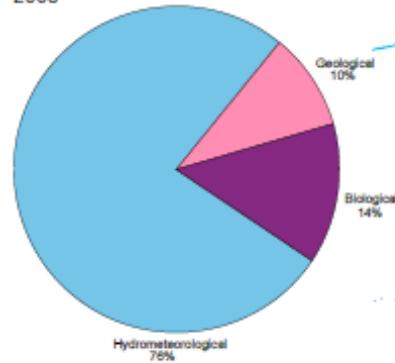
- **Natural disasters** – Natural phenomenon. Earthquakes, Tsunamis, Floods, Hurricanes etc.
- **Technological disasters** - Events that result from the accidental failures of technologies, human error in controlling or handling the technologies, malfunction of a technological structure. Industrial accidents, Dam failure, Bridge collapse.
- **Terrorist disasters** - A deliberate attack that is intended to achieve political objectives by inflicting damage and casualties. Also referred to as terrorism. Conflict situations and war.
- **Pandemic emergencies/ Biological hazard** - Sudden onset of a contagious disease like the [Covid 19].

- There is no country that is immune from disaster, though vulnerability to disaster varies.
- Disasters have a major and long-lasting impact on people long after the immediate effect has been mitigated.
- Disasters cannot be totally prevented but their impact can be reduced.
- Disasters have a major and long-lasting impact on people long after the immediate effect has been mitigated.
- Disasters cannot be totally prevented but their impact can be reduced.

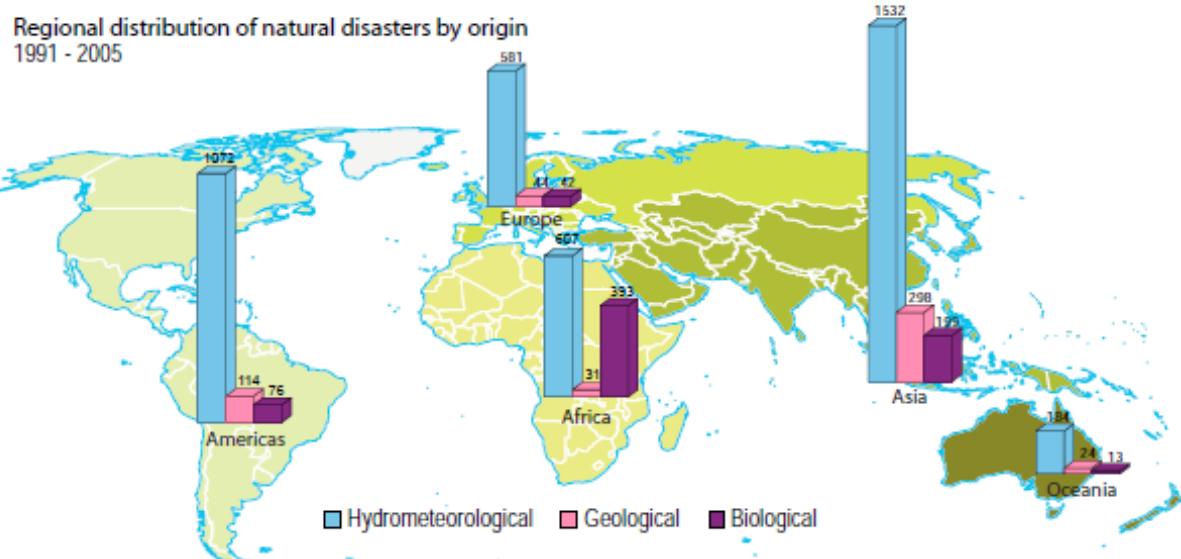
World distribution of disasters by type
1991 - 2005



World distribution of disasters by origin
1991 - 2005



Regional distribution of natural disasters by origin
1991 - 2005



Source: Centre for Research on Epidemiology of Disasters

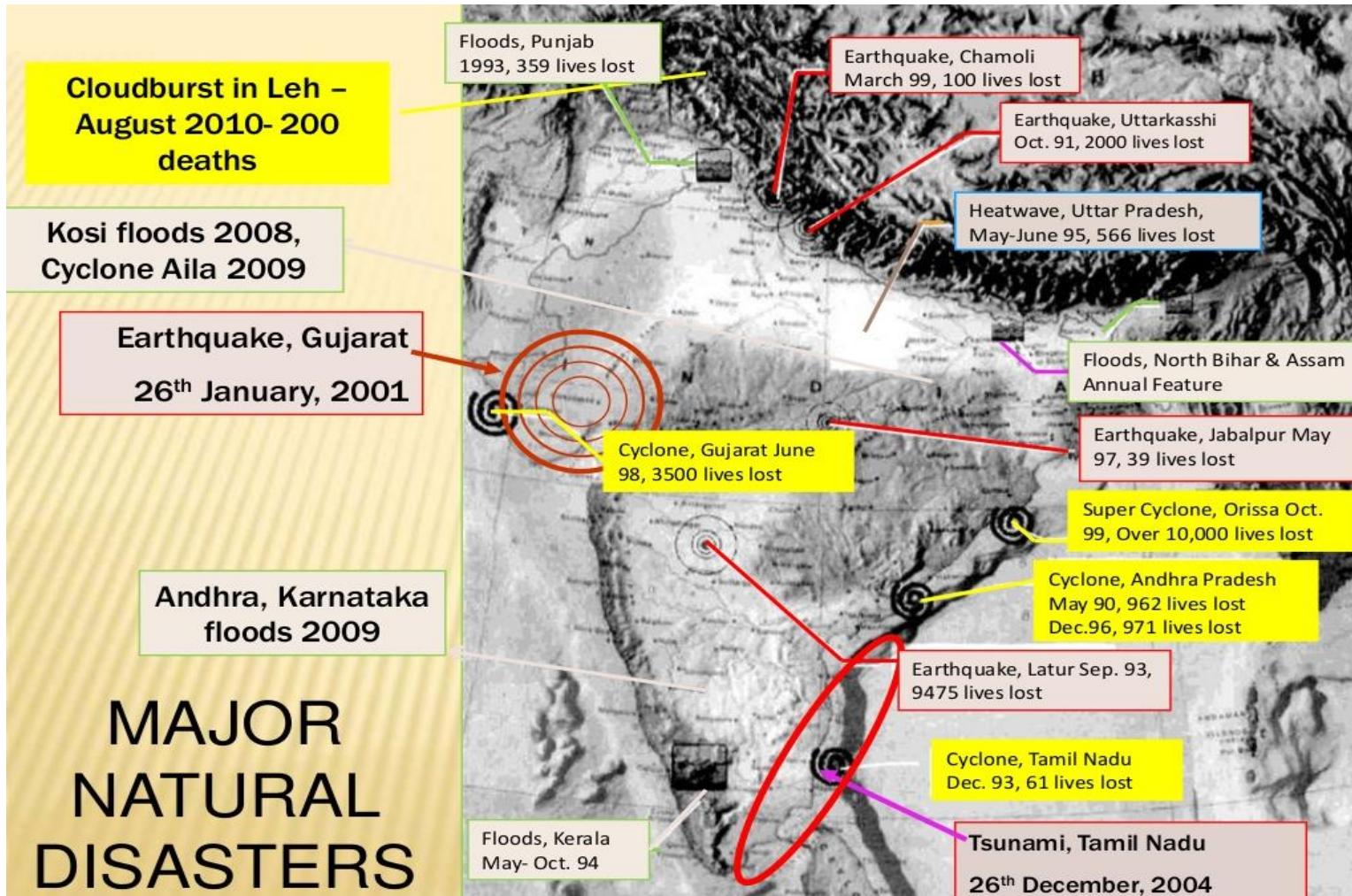


Table: 1.2: India's Deadliest Disasters

Sl. No.	Name of Event	Year	State & Area	Fatalities
In the Known History				
1.	Earthquake	1618	Mumbai, Maharashtra ^o	2,000 deaths
2.	Bengal Earthquake	1737	Bengal ^o	300, 000 deaths
3.	Cyclone	1864	Kolkata, West Bengal ^o	60,000 deaths
4.	The Great Famine	1876-1878	Southern India ^o	58.5 million people affected 5.5 million deaths due to starvation
5.	Cyclone	1882	Bombay, Maharashtra ^o	100,000 deaths
6.	The Indian famine	1896-1897	Whole India ^o	1.25 million to 10 million deaths
7	Earthquake	1934	Bihar ^o	6,000 deaths
8	Bhola Cyclone	1970	West Bengal ^o	500,000 deaths (including Hindu Kush Himalayas and surrounding areas)
9	Drought	1972	Large part of the country ^o	200 million people affected
10	Drought	1987	Haryana ^o	300 million people affected
In the Last Century				
1	Earthquake	1905	Kangra, Himachal Pradesh ^o	20,000 deaths
2	Cyclone	1977	Andhra Pradesh ^o	10,000 deaths hundreds of thousands homeless 40,000 cattle deaths. Destroyed 40% of India's food grains.
3	Latur Earthquake	1993	Latur, Marthawada, region of the Maharashtra ^o	7,928 people died and another 30,000 were injured.
4	Orissa Super Cyclone	1999	Orissa ^o	10,000 deaths
5	Gujarat Earthquake	2001	Bhuj, Bachau, Anjar, Ahmedabad, and Surat in Gujarat State ^o	25,000 deaths 6.3 million people affected



Cyclone Nivar: 3 killed in Tamil Nadu as storm weakens into severe cyclonic storm



Natural Disaster

When – April 1986

Cause – nuclear reactor malfunction

- largest uncontrolled release of radioactive waste into the environment
- release of radioactive materials lasted for 10 days



Location – Chernobyl, Ukraine

Affected countries – Ukraine, Belarus, Russia

Main radioactive wastes:

Iodine – 131

Cesium – 137

Radioactive materials settled down in dust and debris, but lighter materials were carried by wind across countries

Caused 28 deaths within 3 months; plant is still in use today



Technological Disaster [Accidental]



Chernobyl disaster still costly



Terrorist Disaster [Intentional]



The September 11 attacks had shaken the United States and had a huge impact globally as it was one of the most dreadful attacks ever made by the terrorist group al-Qaeda.



Terminology

- **Disaster risk** : The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.
- **Disaster Risk Management**: The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

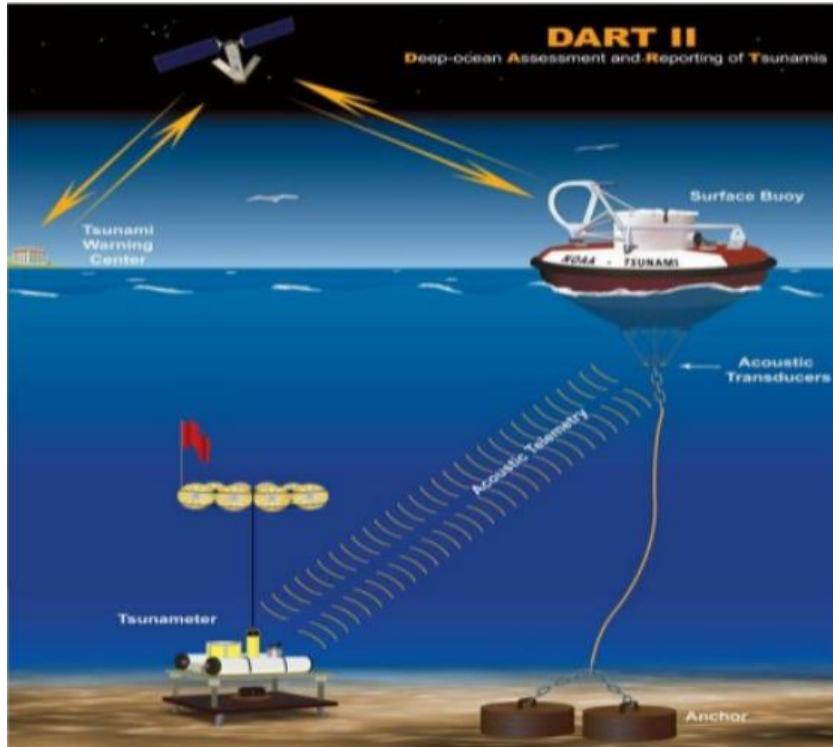
- **Hazard:** A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage.
- **Vulnerability:** The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

- **Biological hazard :** Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
- **Building code :** A set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage.

- **Early warning system :** The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

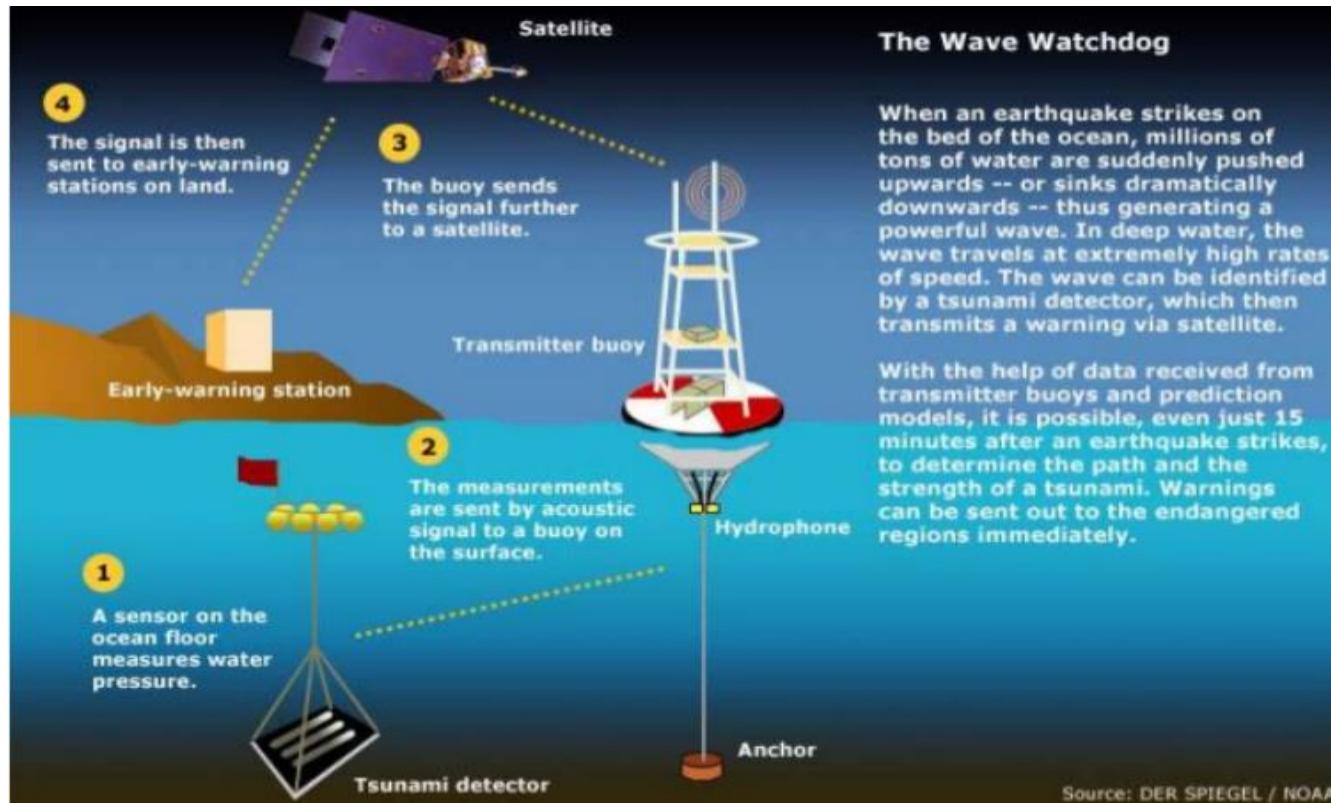


DART : Deep ocean Assessment and Reporting system for detection of Tsunamis

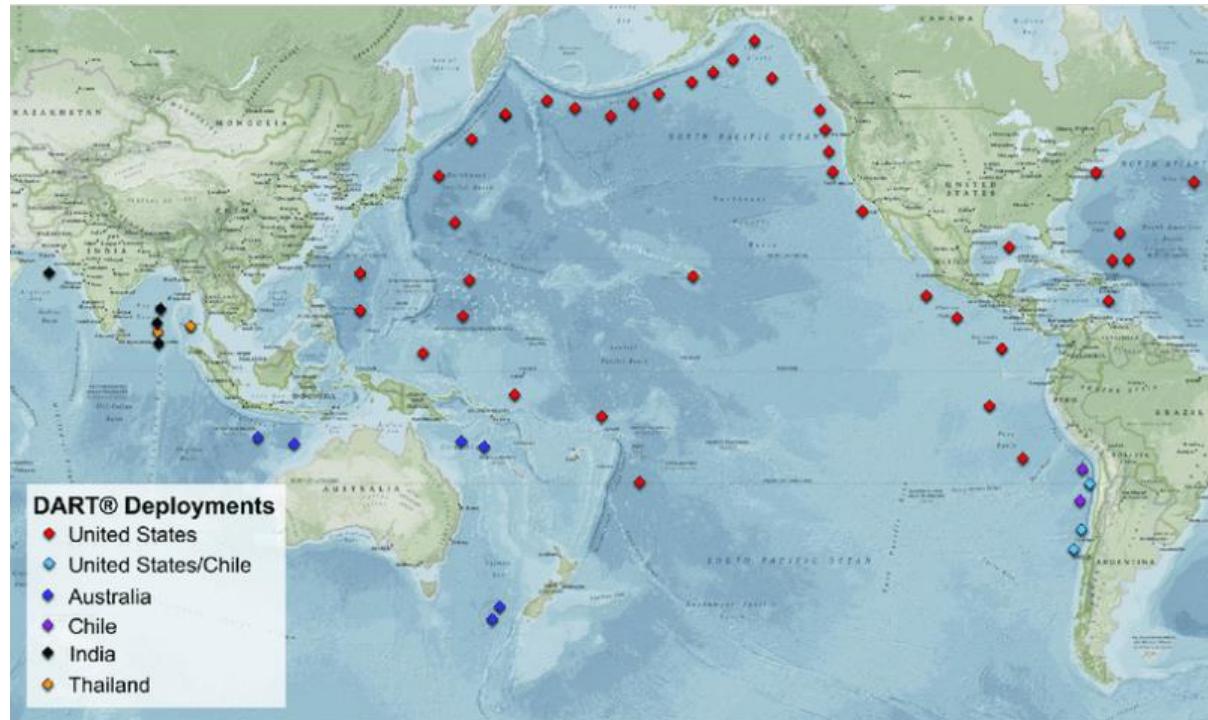


**Early warning
system**

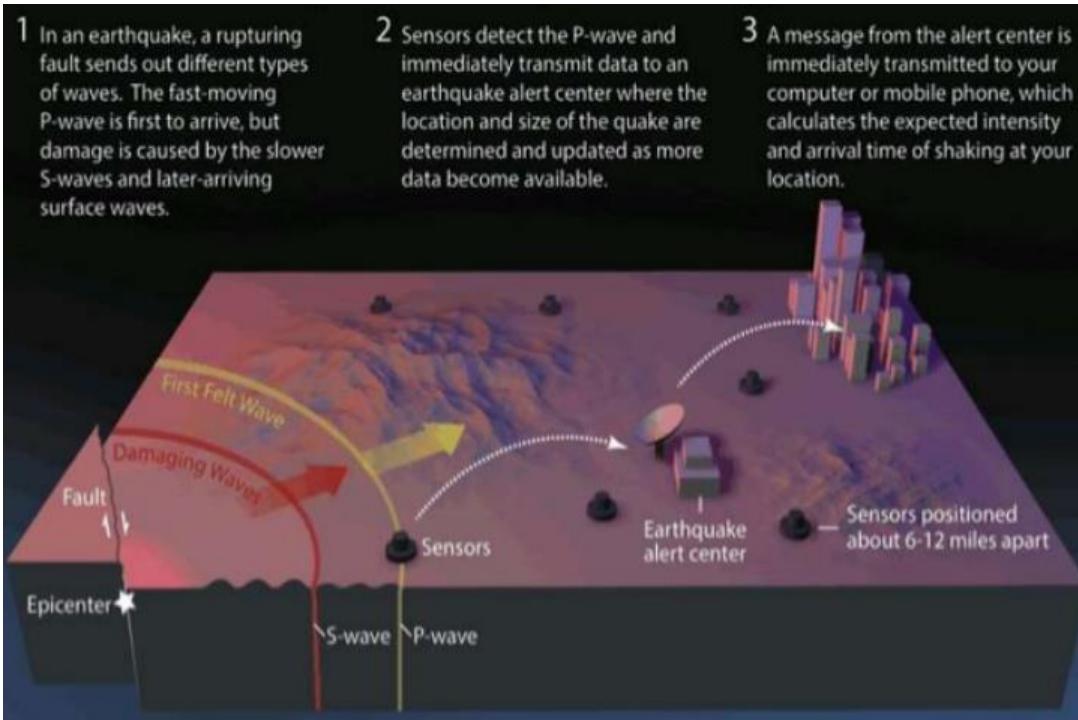
DART system process

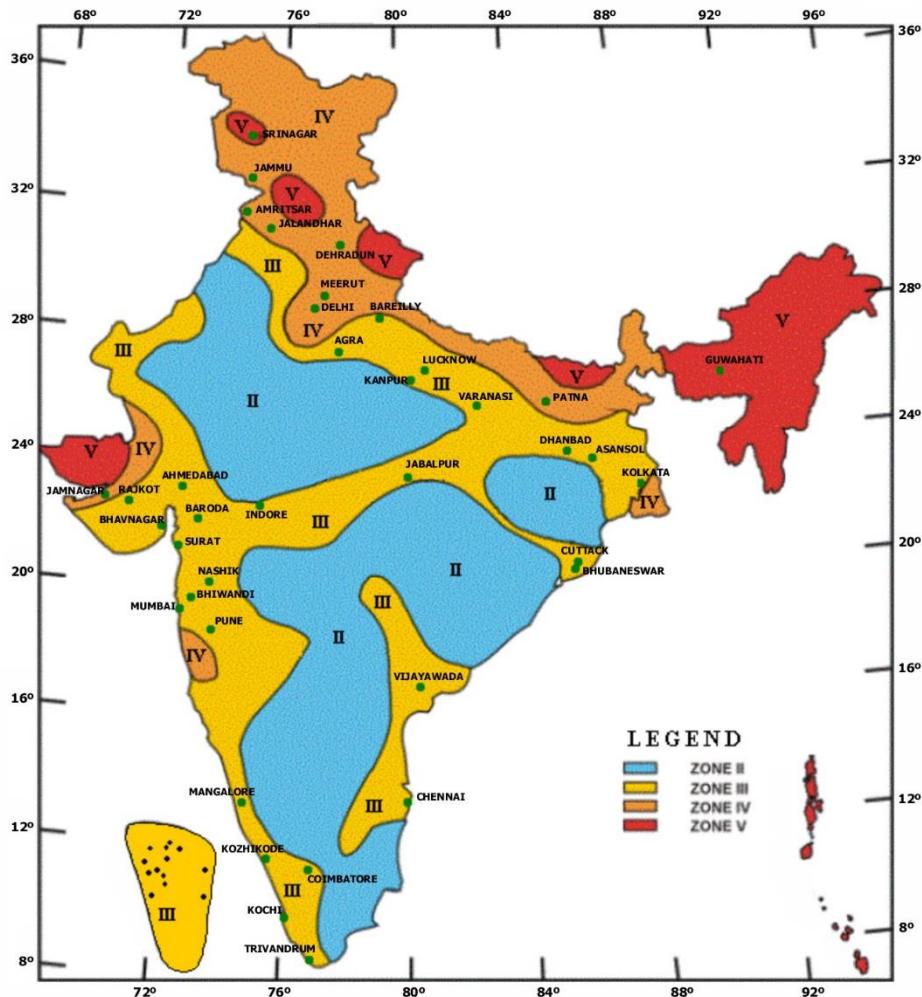


DART system installation maps



Earthquake early warning system

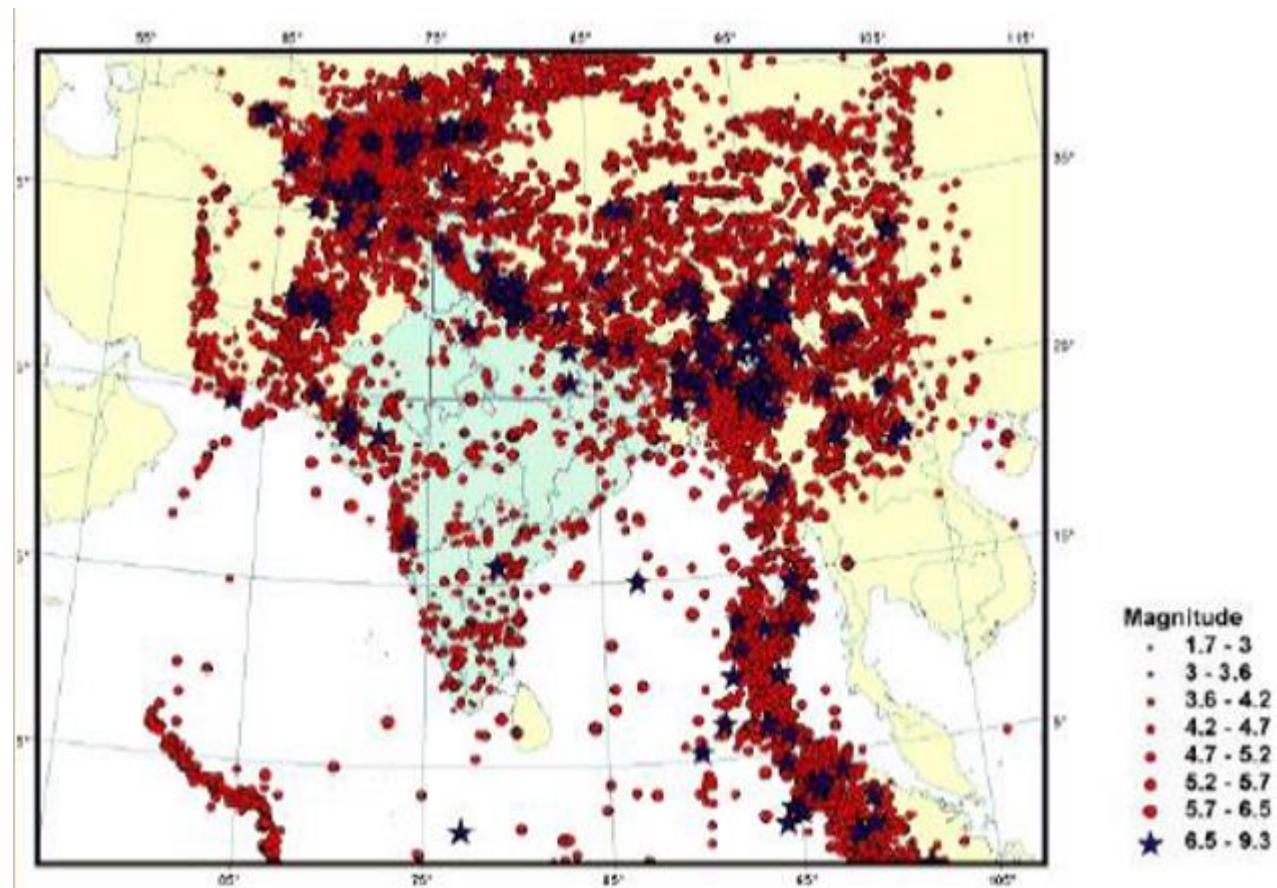




Zone	Magnitude
Zone V	Very High Risk Quakes of Magnitude 8 and greater
Zone IV	High Risk Quakes upto Magnitude 7.9
Zone III	Moderate Risk Quakes upto Magnitude 6.9
Zone II	Seismic Disturbances upto Magnitude 4.9

Indian Seismic zone maps as per IS 1893 (Part 1) - 2002

Seismic activity in India

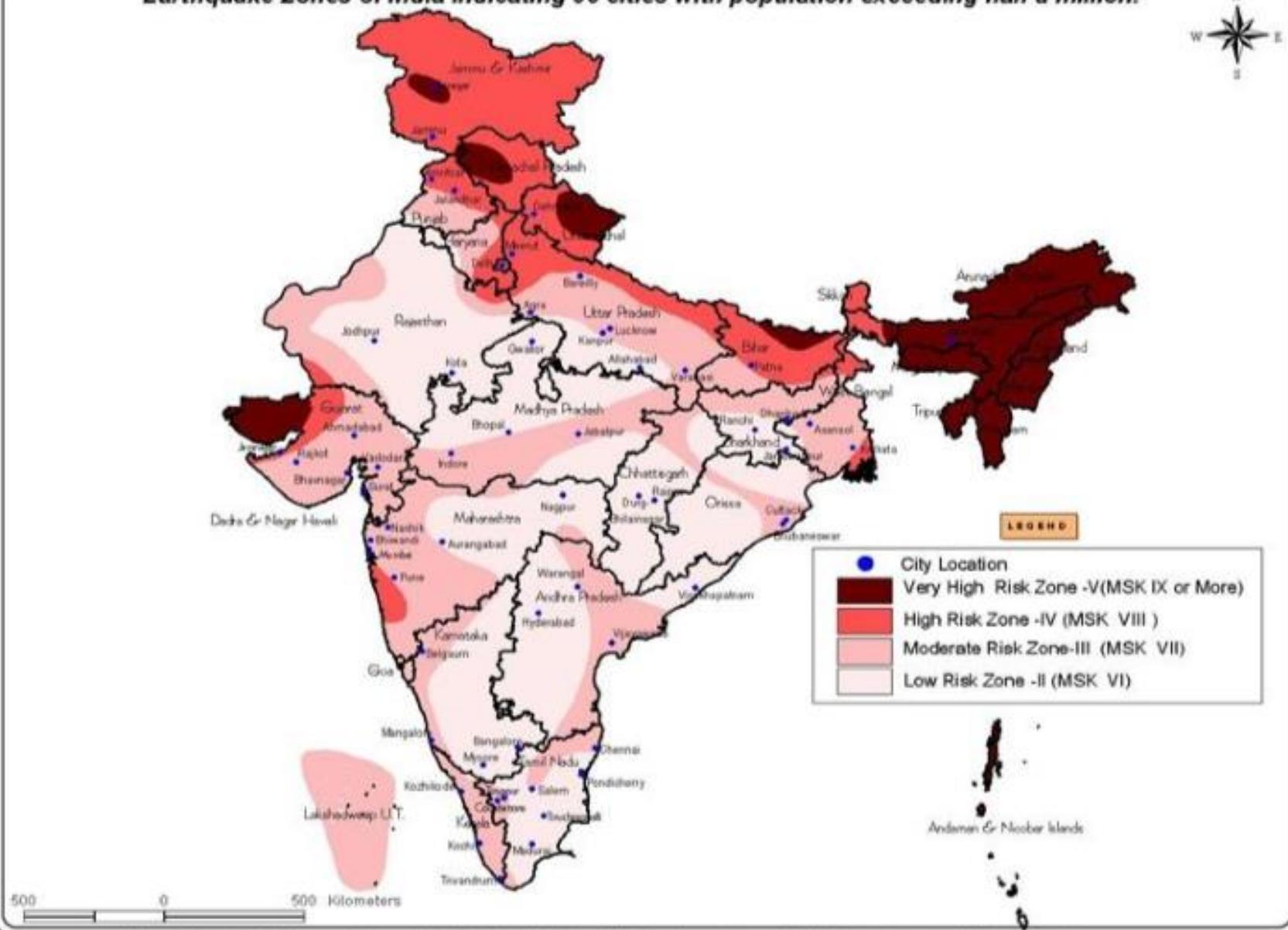


Scale of disaster

Is dependent on :

- Lead Time Available.
- Intensity of Hazard.
- Duration.
- Spatial Extent.
- Density of Population & Assets.
- Time of Occurrence.
- Vulnerabilities existing in the Elements at Risk.

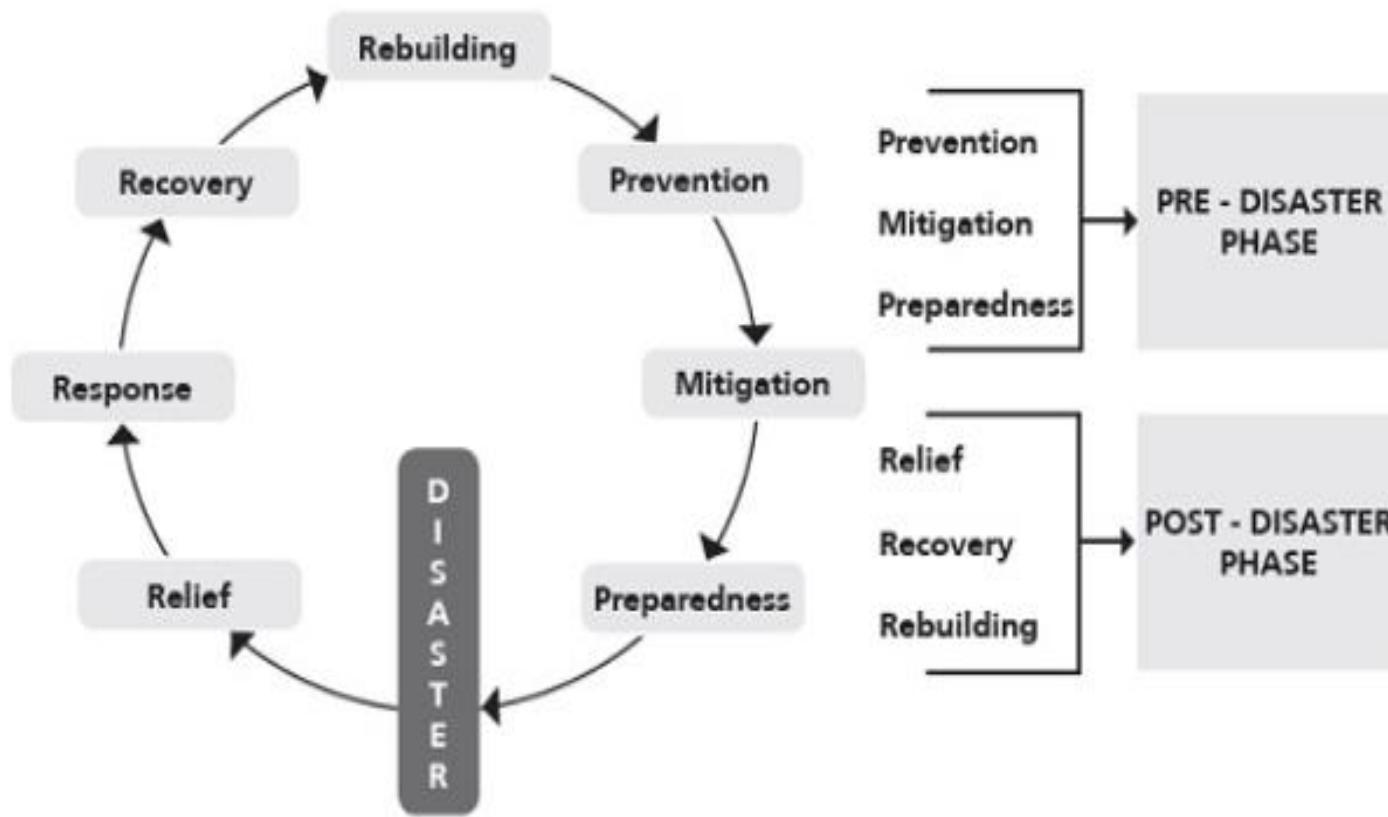
Note : Hazard X Vulnerability = Disaster

Earthquake Zones of India indicating 60 cities with population exceeding half a million.

General effects of disaster

- Loss of life
- Injury
- Destruction of property
- Disruption of lifestyle
- Disruption to essential services
- Damage to national infrastructure
- Disruption to Governmental systems
- National economic loss
- Sociological and psychological after effects

DISASTER MANAGEMENT CYCLE



PREVENTION AND MITIGATION

- Personal mitigation is a key to national preparedness.
- Individuals and families train to avoid unnecessary risks.
- This includes an assessment of possible risks to personal/family health and to personal property.

DISASTER PREPAREDNESS

- Personal preparedness focuses on preparing equipment and procedures for use when a disaster occurs.
- Construction of shelters, implementation of an emergency communication system, installation of warning devices, creation of back-up life-line services (e.g., power, water, sewage), and rehearsing evacuation plans.

RESPONSE AND IMMEDIATE RELIEF

- The response phase of an emergency may commence with Search and Rescue.
- Fulfilling the basic humanitarian needs of the affected population.
- Relief activities include rescue, relocation, providing food and water, preventing disease and disability, repairing vital services such as telecommunications and transport, providing temporary shelter and emergency health care.

NDRF : Response Activities

VISIBLE PART: AT THE CUTTING EDGE LEVEL



KOSI FLOODS



Rescue During Pawna River
Floods, PUNE



SAR OPERATION AT
BELLARY,
KARNATAKA



LANDSLIDE RESCUE,
DARJEELING



AP & KARNATAKA FLOODS

The National disaster response force, **NDRF** was constituted under Section 44 of the Disaster Management Act, 2005 for a specialized response to natural and man-made disasters.



RECOVERY

- The recovery phase starts after the immediate threat to human life has subsided.
- The immediate goal of the recovery phase is to bring the affected area back to some degree of normalcy.
- Recovery activities include rebuilding infrastructure, health care and rehabilitation.
- Developing policies and practices to avoid similar situations in future.

Application of GIS in Disaster Management

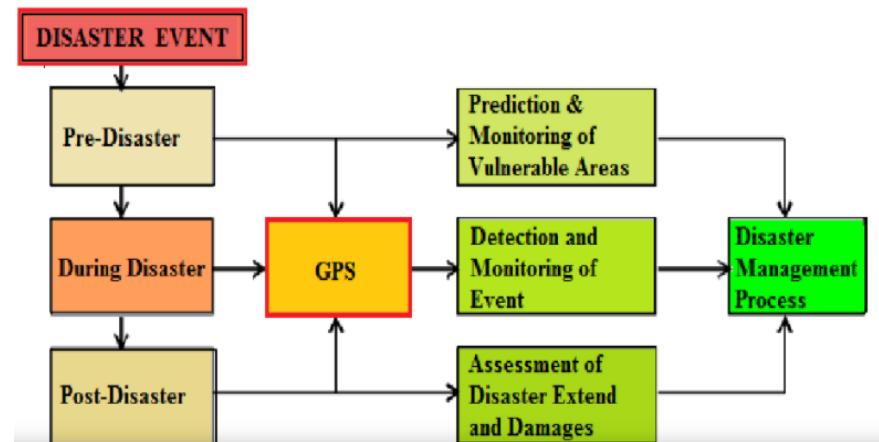
- GIS is a tool that allows users to create interactive queries, analyze the spatial information, edit data, maps and present the results of all these operations.
- The specific application in risk assessment are, hazard mapping to show earthquake, floods, landslides or fire.
- These maps are used for warning system.

GPS : Global Positioning system & Disaster Management

1. GPS is a Global navigation satellite system.
2. A very precise positioning system.
3. Satellite based.
4. 24 satellite & 20,200 km high orbit.

Application of GPS

- Location
- Navigation
- Tracking
- Mapping
- Timing



Nodal agencies for disaster management

DISASTERS



Natural Disasters
Air Accidents
Civil Strife
Railway Accidents
Chemical Disasters
Biological Disasters
Nuclear Accident

NODAL MINISTRIES



Agriculture
Civil Aviation
Home Affairs
Railways
Environment
Health & family Welfare
Atomic Energy

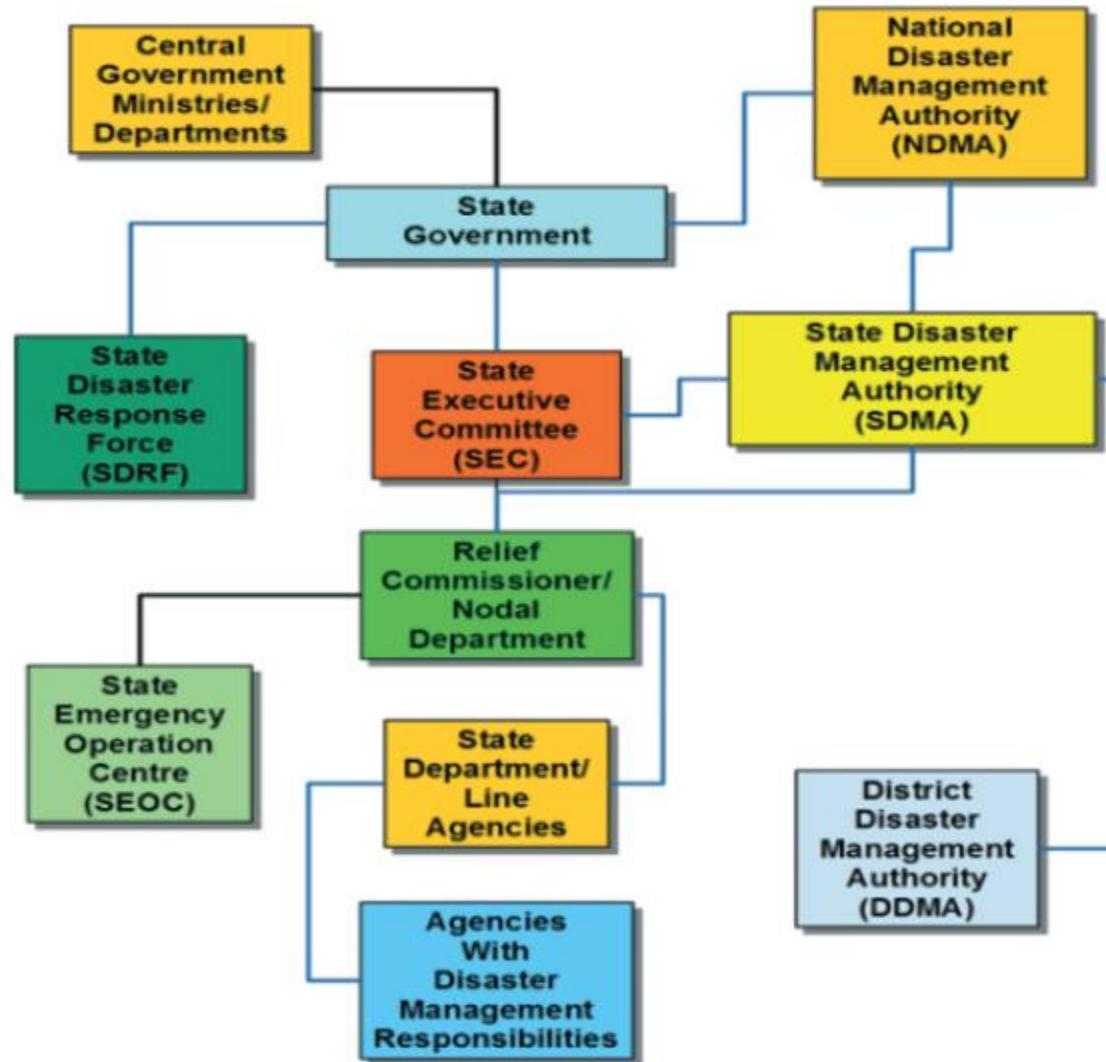


Technological inputs

Nodal agencies for forecasting and early warning dissemination

Disaster	Agency	Ministry
Cyclone	Indian Meteorological Department	Earth Sciences
Tsunami	Indian National Centre for Oceanic Information Services	Earth Sciences
Earthquake	India Meteorological Department	Earth Sciences
Floods	Central Water Commission	Water Resources
Landslides	Geological Survey of India	Mines
Avalanche	DRDO	Defence

State level disaster management coordination mechanism



District disaster management plan



Hazardous waste spills



Causes of chemical spills

- Inappropriate handling techniques
- Inappropriate storage containers
- Damage storage containers
- Uncontrolled access to chemical storage
- Lack of chemical related training
- Lack of supervision



Dangers of chemical spills

- Slip, trip, fall hazard
- Contamination of other materials
- Risk of fire
- Possible release to environment
- Routes of exposure to hazardous materials like inhalation, injection, ingestion and absorption.

Hazardous waste

- A hazardous waste is a waste with properties that make it dangerous or capable of having a harmful effect on human health or environment.
- Examples include oil paint, motor oil, pesticides, fluorescent lamps, medical wastes, e-wastes and so on.

Hazardous chemicals

1. **Arsenic:** Arsenic gets released into groundwater through agriculture, wood preservatives, and glass production. It can cause cancer, respiratory, and circulatory problems.
2. **Lead:** Lead is a hazardous chemical that often occurs near mining sites. It can get into the food chain and cause heart disease.
3. **Benzene:** Benzene can be released into the environment because of gasoline vapors and automobile exhaust, and has been linked to leukemia.
4. **Chromium:** Chromium has been used in the natural gas industry to prevent machinery from rusting.
5. **Toluene:** Toluene can enter the environment through its use in solvents and petroleum products. If inhaled at heavy doses, it can damage the central nervous system.
6. **Cadmium:** Highly toxic even in low doses, cadmium is most found in industrialized areas and is released into the environment through fuel combustion, incorrectly handled sewage sludge, and fertilizers.

7. Zinc: Zinc can be released into the atmosphere due to galvanized metal surfaces, motor oil spills, and tire dust, and can accumulate through stormwater runoff and harm fish and other aquatic life.

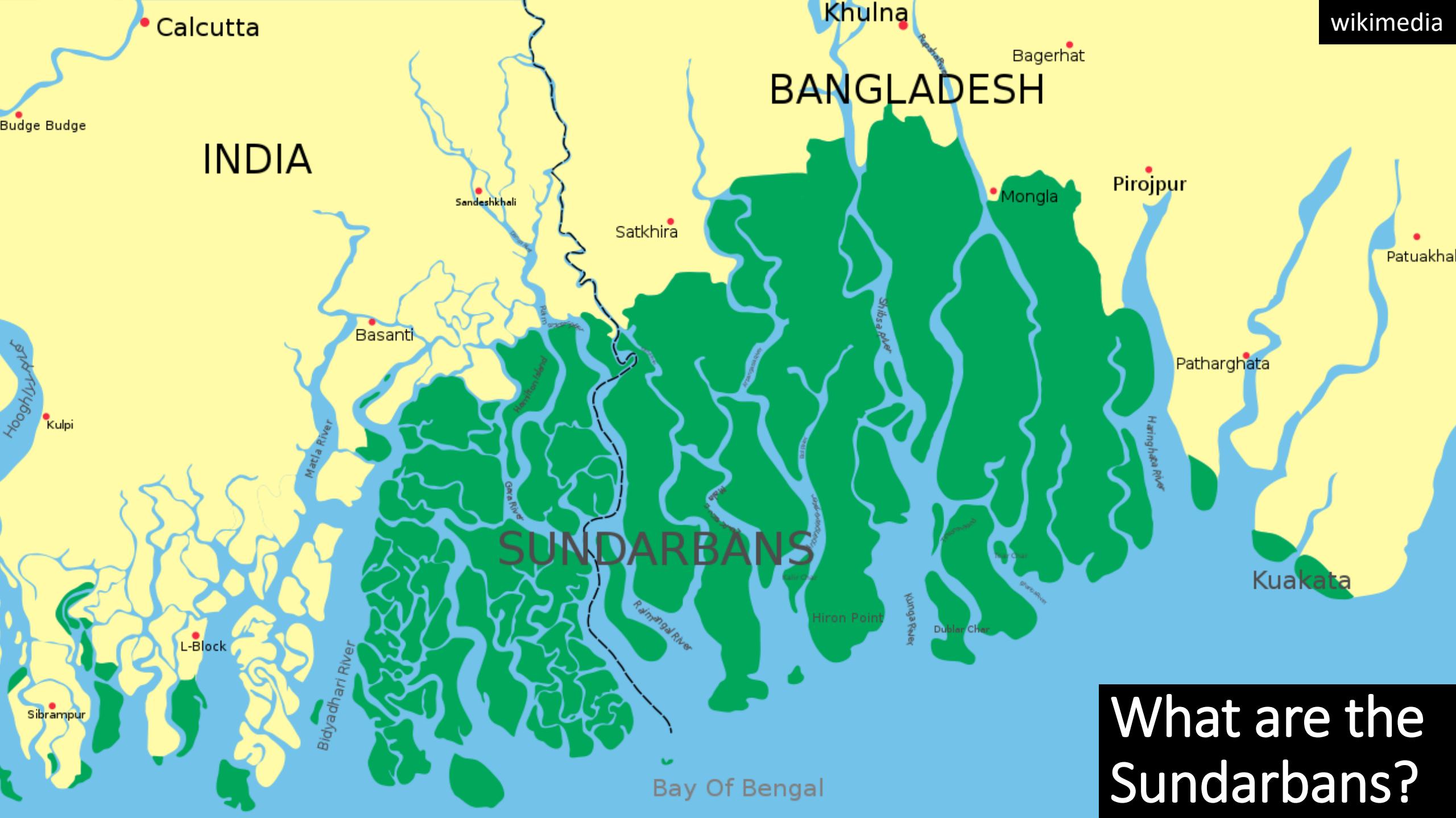
8. Mercury: Mercury gets into the atmosphere through metal processing, coal burning, medical waste, and more. The health problems it engenders are many: brain damage, and kidney and immune system problems can result from overexposure to mercury.

9. Pesticides: Used in industrial-scale agriculture, pesticides accumulate through water runoff and find their way into water supplies. They can cause neurological and reproductive disorders.

10. E-Waste: When electronics are incorrectly disposed of, hazardous substances like lead, mercury, and arsenic can leak out, contaminating their surroundings, such as when they're in a landfill. Over time, these metals and compounds seep into the soil, and through bioaccumulation are passed along the food chain.

Sundarbans's Vanishing Shores

Case Study-1



What are the
Sundarbans?

Sundarbans

Sundarbans are a low lying mangrove forests which stretches the coast of Bangladesh and some of West Bengal in India. They are the world's largest single block of mangrove forest. It is on the delta formed by three large rivers; Ganga, Brahmaputra and Meghna (A major river that resides exclusively in Bangladesh). It's composed of five national parks: The Sundarbans National Park, Sundarbans, south, west and east wildlife sanctuaries and the Sajnakhali Wildlife Sanctuary. First four are UNESCO world heritage sites. Due to the plethora of unique ecosystems that the Sundarbans harbor, it is home to enumerable biodiversity. It is also home to thousands of people who reside on its many archipelagos (Island clusters) and subsist by farming, using/selling non-timber forest products and plantation products.



Saturday, February 24th 2018



[Home](#) [Video](#) [The Latest](#)

[The Reel](#) [The Field](#)

[Magazine](#)

[Pulse](#)

[In Pictures](#)

[Bookshop](#)

[Trending](#) ▾

[Sections](#) ▾

[Newsletters](#)



COASTAL CONFLICT

In Sundarbans, rising sea levels have turned farms into wasteland, threatening to displace millions

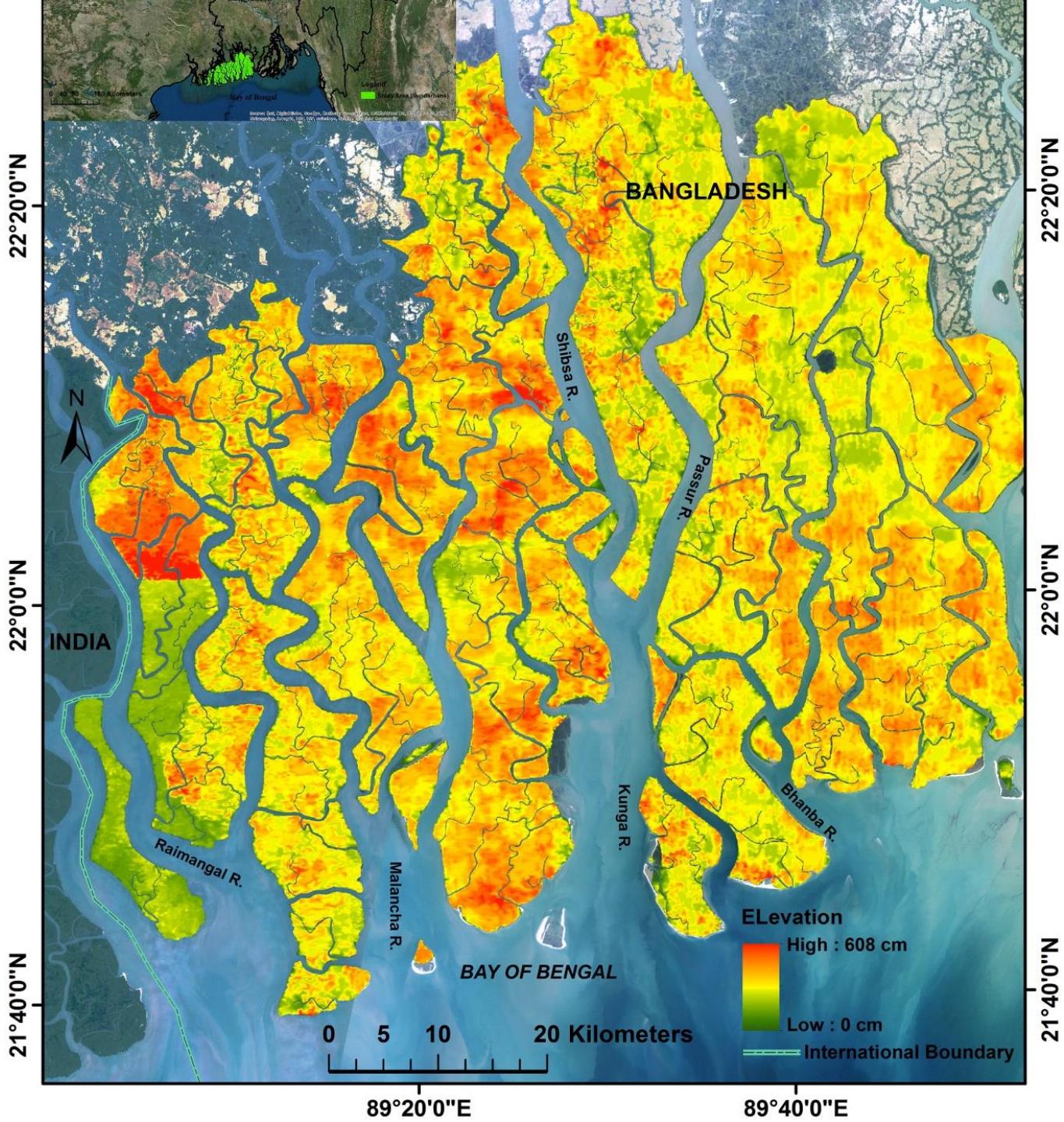
Around 1.5 million people will be displaced in the area, and the process has started.



- Unfortunately due to sea level rise are causing havoc to its ecology and the lives of the people who live in it. This is a serious problem for India in three major ways. First is that the Sundarbans on the Indian side is also inundating. This will cause massive loss of homes and livelihood for many people which the government will have to compensate for. This is not an easy task. Second is that the inundation on the Bangladesh side will trigger an influx of environmental refugees into India from Bangladesh. This is a very serious socio-political issue. It increases burden on the Indian government already stretched funds to manage those refugees and intensifies the political tensions between India and Bangladesh.

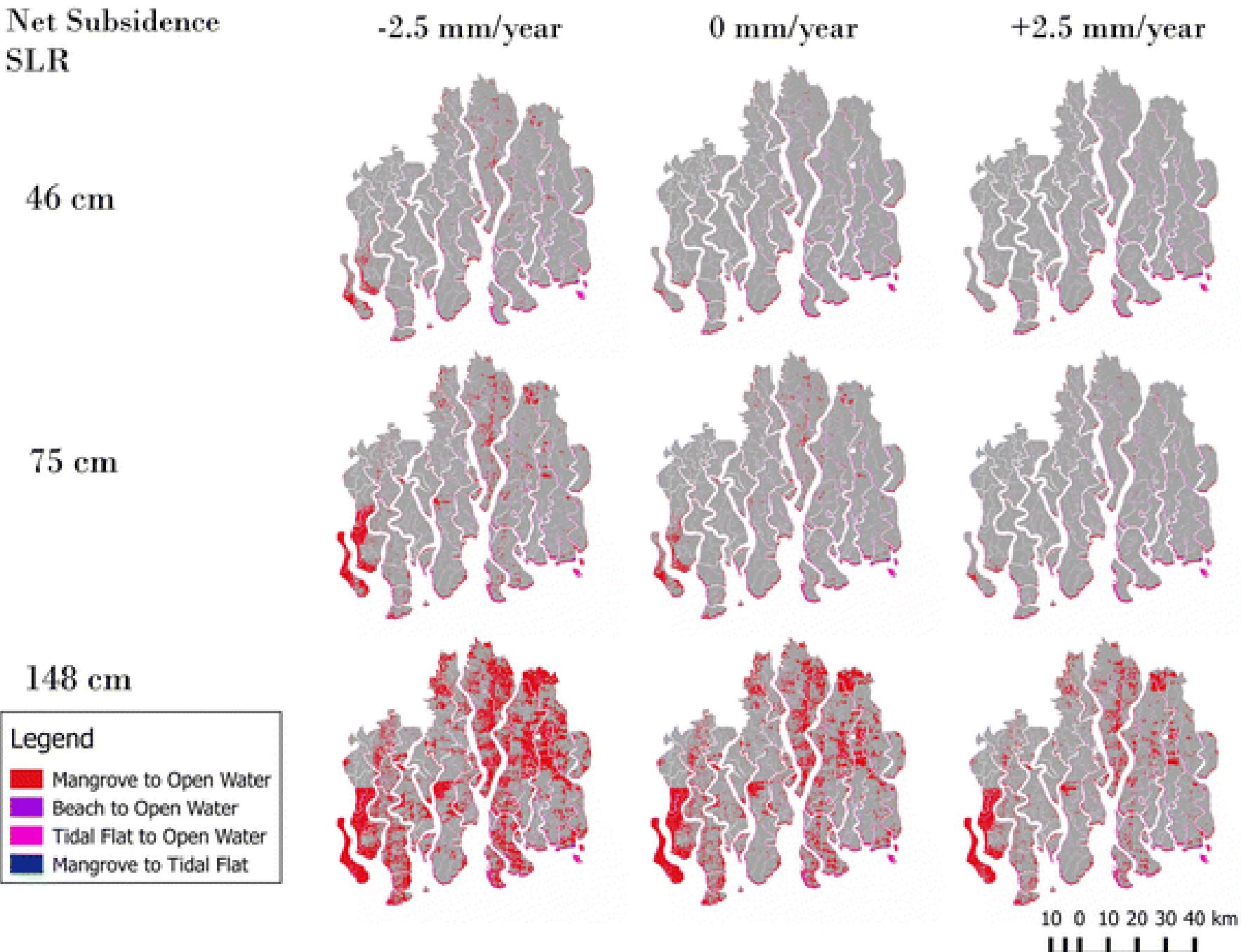
- Third is the ecological consequences of the inundation. Sundarbans are home to some very critically endangered flora and fauna like the Bengal Tiger, Salt Water Crocodiles, Masked Finfoot and Heritiera fomes (locally called Sundri) among many others. The reduction in the size of the forest is already increasing man-wildlife conflicts, especially with the tigers and is causing rapid deterioration of the population of many animals and plants. Their conservation is crucial for the protection of the Sunderbans and the many services we receive from it.

Elevation of the Sundarbans



It is crucial to understand how low the Sundarbans actually are to actually understand the scope of this problem. This is an elevation map of the Sundarbans. As you can see, the highest parts of it are merely 6m over mean seal level with many of the regions being much lower (with not an insignificant area at the mean seal level). This is compounded by the fact that this area naturally subsides due to consolidation of the river deposits in the delta and the erosion of the tidal flats. So the elevation of many areas within the Sundarbans is expected to become lower. Just for a perspective, Manipal is 73m over the mean sea level. Bangalore is at an average 920m over the mean sea level.

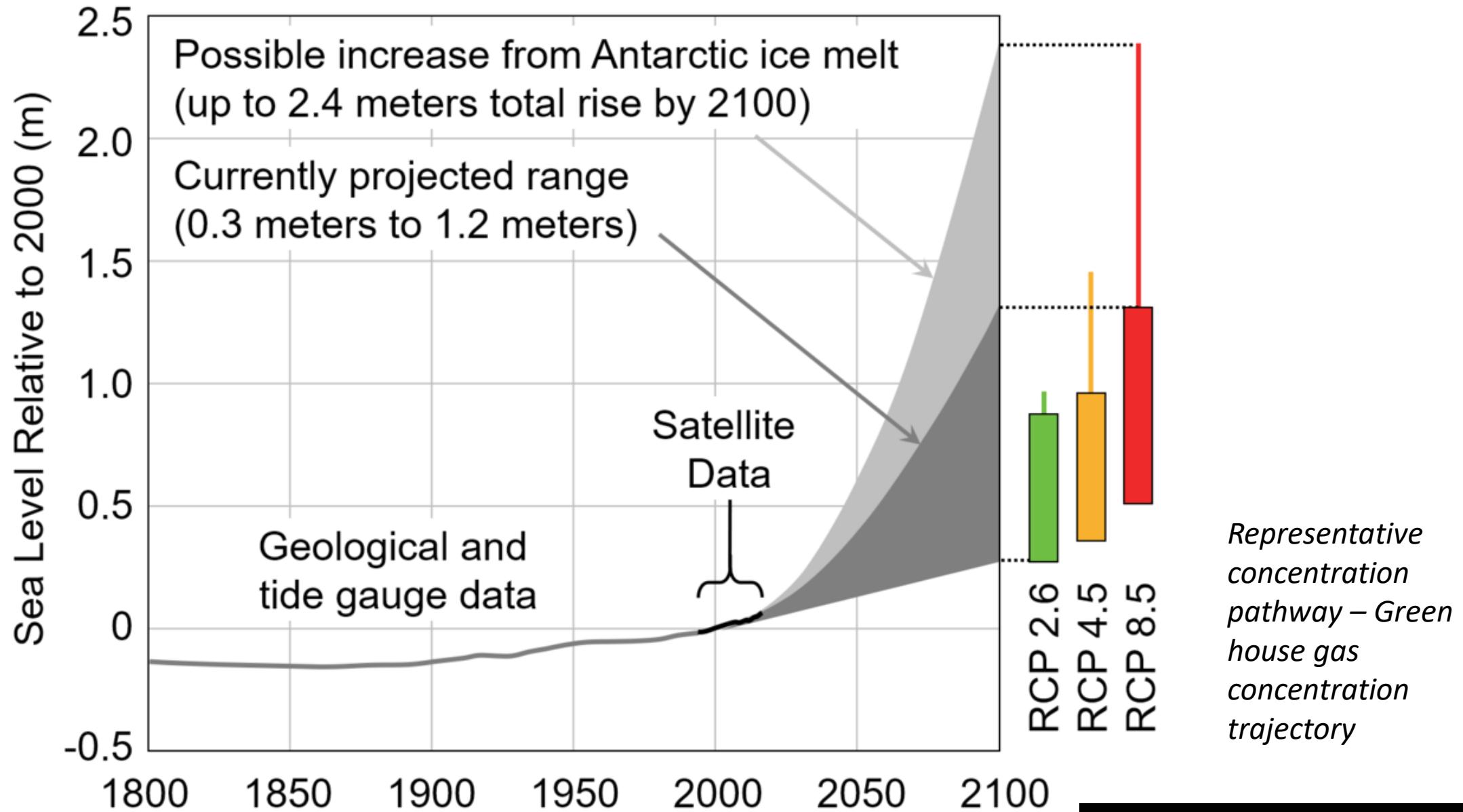
How much
inundation are
we looking at?
(By 2100)



This is the inundation scenario under various natural net subsidence rates (range =+- 2.5mm a year) and various Sea level rise(SLR) scenarios (46-low, 75-medium, 148-high). Which one should we take as a realistic prediction? The area in red color is the inundated area by 2100 under various scenarios.

Citation: Payo, Andres, et al. "Projected changes in area of the Sundarban mangrove forest in Bangladesh due to SLR by 2100." *Climatic Change* 139.2 (2016): 279-291.

Global Mean Sea Level History and Projections



According to global mean sea level projections using various models, we are realistically looking at 1-1.5m rise in mean sea level, if not more. What will be left of the Sundarbans if our worst case scenario (~2.5m level rise due to Antarctic ice melt) becomes true?

Solutions?

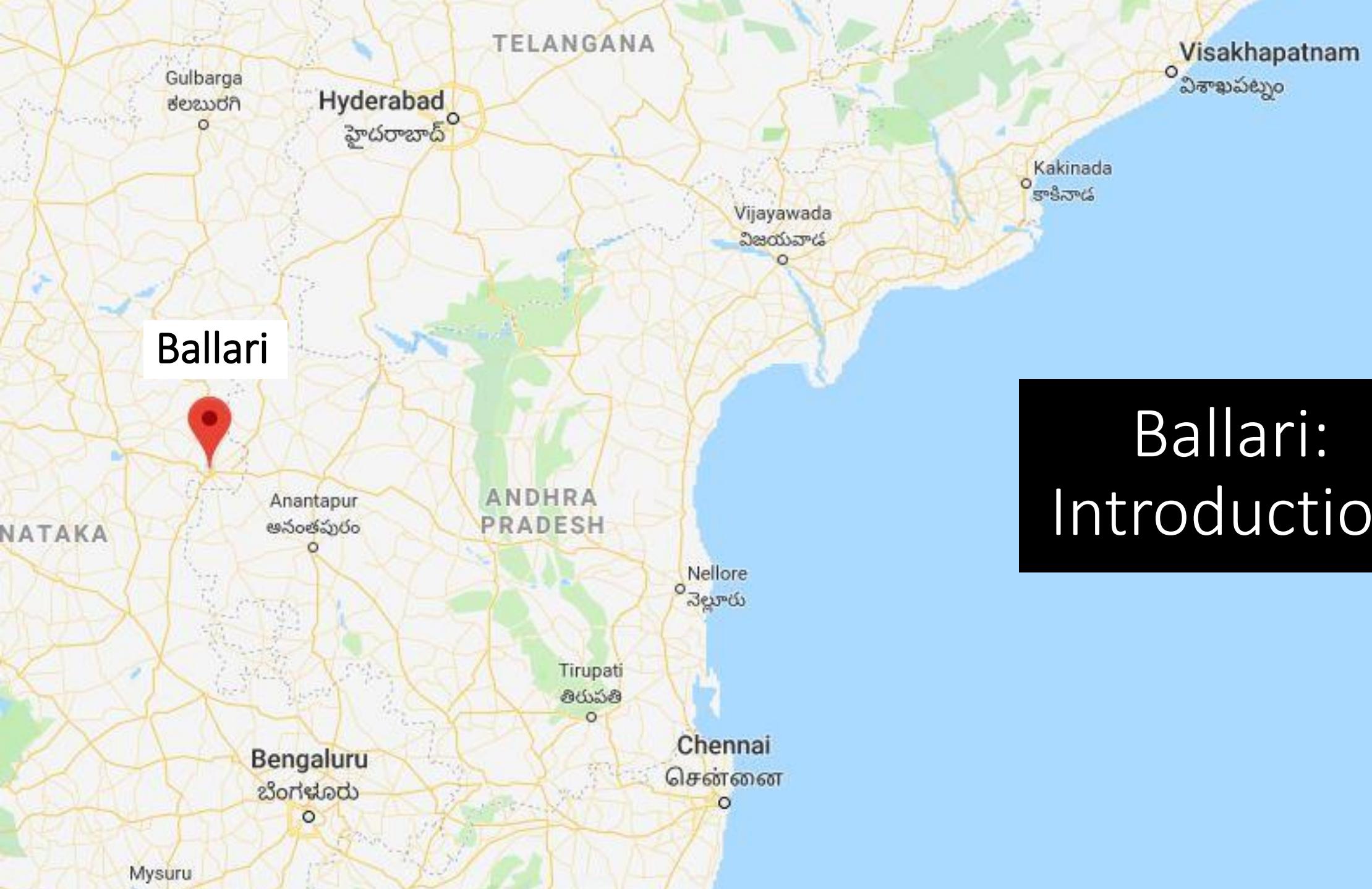
- Zoning according to vulnerability
- Planning, rehabilitation and relocation
- Embankments
- Creating opportunities that do not depend on nature

Read page 144 from the environmental reader book for more details on the solutions.

How Ballari was laid waste

Case Study - 2





Ballari

Ballari: Introduction

- Ballari is a major city in the state of Karnataka, near the border between Karnataka and Telangana and nearly equidistant from Bangalore and Hyderabad.
- It is extremely rich in good quality iron ore with the iron content in its ore ranging from 60-65% (a very high concentration). As a result, it is a popular iron ore mining destination in India and the ore extracted from this region constitutes about 1/5th of India's total output.
- A spurt in the local and Chinese demand for stainless steel has made mining in this region even more lucrative with prices soaring from round Rs.1,200 per ton in 2002 to around Rs.6000 per ton in 2006-2007. Unfortunately, this has also resulted in the emergence of illegal mining in the area which has ballooned into one of the biggest mining scams in India. Through the collusion of government officials, regulatory authorities and private companies, mining was done in the region by violating many environmental, mining, labor and land regulations.

The Scam

Miners get high profits

On low investment

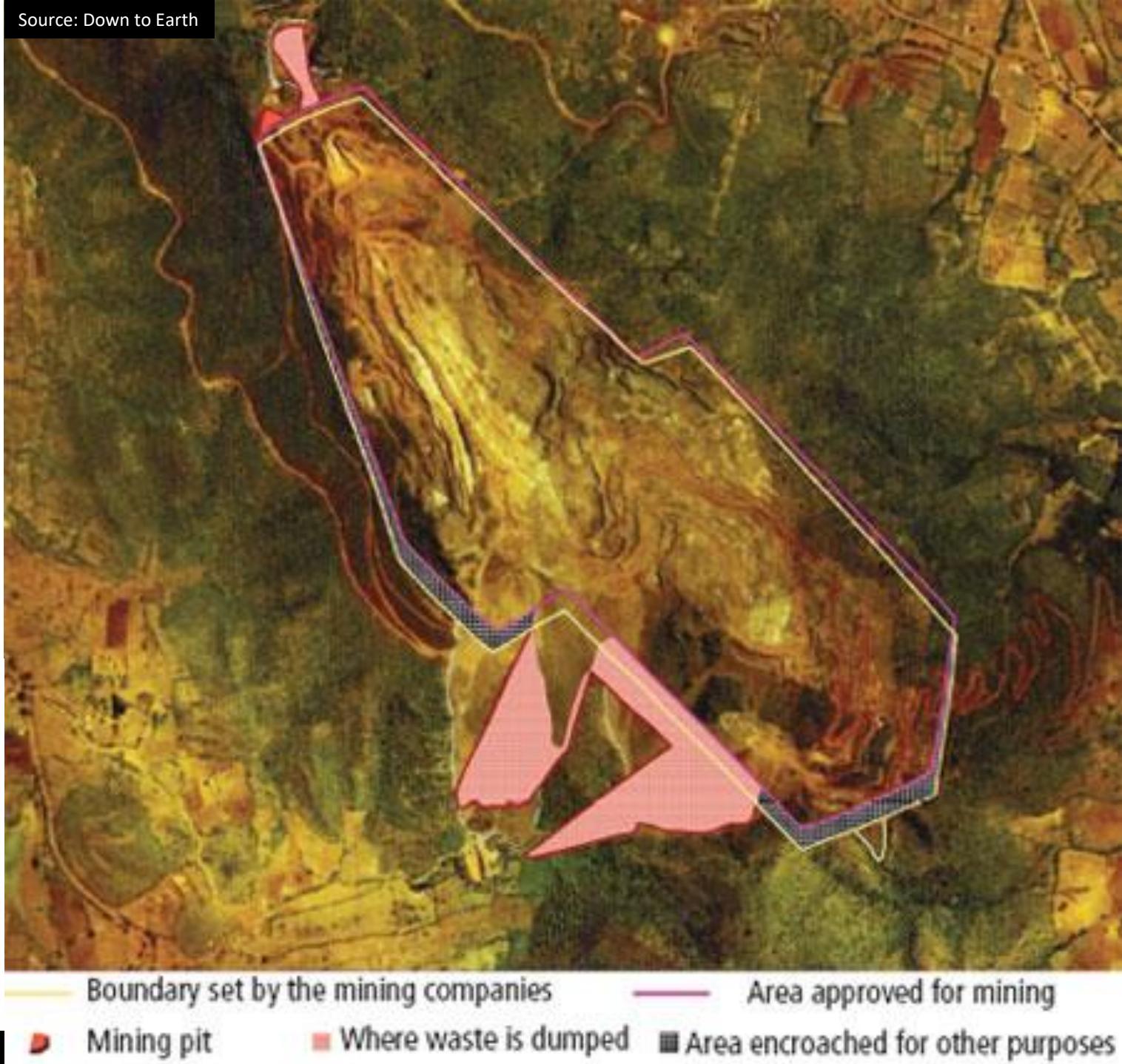
Legal expenses

Royalty paid to state government	Rs 27
Cost of excavation (approx.)	Rs 300
Illegal expenses	
Bribes (approx.)	Rs 200
Total expenses (approx.)	Rs 527
Selling price of iron ore (in international market)	Rs 6,000-7,000
Profit	Rs 5,500-6,500
Percentage of profit	1,300%

*All calculations done for one metric tonne of iron ore

Source: Down to Earth

Source: Down to Earth



The Bribes of Bellary

Total officials bribed	Approximate value of bribes paid	Superintendent of Police	Additional SP	Port directors
617	₹246.6cr	₹1 lakh bi-monthly	₹25,000 per month	₹50,000 per ship

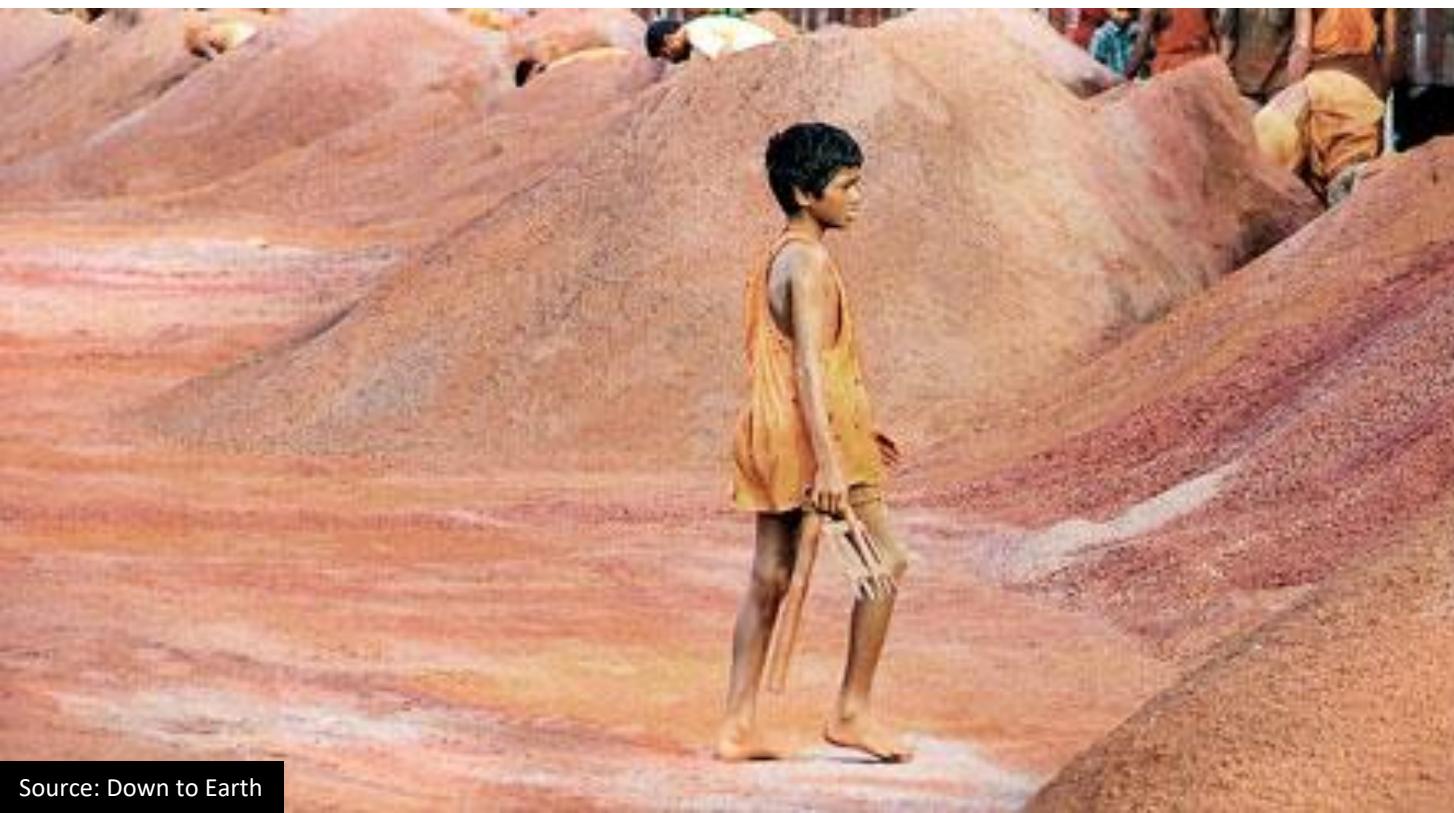
Port staff ₹5,500 per ship	Senior Customs Officials ₹1 lakh every 3 months + ₹0.5/ tonne of ore transported. Was a flat rate earlier
-------------------------------	--

Source: Economic times

- This map shows the extent of illegal mining in Ballari. The pink line is the area approved for mining by the government. The yellow line is the boundary set up by the mining companies.
- The mining companies were supposed to mine and dispose the waste within the designated area. Furthermore, they were supposed to grow a green cover around the mine to suppress the dust released from the mining.
- Finally, they were allowed to only mine a certain amount of iron ore each day and pay royalties to the government for the ore they ship. None of these protocols were followed properly. The mining companies brazenly mined outside the designated zone, dumped mining refuse on the surrounding forest areas, did not install any green cover and paid the government very low royalties, costing the government an estimated 16000 Cr. loss.

- The excess revenues were stored in off-shore accounts in Singapore to hide it from the Reserve Bank of India and other banks. Furthermore, existing mines were given extension leases and defunct mines were reopened without any check on their wanton environmental destruction.
- This was done through a comprehensive network formed by corrupt officials and private companies at every stage of the process. The table in the slide shows the estimated amount of bribe received by some of the officials in the government. In the Lokayukta report which revealed the extent of this scam, it was noted that Ballari is like a republic unto itself with no regard to national law and policies.

The Environmental Destruction



Where are the forests?
Mining barons have taken them all



Consequences

- The real tragedy of the Ballari wanton mining is the extent of damage to the people and environment of Ballari. The unsuppressed red dust released from mines are now the major source of respiratory illness in the region, especially for the children who were illegally employed in the mines and the women.
- When it rains in the region, the water collect the mud from the mines and deposit it in the Tungabhadra river and clog the Tungabhadra reservoir. As a result, the total capacity of the reservoir has fallen from about 133 thousand million cubic meters (TMC) to 99 TMC in recent years.
- Furthermore, because the refuse from the mines were not stored properly, they also enter the forest regions during the monsoons and destroy them causing many species like the Egyptian Vulture and Four-horned antelopes population to completely vanish.



Egyptian vulture

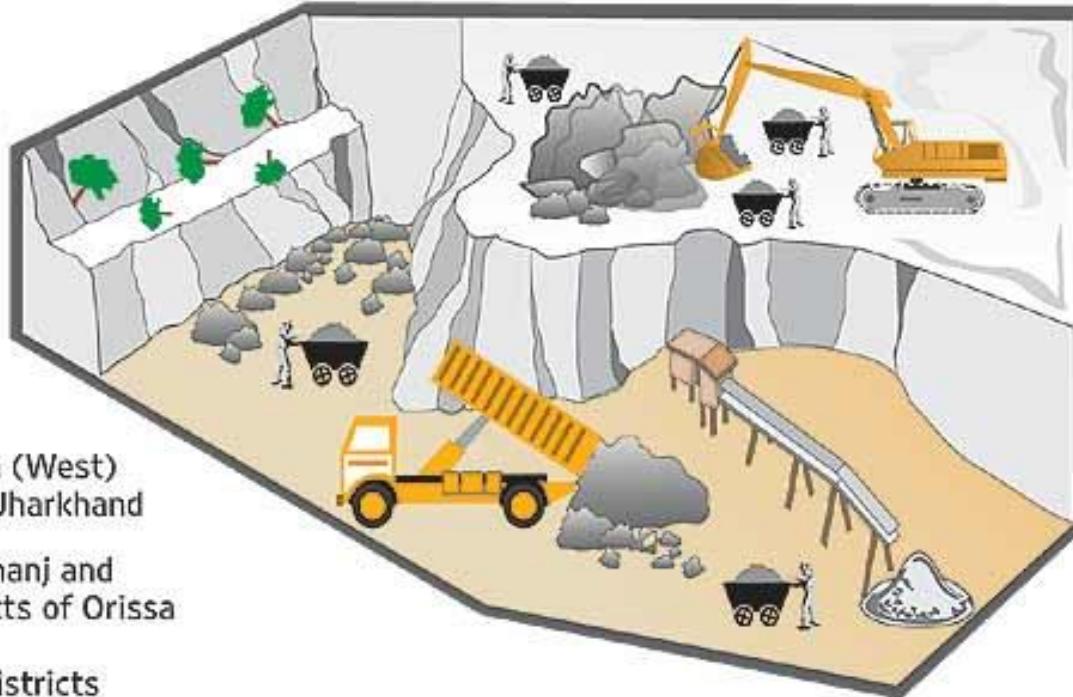
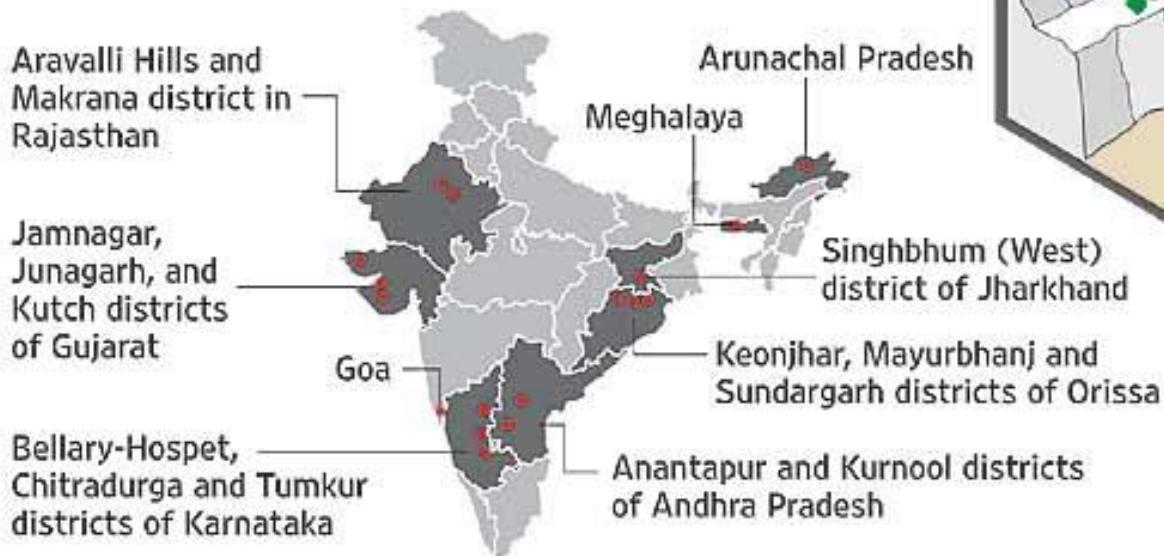


Four horned antelope

- Besides this, the mining has also impacted the earlier main source of employment in the region, **Agriculture**.
- The top soil in most farms are now covered with iron rich soil making it nearly impossible to farm on them. This has made people very dependent on the mines for their employment.
- Now that the mines are closed, the total economy and, as a result, the resiliency of the locals has been destroyed and has led to extreme poverty in the region.

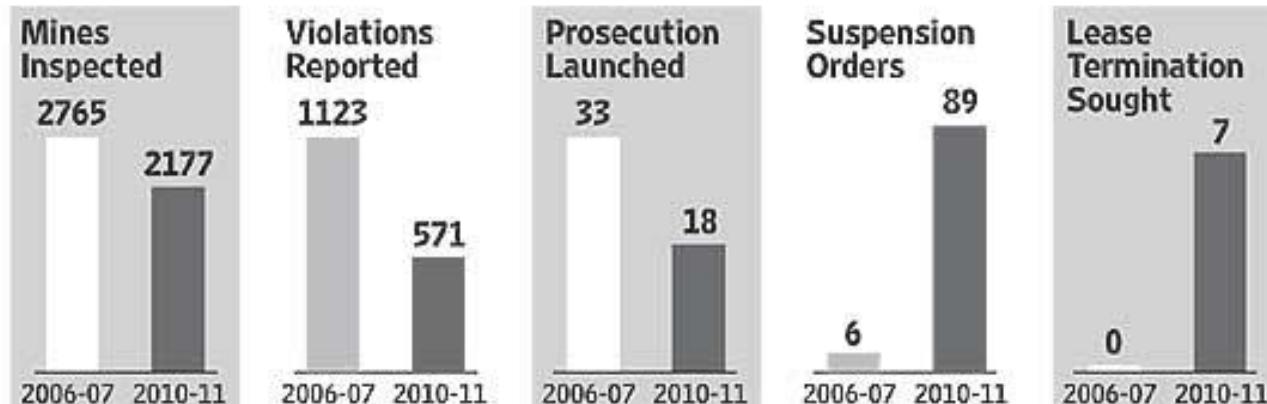
THE GREAT MINING MESS

HOT SPOTS OF ILLEGAL MINING



PAUCITY OF STAFF, DIMINISHING VIGILANCE

Indian Bureau of Mines data on inspections and violations of Mineral Conservation and Dev. Rules



WHAT THE MINING BILL HOPES TO DO

Present Reality

Rampant increase in illegal mining operations and exports

Adverse social and environment impact from mining

Exports of raw minerals not bringing revenue, jobs to mining areas

Opacity in allocation of mining lease, leading to corruption

Future Solution

Independent regulator, mining tribunals to play policing role

States to invest 26% of royalty in development of mining areas

Focus on value addition and employment generation within the state

Auction; Large Area Prospecting Licence rules to be framed

After the revelations of Ballari, many other such instances have come into the limelight around the country. The way the country deals with the Ballari scam with a new mining bill will set the precedent for the resolution of other illegal mining cases in India.

References :

Page 92 of the environmental reader textbook

<https://www.downtoearth.org.in/coverage/how-bellary-was-laid-waste-33862>

<https://www.downtoearth.org.in/coverage/what-bleeds-bellary-1739>

<https://www.outlookindia.com/magazine/story/the-wanton-sins-of-the-soil/277937>

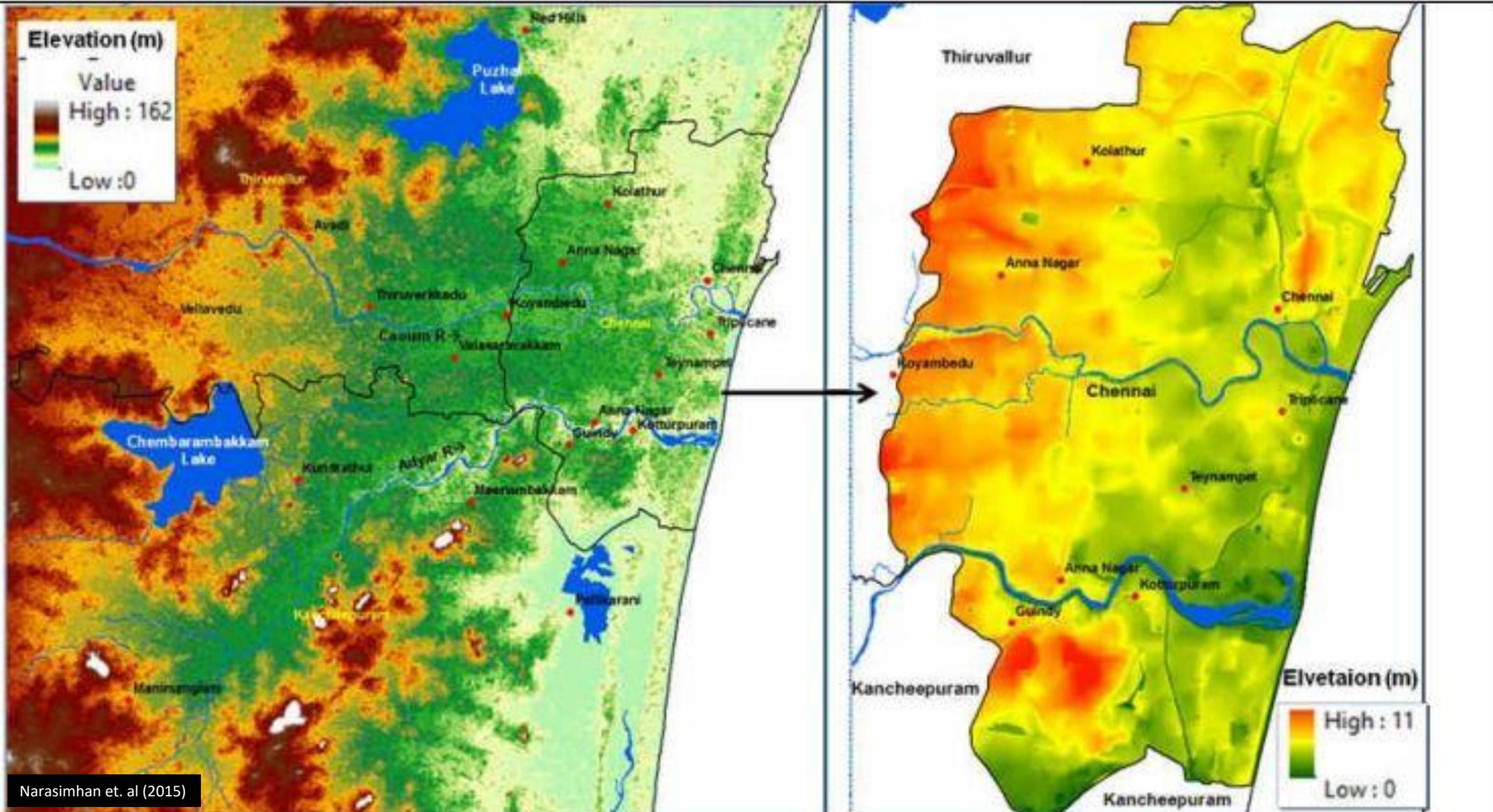
<https://economictimes.indiatimes.com/news/politics-and-nation/anatomy-of-bellary-mining-loot-efficient-system-of-corruption-to-mine-store-and-transport-iron-ore/articleshow/9424299.cms>

Chennai Floods

Case Study-3

A Man-made Natural Disaster

Elevation within suburbs of Chennai and within the Chennai District



Chennai, based on its geography and geology, has historically been characterized as a flood plain where a set of interconnected wetlands and natural water channels store and drain the surcharge during its two monsoonal seasons (the south-west monsoons and the north-east monsoons) from what is essentially a flat land (as you can see from the elevation in the above provided maps. For reference, Manipal is 73m over mean sea level (MSL)). It is also dependent on many of these wetlands for protection against cyclones, to which the entire Indian Eastern coastline is particularly vulnerable to. These complex network of wetlands are therefore extremely important for the city's resiliency and it is crucial that any urban planning of the city is sensitive to them.

Water body and Built up area
Chennai – 1980

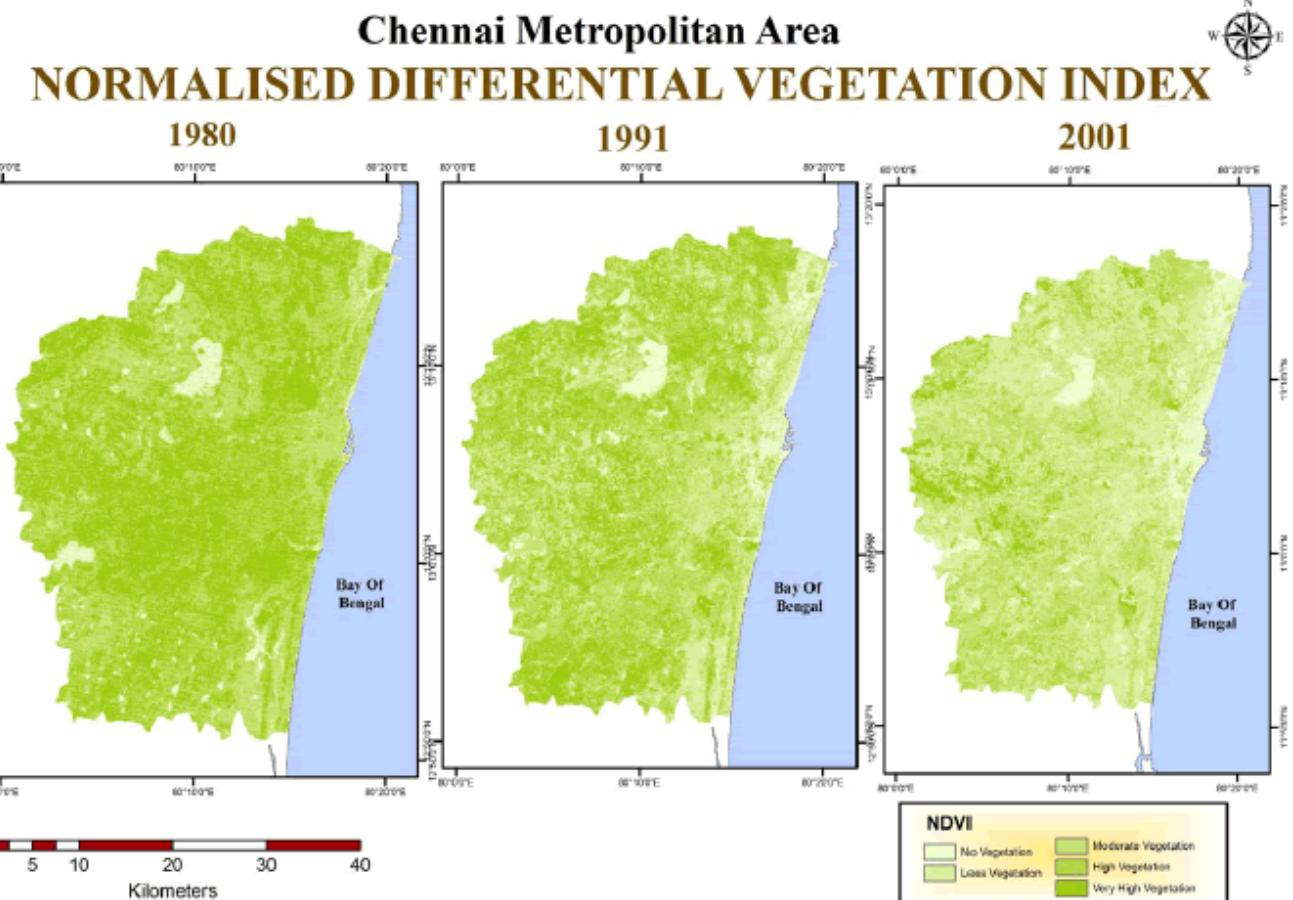
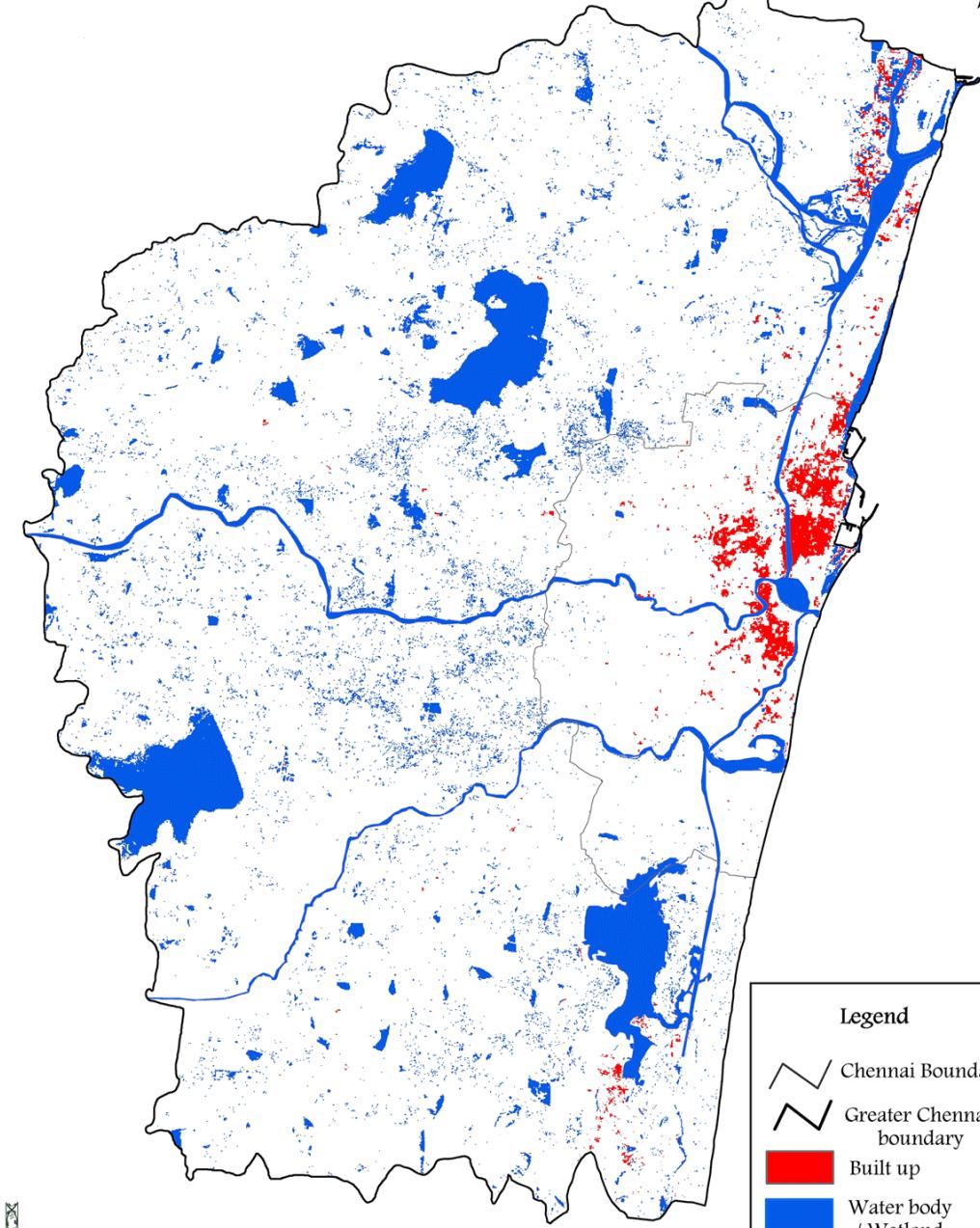


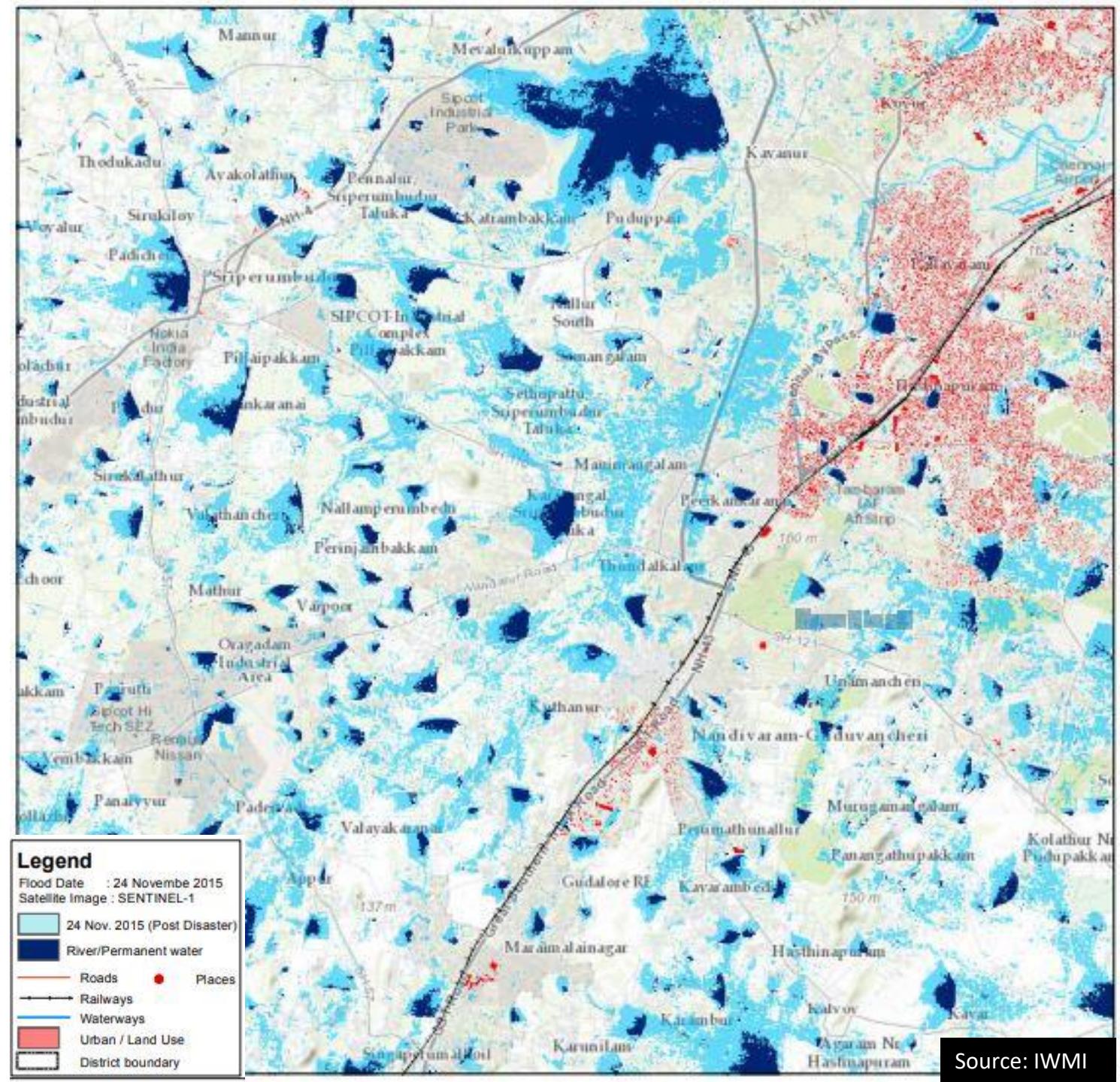
Figure 2: Normalized differential vegetation index – 1980, 1991 & 2001.

Narmada K, Bhaskaran G (2017)



Unfortunately, since independence and more recently in 2000s, due to the IT boom, the city has seen an unsustainable and unscientific urbanization which in numerous cases has led to loss of green cover and encroachment of waterbodies. The entire urban plan of the fast expanding city was disconnected from the hydrology of the area and this led to a sharp decrease in the effectiveness of Chennai's wetlands to perform their water regulatory functions.

2015 CHENNAI FLOODING



Source: IWMI

As a result, during the months of November-December in 2015 Chennai received record setting rainfall (highest recorded) due to an exceptional warming of the eastern equatorial pacific ocean. Since, the lakes which would have otherwise help absorb the excess flow and their network was encroached on, and the urbanization stopped the flow of water where it should not have stopped, the effect of the heavy rains was amplified; multiplying the scale of the disaster. The above maps show the scale of the flooding. The dark blue zones are natural water bodies, light blue zones are the flooded areas and the red areas are urban areas.

June 15, 2018



April 6, 2019



CHENNAI WATER SHORTAGE: PUZHAL RESERVOIR

June 15, 2019



Source: Indian Express

This encroachment has caused another serious issue. Water shortages. Since the wetlands are not connected or are encroached on, they don't receive sufficient water to ensure that they have water during the summer months. As a consequence, the city has had to rely on ground water in the summer for its supply which has also started to dry (again, due to poor surface water circulation and storage). Furthermore, since Chennai is on the coast, the drained aquifers are intruded by sea water, increasing the salinity of the land above them (and of the aquifers themselves, of course), destroying the agriculture of the region. This has led to increased burden on the already in-debt farmers leading to a sharp rise in farmer suicides. In the above images, you can see the sharp decreased in the water level in the Puzhal Reservoir, the largest reservoir in Chennai over the summer months between 2018-2019 as a consequence of the bad urban planning, over extraction of ground water and a drought.

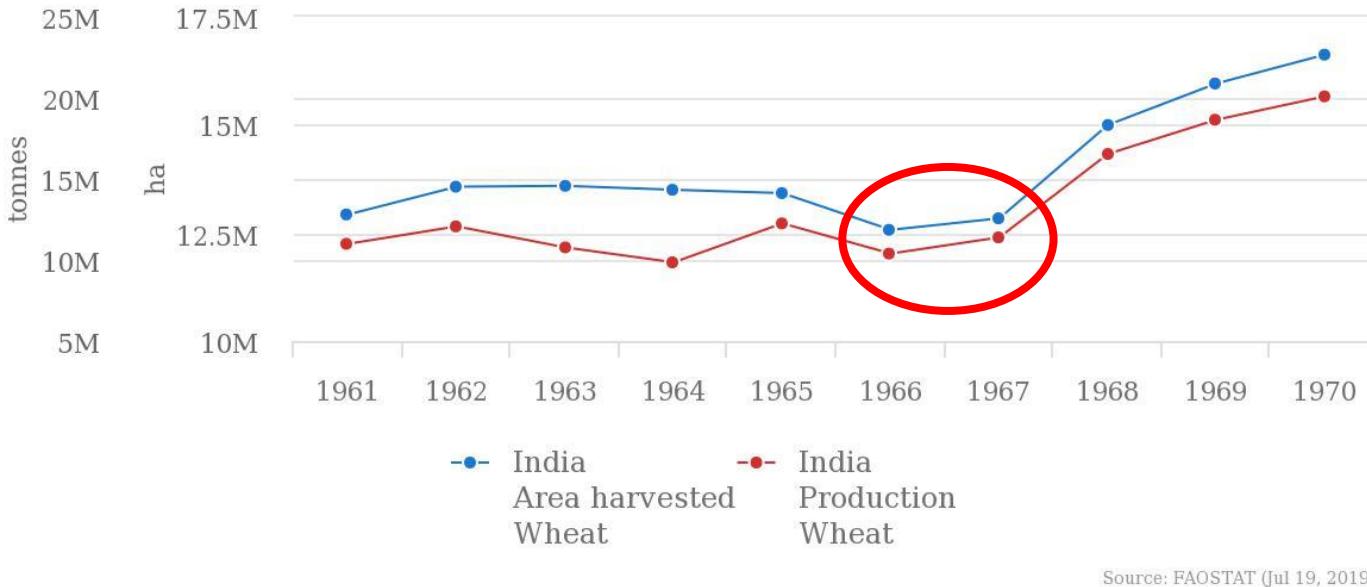


The Cost of Green Revolution

Case Study - 4

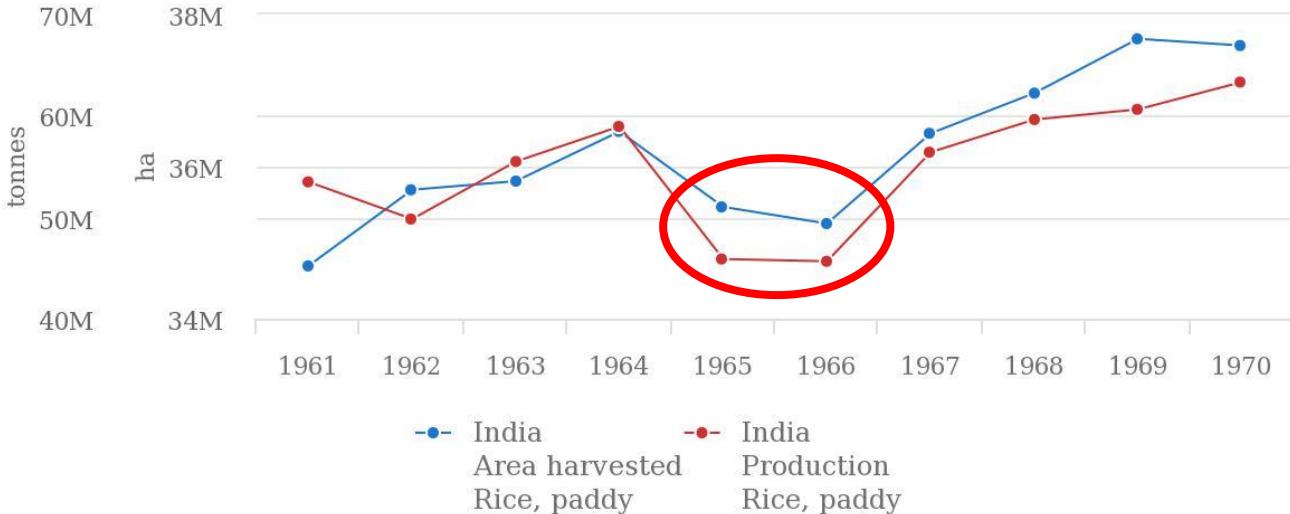
Production/Yield quantities of Wheat in India

1961 - 1970



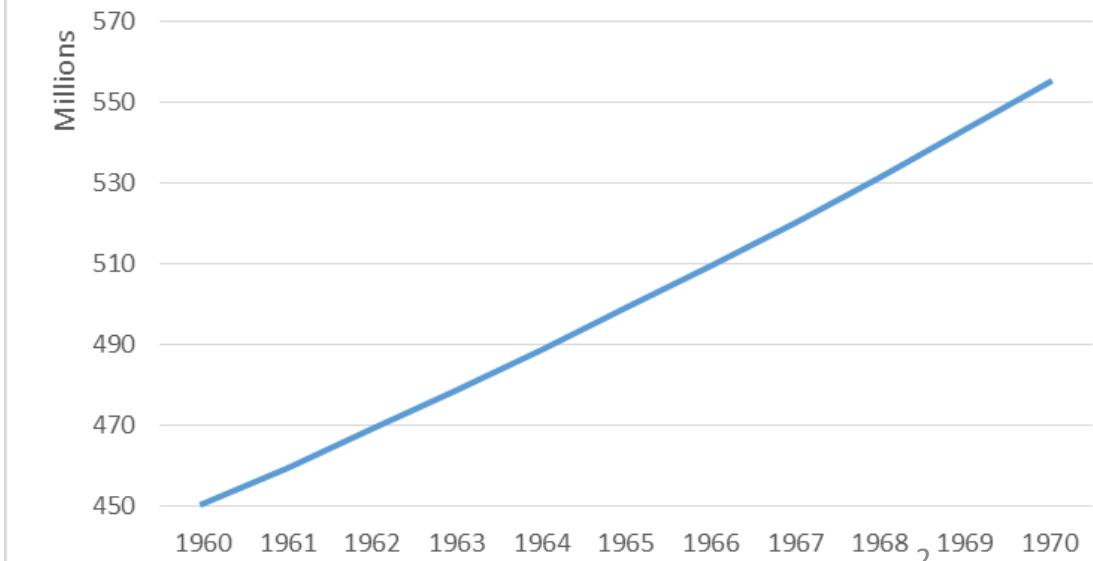
Production/Yield quantities of Rice, paddy in India

1961 - 1970



India's Food Security Scenario 1960-1970

Indian Population 1960-1970



- India, historically, has always been known to be a country of famines. Towards the end of the colonial rule in the country, agriculture had seen stagnant or negative growth rates which partly contributed to The Bengal Famine of 1943, leaving parts of the country devastated.
- Post independence, India did try to boost agricultural productivity but it frequently fell below the requirements of the steadily growing nation (Refer to graph on the right) which forced it to import grains. This was a huge burden on the coffers of an already impoverished country. Furthermore, successive droughts such as those in the years 1966-67 (highlighted in the graphs on the left) severely compromised the country's food security causing a famine in some areas, whose effects were only reduced due to international intervention.

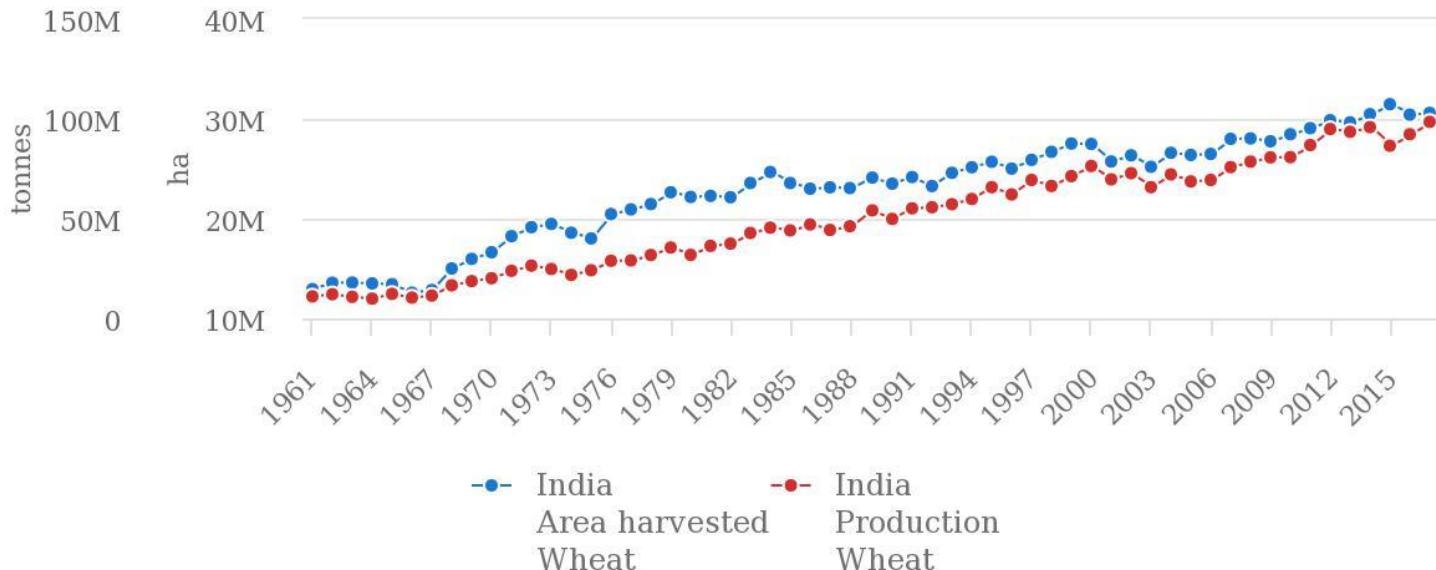
Note : 1 hectare = 2.471 acre

- As a result, it was quickly becoming imperative for India to strengthen its agriculture to improve its self-sufficiency/sovereignty, economy, food security and the general well-being of its citizens. That is why in the 1960s and 1970s, Government of India introduced a string of policies which included introduction of high-yield variety (HYV) seeds, irrigation facilities, pesticides, fertilizers and land consolidation for agriculture.
- Together, these policies culminated as what we now call as the “green revolution” in India. Punjab was the first state to be subjected to these policies by receiving HYV dwarf wheat seeds imported from Mexico because it was more water secure than the rest of the country and had a successful agricultural history.

The Indian Green Revolution

Production/Yield quantities of Wheat in India

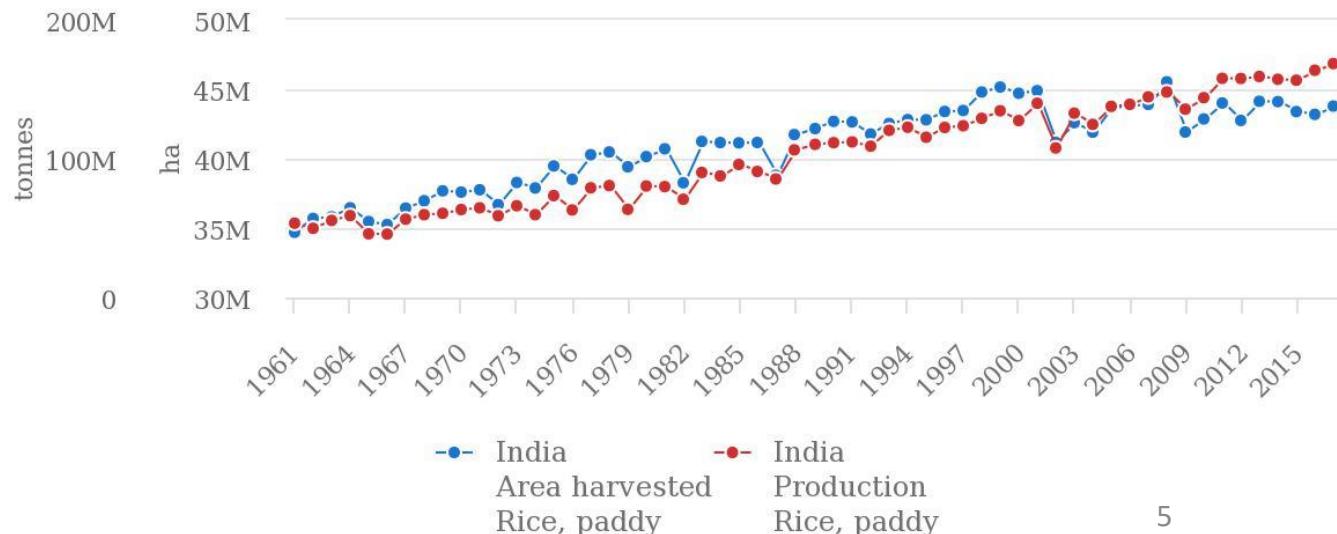
1961 - 2017



Source: FAOSTAT (Jul 20, 2019)

Production/Yield quantities of Rice, paddy in India

1961 - 2017



5

Source: FAOSTAT (Jul 20, 2019)

- As a result of those policies, India's agricultural production shot up to the point that it became food self-sufficient and was even able to start exporting its agricultural produce. The graphs in the slide show the scale of boost. Rice production rose almost 3 times and Wheat production rose almost 10 times in the period 1960-2015.

The Flipside

Opinion

Source: Hindu Businessline

npr  DONATE

≡

INDIA IN TRANSITION

The paradox of India's Green Revolution

Marshall M Bouton | Updated on June 04, 2019 | Published on June 04, 2019



Despite the rapid strides made in foodgrain output, malnutrition remains stubbornly high

Current Issue Download Print Archives

DownToEarth

SIGN IN

SUBSCRIBE

News In-depth Blogs Videos Book Store Africa Climate Agriculture बूदों की संरक्षिति

ਡਾਊਨਟੋਅਰਥ



Green Revolution's hidden toll

Diabetes, obesity, malaria, Japanese Encephalitis and more



By Biplab Das
Last Updated: Saturday 04 July 2015



NEXT NEWS >

WORLD

India's Farming 'Revolution' Heading For Collapse

April 13, 2009 · 4:01 PM ET
Heard on All Things Considered

DANIEL ZWERDLING

The first of a two-part series



Farmers in the village of Chotia Khurd in northern India don't realize it, but they symbolize a growing problem that could become a global crisis.

They gathered on a recent morning in a stone-paved courtyard — a circle of Sikhs with brightly colored turbans and big, bushy beards — to explain why the famed "bread basket" of India is heading toward collapse.

[Photo Gallery »](#)



Revisiting India's 'Green Revolution'

Crosscurrents

A pattern of farmer suicides in Punjab: Unearthing the Green Revolution

By KANWALROOP KAUR SINGH • DEC 4, 2018

Share Tweet Email



Source: kalw.org

- Though the green revolution yielded great short term benefits for India, it is now posing some serious long term consequences. Heavy pesticide and fertilizer use coupled with resource intense crops have deteriorated the micronutrient content of soil in Punjab.
- Heavy dependence on irrigation from borewells coupled with weak monsoons has severely depleted the underground aquifers, forcing the farmers to dig deeper borewells than ever before. Unfortunately, deeper borewell waters are also more saline and cause damage to crop roots and the soil, further decreasing their productivity.
- Beyond this, the heavy pesticide and fertilizer use have had some serious health consequences for the farmers and intensification of irrigation and machine farming has increased their debt causing a sharp rise in drug use and their suicide rates.

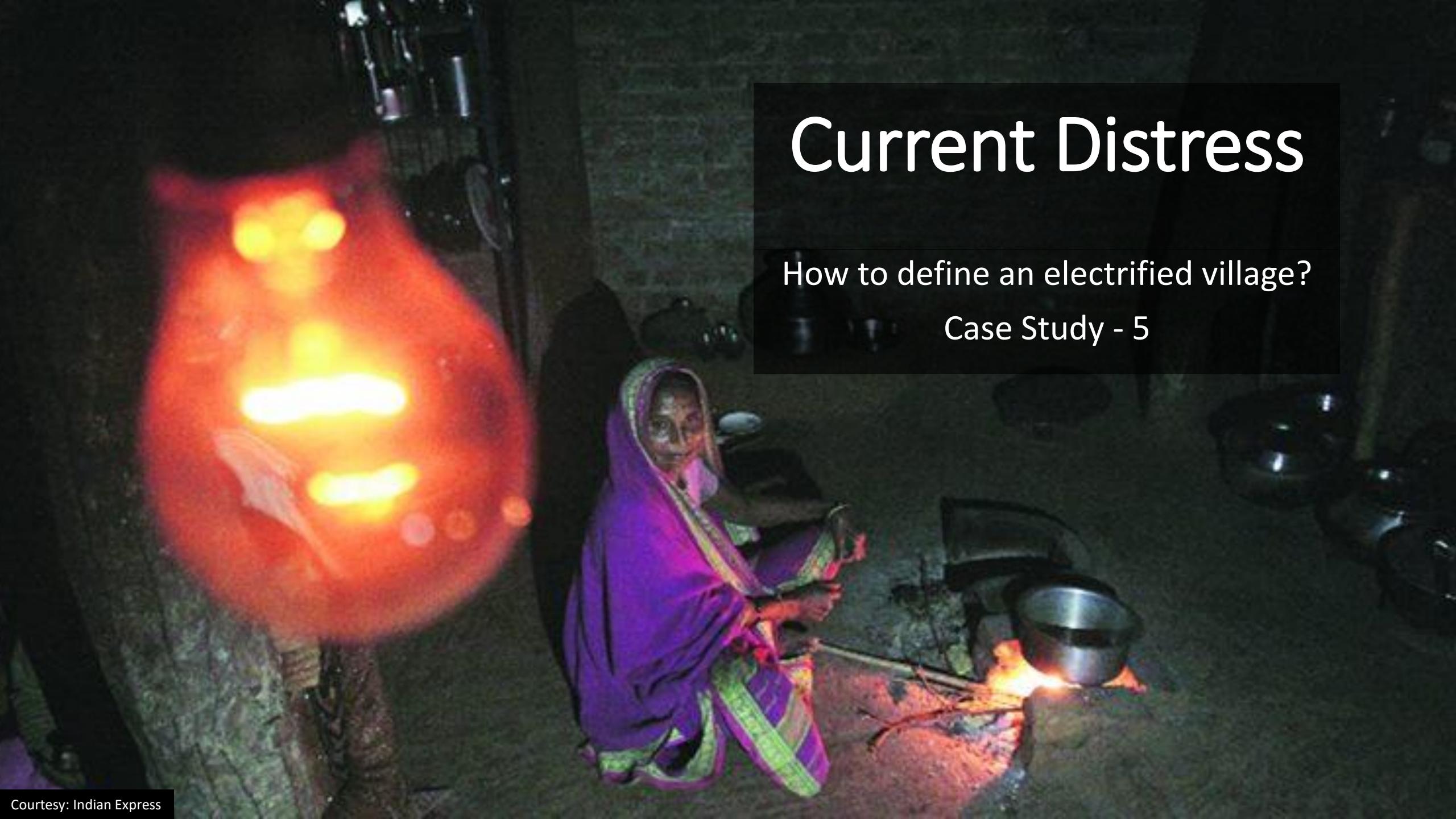
Solutions?

- Refocus on ecologically sensitive agriculture
- Reintroduction of native seeds to maintain genetic diversity of seeds
- Shifting from mono-cropping to multi-cropping system to better regulate the nutritional content of soil
- More effective water management programs to ensure better water and moisture conservation
- Introduction of crop insurance schemes to better protect the farmers

Current Distress

How to define an electrified village?

Case Study - 5



State of Rural Electrification in India



Narendra Modi

@narendramodi

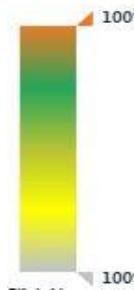


28th April 2018 will be remembered as a historic day in the development journey of India. Yesterday, we fulfilled a commitment due to which the lives of several Indians will be transformed forever! I am delighted that every single village of India now has access to electricity.

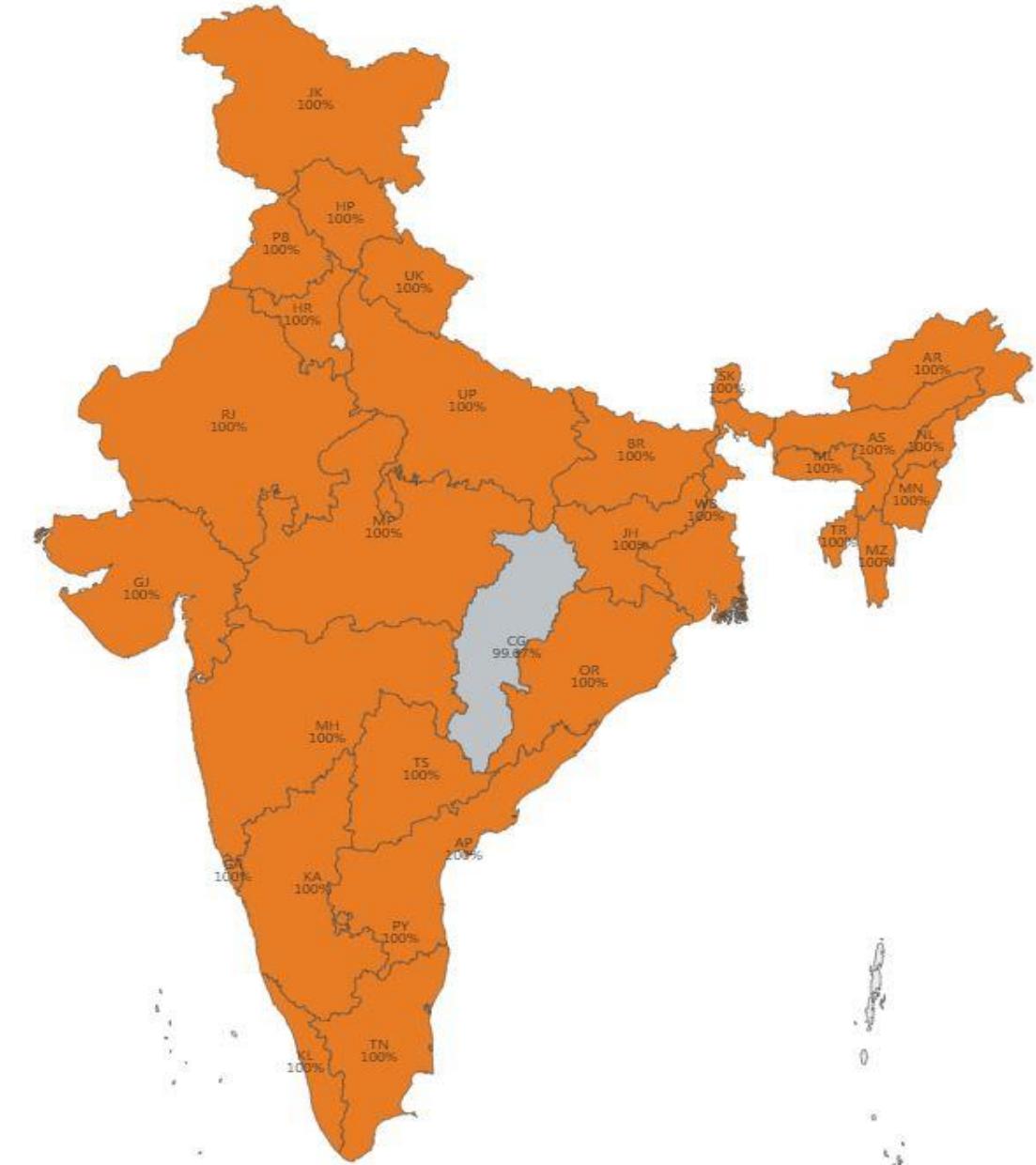
46.6K 10:28 AM - Apr 29, 2018



18K people are talking about this



Electrification Status (%)



Source: saubhagya.gov.in

On 29th April, 2018, the prime minister of India declared that on the 28th, “every single village of India now has access to electricity.” The map in the presentation is from the Ministry of Power’s “saubhagya” website and shows that all states have indeed achieved 100% electrification with the exception of Chhattisgarh whose electrification rate is above 99.67% (hence the grey color) and Delhi, which according to the website, has no households which require electrification.



State of Rural

Electrification in India



Villages With Availability Of Electricity For Domestic Use

Show 10 rows

COPY

CSV

Excel

Print

Search:

State Name	Total Number Of Villages	1-4 Hrs	%	5-8 hrs	%	9-12 hrs	%	>12 hrs	%	No Electricity	%
All India	577528	27453	4.75	63872	11.06	188091	32.57	273072	47.28	25040	4.34
JAMMU AND KASHMIR (1)	7541	1035	13.72	1906	25.28	2682	35.57	1768	23.45	150	1.99
HIMACHAL PRADESH (2)	18591	414	2.23	210	1.13	1351	7.27	15742	84.68	874	4.7
PUNJAB (3)	14065	116	0.82	211	1.5	3819	27.15	9727	69.16	192	1.37
CHANDIGARH (4)	12	0	0	0	0	0	0	12	100	0	0
UTTARAKHAND (5)	15148	172	1.14	425	2.81	3470	22.91	10670	70.44	411	2.71
HARYANA (6)	6722	120	1.79	406	6.04	3256	48.44	2887	42.95	53	0.79
RAJASTHAN (8)	45061	1372	3.04	7503	16.65	16648	36.95	18229	40.45	1309	2.9
UTTAR PRADESH (9)	98117	6132	6.25	10318	10.52	51487	52.48	26595	27.11	3585	3.65

- But, this number is widely disputed even from within the government. For example, according to a 2018 survey conducted by the Union Rural Development Ministry (URDM), around 25000 villages around India still do not have any access to electricity.

Definition of an electrified village

The Electricity Act, 2003

MINISTRY OF LAW AND JUSTICE
(Legislative Department)

New Delhi, the 2nd June, 2003.Jyaistha 12, 1925 (Saka)

The following Act of Parliament received the assent of the President on the 26th May, 2003, and is hereby published for general information:

THE ELECTRICITY ACT, 2003
[No.36 of 2003]

[26th May, 2003]

An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.

Be it enacted by Parliament in the Fifty-fourth Year of the Republic of India as follows:-

The Gazette of India

**EXTRAORDINARY
PART-I - Section-1
PUBLISHED BY AUTHORITY
Ministry of Power**

New Delhi,
Dated the 23rd August, 2006

RESOLUTION

No.44/26/05-RE (Vol-II)

Rural Electrification Policy

In compliance with Sections 4 & 5 of the Electricity Act, 2003, the Central Government hereby notifies the Rural Electrification Policy.

5. Definition of Electrified Village

5.1 The definition of an Electrified Village was specified under the Ministry of Power's O.M. No.42/1/2001-D(RE) dated 5th February 2004 as given below.

A village would be classified as electrified based on a Certificate issued by the Gram Panchayat, certifying that –

- a) Basic infrastructure such as Distribution Transformer and Distribution Lines are provided in the inhabited locality as well as a minimum of one Dalit Basti / hamlet where it exists; and
- b) Electricity is provided to public places like Schools, Panchayat Office, Health Centers, Dispensaries, Community Centers etc.; and
- c) The number of households electrified are at least 10% of the total number of households in the village.

- To get to the definition, one has to look the rural electrification policy which was drafted to address the requirements of sections 4 and 5 of the Electricity Act of 2003 (In the act, section 4 is about national policy on stand alone systems for rural areas and non-conventional energy systems and section 5 is about the national policy on electrification and local distribution in rural areas), which defines an electrified village as, among other things, a village whose at least 10% of households have an electric connection.
- This hypothetically means that 90% of village households in India are still possibly un-electrified. Furthermore, as is evident from URDM's data, around 50% of the villages in the country get less than 12 hours of electricity a day even when they have an electric connection.

- Therefore, the issue of rural electrification in India is two pronged.
- The first is actually providing the rural population of the country access to electricity. This is still a daunting task as many of the remaining villages are remote, and the upfront cost of installing an electric connection is out of the scope of many villagers. Adequate subsidies need to be provided to make the connection viable for such households.
- Second, is to provide a **good quality** electric connection. This means having an almost round-the-clock electric connection with enough voltage to power basic equipment like fans, lights etc. in a household.

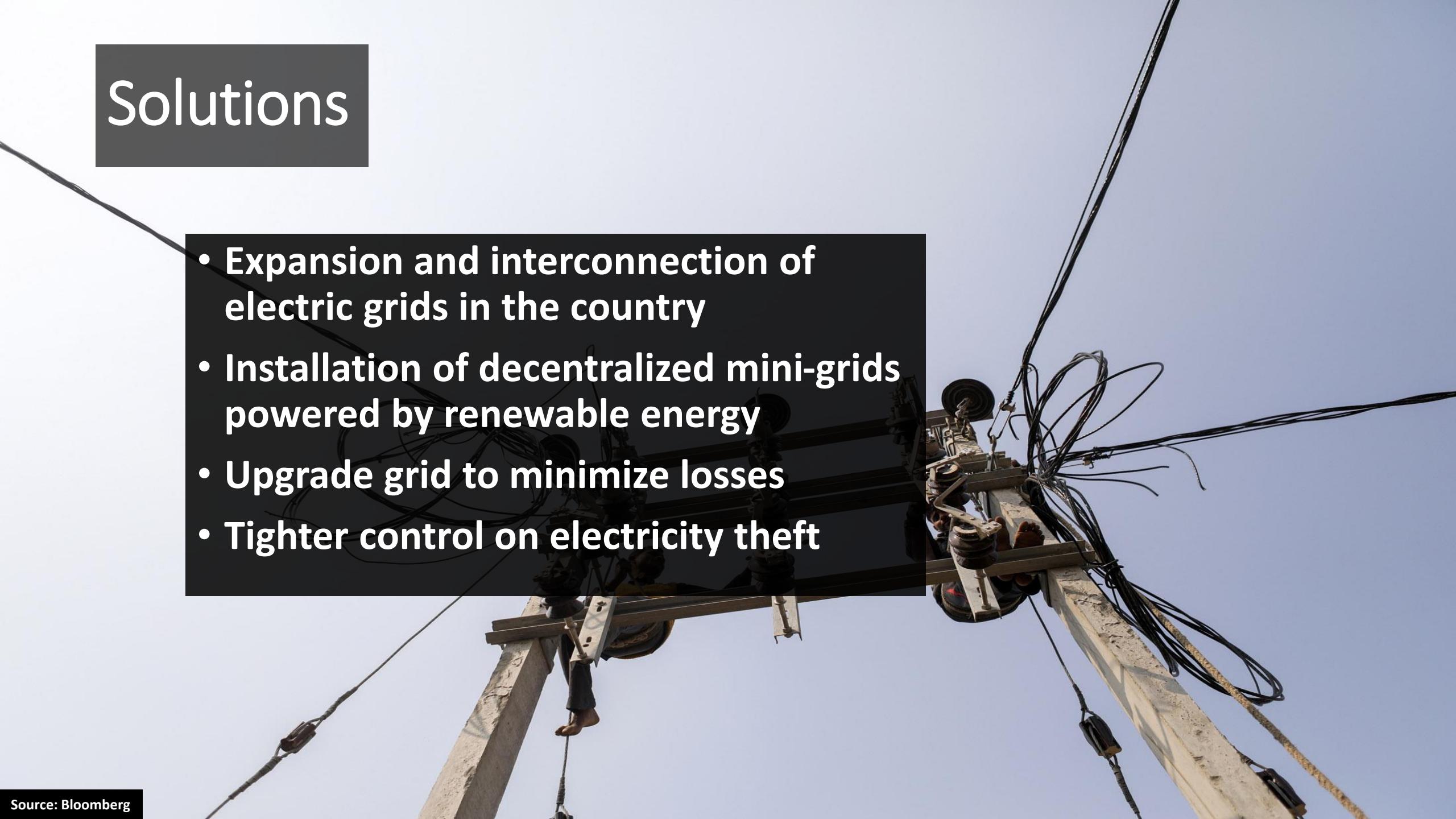
Implications

Kerosene and biomass usage

- Poor indoor air quality
- Fire related accidents and deaths
- Increase in overall health burden especially for women and children
- Poor overall productivity

Solutions

- Expansion and interconnection of electric grids in the country
- Installation of decentralized mini-grids powered by renewable energy
- Upgrade grid to minimize losses
- Tighter control on electricity theft



Citizen Conservation

Limitations of traditional
conservation measures and the role
of technology in mitigating them



Laterite Narrow-mouthed Frog

Source: Ramit Singal

- The Laterite Narrow-mouthed frog was discovered at End Point in 2016 as a result of a citizen's observations.

- Which are the animals that require conservation ???

Popular Subjects of Conservation Measures



Source: National Geographic Channel



Source: Earth.org

- When asked about what animals require conservation, the answer is usually a tiger or a panda or other such popular animals. But these animals are usually not the ones who are in most need of conservation.
- Furthermore, these animals are somewhat easier to conserve because they are easily marketable due to either their cultural importance and/or innate aesthetic appeal.
- This makes it easier to get funding and/or influence policy that enables their successful conservation.



INDIA India's Tiger Population Has Increased By 1300% Since It Was Declared National Animal 44 Years Ago



BOBINS ABRAHAM | NOVEMBER 18, 2017

10.6K SHARES

 [FACEBOOK](#) [TWITTER](#) [REDDIT](#) [SAVE](#)

It has been 44 years since India got its national animal, the bengal tiger. It was a part of 'Project Tiger' an initiative launched by the then minister Karan Singh on April 1st that year to check the dwindling population of tigers in India.



WWF Global



WWF

WHAT WE DO

OUR EARTH

YOU CAN HELP

NEWS & STORIES

IMAGES

GIFTS

DONATE

HOME EN ESPAÑOL

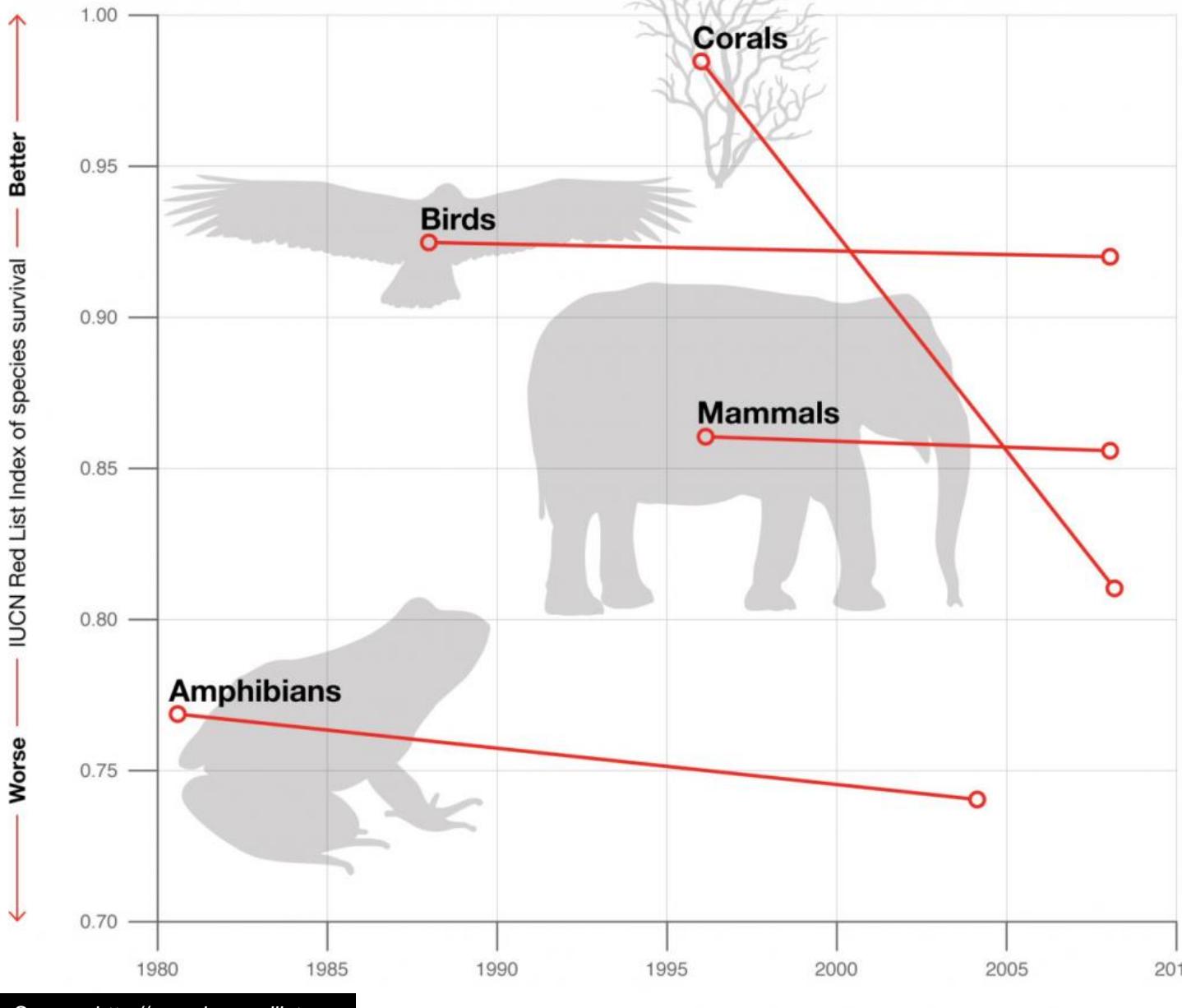


Step away from extinction

Great news! Giant pandas are no longer classified as 'endangered'. They've been downgraded to 'vulnerable' on the global list of species at risk of extinction after their population increased by 17% in a decade. It shows that conservation efforts are working and provides hope for the world's other threatened wildlife.

- The success of their conservation is evident in their numbers. Tiger populations have risen 1300% since it was declared as the national animal 44 years ago and Panda populations have risen 17% in a decade and is no longer listed as endangered.

Extinction risk of various animals



One in four species are at risk of extinction

Species assessed by the IUCN Red List



Amphibians
40%



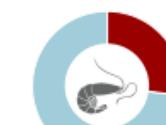
Conifers
34%



Reef corals
33%



Sharks and rays
31%



Selected crustaceans*
27%



Mammals
25%



Birds
14%

*Assessed species include lobsters, freshwater crabs, freshwater crayfishes and freshwater shrimps

Source: IUCN Red List of Threatened Species

BBC

- Instead, there are other animals like amphibians which are in much higher need of conservation, as can be seen from the graph.
- But there in lies the problem.
- Animals like amphibians don't receive adequate funding for conservation usually because of their weak cultural influence and lack of aesthetic appeal. This is a huge problem because their conservation requires specialist training and separate efforts for monitoring which requires considerable financial backing. It is also harder to influence policy for their conservation for the same aforementioned reasons.

Citizen Science Initiatives

India Biodiversity Portal

Search Groups Login

BIODIVERSITY INDIA India Biodiversity Portal

Species Observations Maps Documents Contribute Discussions Datasets Pages More

National Moth Week 2019 is on between 20 and 28th July. Participate by uploading moth observations.

Welcome to India Biodiversity Portal

A unique repository of information on India's biodiversity. The Portal aims to provide open and free access to biodiversity information. The portal enables widespread participation by all citizens in contributing to and accessing information on Indian biodiversity. We believe such open access benefits science and society, and contributes to sustainable future. Your participation is vital. We welcome your participation and feedback. [More ...](#)

Species	Observation	Maps	Documents	Groups	Discussions
31236	1373956	206	2588	60	181

Latest Observations

Show all >

Partners

eBird Submit Explore My eBird Science About News Help

Discover a new world of birding...

▶ Learn more Get started



Bare-throated Tiger-Heron *Tigrisoma mexicanum* © Daniel Irons
Macaulay Library | eBird

FEATURES

iNaturalist Explore Community More Log In or Sign Up



23,698,494 Observations to Date

SIGN UP EXPLORE

BJ Stacey - Shark Eye Snail from Essex County, Massachusetts, USA

CALIFORNIA ACADEMY OF SCIENCES NATIONAL GEOGRAPHIC

iNaturalist.org is a joint initiative of the California Academy of Sciences and the National Geographic Society.

How It Works

- This is where the role of technology and citizen science comes in. Citizen science initiatives are those where people even without advanced scientific training can contribute to the progress of the scientific field of their interest.
- It encourages people to submit their observations on various online platforms which are reviewed by experts and confirmed. This is an advantage for the hobbyists as they get their observations confirmed by an expert and also get an online database of their observations.
- It is also an advantage for the experts as it saves them the trouble of making these observations and get a rich dataset for next to no cost.
- For wildlife, ebird, inaturalist and india biodiversity portal are few of the famous ones being used in India.

The Case of Amur Falcons



January



- Amur Falcon is a small pigeon-sized raptor. It has one of the longest migration routes in the world, covering almost 22000km in a single year. Their biggest congregation according to some estimates happens in the Wokha district of the north-eastern state of Nagaland. This entire data in this map was generated by people contributing their observations to ebird, an online citizen science portal for submitting observations of birds.



UPDATES

WILD SEVE CELEBRATES 10,000 CASES

JULY 9, 2018



- In India, technology does not only aid in helping wildlife, but also humans. Wild seve is a mobile technology-based platform where a farmer can call a toll-free number to report a wildlife-conflict related incident. Trained personnel then physically come to help the farmer in filing compensation claims and other due processes to get fair compensation for their damage from the government. This helps the farmers be more tolerant of wildlife around them and ensure protection of the wildlife as well.