General Knowledge Today

EIA and Current Issues in Environment

Target 2016: Integrated IAS General Studies

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Environment Impact Assessment

Environment Impact Assessment (EIA) is a formal process used to predict the environmental consequences of any development project. Environment Impact Assessment in India is statutory backed by the Environment Protection Act in 1986, which contains various provisions on EIA methodology and process.

Rationale behind EIA

EIA looks into various problems, conflicts and natural resource constraints which may not only affect the viability of a project but also predict if a project might harm to the people, their land, livelihoods and environment. Once these potential harmful impacts are predicted, the EIA process identifies the measures to minimize those impacts. Thus, the objective of the EIA is to:

- Identify the environmental, social and economic impacts of a project prior to taking a decision on its implementation.
- Mitigation of harmful impacts and maximizes the beneficial effects.

Once the assessment is complete, the EIA findings are communicated to all stakeholders viz. developers, investors, regulators, planners, politicians, affected communities etc. On the basis of the conclusion of EIA process, the government can decide if a project should be given environment clearance or not. The developers and investors can also shape the project in such a way that its harms can be mitigated and benefits can be maximized.

Historical Facts

The EIA process finds its origin from United States where due to huge public pressure; the government enacted National Environmental Policy Act (NEPA) in 1970s. The role of EIA process was formally recognized at the Earth Summit in Rio Conference in 1992 in which the Rio declaration stated that EIA shall be taken as national instrument for proposed projects which might adversely impact the environment.

Till 1980s, almost all projects were implemented with little or no environment concerns in India. The Department of Environment came into existence in 1980s. Before that the matters related to environment and forests were within the purview of Department of Science and Technology and Agriculture respectively. The department of environment was upgraded to a full-fledged ministry in 1985. Gradually, the environment clearance to large projects became administrative requirement. In the early 1990s, the MoEF issued guidelines for River Valley Projects requiring EIA process that would study the impacts of submergence zones of such projects on forest, wildlife, water logging potential, impacts on upstream and downstream aquatic ecosystems, water related pathogens and diseases, climate changes and seismicity etc. However, it was 1994 when ministry released official "Environment Impact Assessment Notification 1994". Criteria were decided to take environment

clearance for projects from centre or state level. Around 30 projects were put under Central Government to provide environment Clarence. Such projects included Nuclear Power and related projects, River Valley Projects, Ports, Harbours, Airports, Petroleum refineries, Chemical fertilizers, Pesticides, Bulk drugs and Pharama, Oil Exploration, Synthetic rubber, Asbestos etc.

The EIA Process

In India, there is an elaborate EIA process involving many steps such as Screening, Preliminary Assessment, Scoping, Main EIA including public hearing, appraisal etc.

First of all, the developer has to prepare an EIA report with the help of an environment consultant. On the basis of such report, the EIA may be either **comprehensive EIA** or **Rapid EIA.**

- If the EIA report has to incorporate the data of *all four seasons of a year*, it is called *Comprehensive EIA*.
- If the EIA report has only one season data, then it's called *Rapid EIA*.

We note here that the comprehensive EIA was later on diluted by Environment Ministry and currently, only Rapid EIA is sufficient. Once this report is prepared, it is submitted to the regulatory agency. The agency may then decide if the project may go for formal EIA or not.

Screening

Screening is the first and simplest process in project evaluation. It decides if the project needs EIA or not. The government rules categorize projects into two categories, A and B based on the spatial extent of the impacts, effects on human health and the effects on the environment.

- **Category A** projects are looked into by the Central Government
- **Category B** Projects go to the State Government.
    - Category B projects are further sub divided into Category B1 and Category B2.
        - B1 *require a public hearing* for EIA
        - B2 don't require.

Screening basically screen outs the projects that don't require EIA process. But there are several issues with this. *Firstly,* the projects are excepted from EIA on the basis of value of investments they would be involving. The logic behind this is to keep out the small projects from tangles of the complex process. But, no one has proved that environment impacts are caused only by projects above certain value. There are many small scale industries that contribute to pollution to a great extent, and sometimes at par with large projects. *Secondly,* even if a project may be eligible for exception from EIA process, they might involve some technical processes which might be harmful to the environment.

Preliminary Assessment

The screening would thus clear a project or hold it for further stages. If it is held for next stage, the

developer will have to take Preliminary Assessment, which involves sufficient research, review of available data and expert advice in order to identify the key impacts on the project at local environment. This study will predict the extent of the impacts and would briefly evaluate the importance for decision makers.

After the preliminary assessment, the competent authority would review it and would decide if there is a need of comprehensive EIA or Rapid EIA. Then, the developer will have to prepare the EIA report. The competent authority would create an EIA team with independent coordinator and an expert study team. *However, it is often seen that members of such teams don't have experts from social science, anthropology etc.*

Scoping

Scoping is yet another stage before the main EIA process begins. The EIA study team which was organized after preliminary assessment would get engaged into discussions with developers, investors, regulatory agencies, scientific institutions, local people etc. It would study and address all issues of importance and the concerns raised by various groups. Then the team would select the primary impacts for main EIA to focus and determines detailed and comprehensive Terms of Reference (ToR) for the main Environment Impact Assessment (EIA).

The key issue with current scoping method in India is that it generally ignores some important issues which might appear later as conflict.

Main EIA

Once scoping is over, the main EIA begins. Basically, EIA would try to answer the following questions:

1. What are the potential results of the project?
2. What are the potential changes and extent of those changes? To what extent such changes matter?
3. What can be done about these changes? How the decision makers have to be informed of these changes?

Thus, the EIA becomes a cycle of asking questions, and further questions until workable solutions are reached. During this process, the key impacts on environment such as changes in air quality, noise levels, impacts on wild life, impact on biodiversity, impact on local communities, changes in settlement patterns, changes in employment stats, changes in water consumption and availability etc. are formally identified.

The answers of the questions make the so called "prediction" in the EIA process. The prediction scientifically characterises the impacts quantitatively as well as qualitatively. We note here that prediction techniques involve some degree of uncertainty.

Prediction is followed by evaluation. This part evaluates the predicted adverse impacts and

determines if they can be significantly mitigated. The next step is mitigation ion which the study team would analyze the wide range of measures for mitigation of adverse impacts. Such measure may include changing the project site, operating methods, raw materials, disposal methods and routes, engineering designs, waste treatment, phased implementation, landscaping, training, social service etc. The compensation for damaged resources, affected persons etc. are also offered here. Overall, the mitigation costs are identified and quantified. This part also involves the Cost benefit analysis of the project in terms of mitigation costs.

Once mitigation measures and costs are identified, the next part is documentation, which is called EIA report. This report has executive summary of the project, a description of the proposed development, major environment issues, impacts on environment, prediction, mitigation measures and options etc. along with gaps and uncertainties in the information; and a summary of the EIA process for general public.

The project developer would now submit 20 copies of the executive summary to SPCB (State Pollution Control Board). It is now responsibility of the SPCB to conduct a public hearing.

Public Hearing

The SPCB conducts a public hearing at the site or in its close proximity- district wise for ascertaining concerns of local affected persons. It includes obtaining responses in writing from other concerned persons by posting on website within 7 days of receiving application. in India, Public hearing is not required for the following projects:

- Small scale industrial undertakings located in
    - Notified or designed industrial areas/ industrial estates.
    - Areas marked for industries under the jurisdiction of industrial development authorities.
- Widening and strengthening of highways
- Mining projects (major minerals) with lease areas upto 25 hectares
- Units located in export processing zones and special economic zones and
- Modernization of existing irrigation projects. MoEF is the nodal agency for environmental clearance.

Once public hearing is over, the project developer will get a NOC from SPCB and submit application to the MoEF secretary to get environmental clearance. In MoEF, the application evaluated by an *Impact Assessment Agency (IAA). IAA* may consult the experts and again create a team to study the project. It has full right of entry and inspection of the sites or factory premises prior to, during or after the commencement of the project.

IAA team does a technical assessment and gives its recommendations within 90 days. On the basis of

this, the MOEF grants the environmental clearance which is valid for a period of five years for commencement of the construction or operation of the project.

Public Hearing Process

Public hearing has been recognized as an essential element in the Environment Impact Assessment procedure. In 1997, the EIA notification was amended to make public hearing for development projects *mandatory*.

Importance of Public Hearing in EIA Process

Involving public is one of the basic principles of a successful EIA process. Public hearing provides an opportunity to the directly affected people to express their concerns and brings transparency in the environmental clearance system.

We note here that public involvement is a part of almost all EIA processes around the world. Public involvement is via two ways. First is ***public consultation*** in which concerns of the local people regarding the adverse impacts of a project are defined and taken into account in the EIA study. Second is ***public participation***, which is more interactive and intensive kind of public involvement.

The *difference between public consultation and public participation* is that while former is a passive process of asking the public about their concerns in writing, later is more intensive and involved active participation of public. In other words, public consultation is generally done in "listening mode" while public participation goes a step ahead and takes into account the dialogue, scrutiny, consideration, response etc.

Process of Public Hearing

In our country, public involvement was introduced in 1997 in the form of public hearing. However, even today, the role of public is very limited in India.

The process begins when SPCB issues notice in at least two newspapers circulated in the region. One of these newspapers must be in local language. This notice mentioned the date, time and place of public hearing. The public can hand over the written suggestions, views, comments and objections to SPCB within 30 days of releasing such notice. The public is entitled to have access to the executive summary containing salient features of project both in local language and English. They also have access to the EIA report which can be obtained from office of district collector or zilla parishad or SPCB office or other departments dealing with the project.

The SPCB forms a public hearing panel that has representative from SPCB, district collector or his / her nominee, representatives of state government dealing with the project, maximum 3 representatives of the local Panchayat / municipality and maximum 3 senior citizens nominated by district collector.

Once public hearing is over, the project developer will get a NOC from SPCB and submit application

to the MoEF secretary to get environmental clearance.

Projects exempted from public hearing

- Small scale industrial undertakings located in
  - Notified or designed industrial areas/ industrial estates.
  - Areas marked for industries under the jurisdiction of industrial development authorities.
- Widening and strengthening of highways
- Mining projects (major minerals) with lease areas upto 25 hectares
- Units located in export processing zones and special economic zones and
- Modernization of existing irrigation projects. MoEF is the nodal agency for environmental clearance.

EIA: Issues and Analysis

Critical Assessment of EIA Process in India

There are several drawbacks with the EIA process in India from screening to environment clearance stages. During the initial stages such as screening, preliminary assessment or scoping, the major issues are ignored which later on appear as conflicts. During prediction phase, there is always lack of reliable primary and secondary data. The data collectors don't pay attention to the knowledge of the indigenous people. During other phases, there are problems of fraudulent EIA reports, staged public hearings and unscrupulous environmental clearances etc. In fact, today, the entire process of environment clearance has become highly polarized in the country diving all the stakeholders into two sides viz. Government and industry in one side while NGOs and local communities on the other. In recent times, the public opposition to certain projects have become increasingly intense leading to violence and police firing on demonstrators. This is mainly because the EIA process passed too quickly without proper public involvement. The key drawbacks of our EIA system can be summarized in the below points:

- Deliberate omission of vital information which may alter the fate of projects.
- False, unreliable and doubtful data; Inadequate single season data in Rapid EIA; Absence of centralized databank
- EIA is funded by agency whose primary business is to obtain clearance; it cannot be unbiased.
- No accreditation of EIA consultancy. Many a times, consultancies working on a project have no specialization on concerned subjects.
- The EIA documents are bulky and technical and make it really difficult to help in decision making.
- Plagiarism in EIA reports, wherein the same facts used for two different places.

- False assumption that once site clearance is granted, environment clearance will follow. The developers start construction work such as housing colonies, roads etc. However, in EIA notification, it is mentioned that such works should not be taken before environmental clearance.
- In some cases, environment clearance is granted despite of public objection. In other cases, staged public hearing is carried out without involving the really affected people.

Policy Options

Independent EIA authority

Earlier, there was a suggestion for creation of an **Independent EIA Authority** which is not attached to MoEF. This authority should have representatives from communities, civil society groups, sociologists and environmentalists on board. In 2014, the Supreme Court had also directed the government to create such watchdog. However, such watchdog would further add to the multiplicity of monitoring authorities and further complicate the regulatory maze, thereby helping only the unscrupulous elements in the industry and Government.

Sector wise EIA

This suggestion is based on premise that the EIA should be conducted policy-level and sector-wide EIAs in the form of strategic impact assessments (for various sectors including mining , power and so on).

Creation of IT bank

There is a lack of centralized databank and information dissemination. The MoEF can work towards creation of such a databank and information dissemination desk.

Inclusion of Environment Risk Assessment into EIA

The government should include Environmental Risk Assessment in the EIA process with bringing recognized Safety and Environmental Auditors on board. They should compulsorily meet local populations and submit a detailed report of potential risks due to the project.

Independent Environment Regulator

In January 2014, the Supreme Court had directed the union government to appoint a national regulator with offices in as many states as possible for granting and monitoring environmental clearance to projects. The objective was to deprive the centre /states of their arbitrary power to take decisions on projects and ensure that those found guilty of violations are awarded sizeable penalties under the "polluter pays" principle.

After this direction, the MoEF strongly objected because it would not be feasible for a single authority with limited number of experts to look into the diverse and inter-linked nature of issues involved in the grant of environment clearances to various categories of projects.

Rationale behind such directions

The rationale behind SC direction was clear. The current system of granting clearance by the

Ministry has often been politicized with some out-and-out environmentally damaging projects receiving approval only because of the political influence of their promoters. Court had opined that another reason for having a regulatory mechanism in place is to have authentic environment impact assessment (EIA). This is so because under the current mechanism, the EIA clearances rely predominantly on data provided by the project promoter and the absence of verified and reliable data and the lack of mechanisms to validate the data generally lead to subjectivity, inconsistency and inferior quality of EIA reports.

The government objected to this order contending that the new regulator would have *conflict of interest with the National Green Tribunal*. However, the court rejected this contention saying that the role of a tribunal is to resolve conflicts while a regulator is to be a proactive body in framing statutory rules and regulations.

Issues around GM Crops

Basics: Selective Breeding versus Genetic Engineering

It is thought that agriculture involving domestication of plants and animals was developed around 12,000 years ago. Human ventures of altering the communities of plants and animals are even older than that.

Over the centuries, man has carried out selective breeding between different but related plants. The best example of this selective plant breeding is origin of *Maize*. It has been estimated that around 7500 years ago, the farmers in Mexico had domesticated a wild plant called *Teosinte,* and kept doing selecting breeding improving the characteristics until their offsprings was turned into today's Maize. The two plants viz. Maize and Teosinte are so different that the scientists kept them in different genera, until they were finally found to be of same genus with varying species. Thus, selecting breeding in plants (and animals) is as old as our history.

The selective breeding remains fundamentally same even today. The breeders take two different varieties of a plant, each of which has individual traits that make it useful over others and then breed them. For example, one variety may be of high yield while another may be pest resistant. The two varieties are interbred and from among the offsprings, random plants that show both high yield and pest resistance are selected. The resulting plants are called Hybrids. A Hybrid represents combination of *two sets of genes*, one set originating from each parent.

Traditional selective breeding versus Genetic Engineering

There are two main drawbacks of the traditional selective breeding. *First,* it is a *slow process*. *Second,* selective breeding is a random process. In this random process, it is possible that the selected plants may have also acquired some undesirable traits, which were not observed in parent. For example, parent was not susceptible to a particular virus but offspring was found to be. Similarly, it is also

possible that what was observed as a desirable trait in parent, was not seen in offspring. Thus, to avoid the undesirable traits, and to recover the desired traits, the scientist / breeders need to do something which is called back-crossing to one of the parent lines. The back crossing is done for usually three generations to arrive at what is desired. All this makes the process too long and tardy. Further, this process is limited by natural barriers which *stop different species of organisms* from breeding with each other. This is where genetic engineering comes into play. Genetic engineering can *make things faster* and allow mixing of genes of distantly related or even unrelated plants / animals.

Basics of Genetic Engineering

Genes, as we know are unique set of instructions which decide how all the living things (including the non-living Virus) develop, grow and live. These instructions are found inside the cells on Chromosomes. Chromosome is divided into small stretches of deoxyribonucleic acids (DNA) and ribonucleic acids (RNA) that control different aspects of the organism's growth and traits. Thus, gene is the molecular unit of heredity of a living organism. The number of genes varies from organism to organism and increases with complexity of the organisms.

Mutational Breeding

On genetic level, there are two ways to achieve desired traits. One of them is to introduce *heritable changes into the DNA of one parent using mutations*. For this, the agents used are called mutagens. Mutagens can be various chemicals or various types of radiations. This type of breeding is known as "mutation breeding". There are more than two thousand Mutagenic plants currently. One of India's high yield varieties of wheat called "*Sharbati Sonora*" was produced via Mutation Breeding only. However, the basic problem with mutation breeding is that the mutagens introduce random changes in the plant's DNA the results are far more unpredictable than changes brought about by specific genetic modification. Thus, mutation breeding also remains haphazard and unpredictable.

Jumping Genes

For plant breeders, there is a highly assisting phenomenon that the DNA is *inherently plastic* and not a static molecule. It can undergo considerable natural rearrangements. These rearrangements are caused by the regions of DNA which jump around an organism's genome. These regions are called *transposons or jumping genes.* The more the fraction of jumping genes, the more is the variability and plasticity of genome of a particular organism. This jumping of genes occurs naturally also. For instance, if a piece of such DNA jumps into a gene that is involved in the biosynthesis of chlorophyll, the offspring may lack normal biosynthesis of Chlorophyll resulting in the variegation of the foliation leaves. Eventually, the jumping genes were first discovered in maize plants.

Horizontal Transfer and Vertical Transfer of Genes

Other natural phenomena that have assisted the plant breeders are horizontal & vertical transfers of genes. The vertical transfer of genes is what happens when genes are passed from parents to offsprings. Horizontal gene transfer is the movement of genetic information between sexually unrelated organisms. While vertical gene transfer is the basis of life of all living things, horizontal transfers have occurred naturally rarely. One example of Horizontal gene transfer is the Bacterium that causes TB (Tuberculosis). This TB Bacteria called *Mycobacterium tuberculosis* carries a chunk of human DNA too.

Transgenic Organisms

The traditional plant / animal breeding have resulted in the development of wide variety of flora and fauna, yet as we discussed above, it is a tardy hit-or-miss process. The Genetic engineering allows the scientists to transfer specific genes into organisms, thus enabling them to introduce ONLY the desired traits. The plants and animals such produced are called *transgenic* plants and animals.

Golden Rice in comparison to normal rice

One of the advantages of genetic modification is that genes can be taken from *any organism* and thus it allows *horizontal transfer of genes*. Such horizontal transfer of genes would not be possible by natural breeding. Many of the insect resistant crops, herbicide tolerant crops, and crops with other desirable traits have been produced by such horizontal transfer of genes. One popular example is the *Golden Rice*, a variety of common rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of vitamin A, in the edible parts of rice. To 'create' Golden rice, two genes were horizontally transferred into the plants viz. *psy* from *daffodil* and *crtI* from soil bacterium *Erwinia uredovora*.

Bt Toxin

Bacillus thuringiensis is a naturally occurring soil bacterium. This bacterium produces some proteins which are called Bt proteins. These Bt proteins are toxic to certain insects (not all); so also called *Bt toxins*. There are around 50 verities of such Bt Toxins identified. Some of the Bt toxins target the larval forms of butterflies and moths, while others target flies and mosquitoes. Some others target

beetles. They cause e*ither little or no harm* to other organisms such as people and other flora / fauna. For decades, such toxins have been used in the conventional and organic agriculture. In fact, Bt toxins have been considered environmentally friendly alternatives to the broad-spectrum insecticides sprays, which target all insects.

The problem with the insecticide sprays is that they are sprayed on plants and they can kill only those insects which are exposed to sprays. They cannot harm the pests which burrow into plant tissues and are not exposed to sprays. The use of Bt genes was based upon this premise that *it will produce the toxin deep within the plant itself* and thus plant would automatically become insect resistant. This trait was successfully achieved in Maize, cotton and some other crops. The Bt gene was successfully transferred and thus produced transgenic maize plants were resistant to corn borer, corn earworm etc. while the cotton plants were resistant to Cotton bollworm and Pink bollworm.

Transgenesis versus Cisgenesis

Cisgenesis is the genetic modification of a recipient plant with a natural gene from a crossable—sexually compatible—plant. This means that Horizontal transfer of genes in related organism (for example one domesticated and another wild) is Cisgenesis. On the other hand, Transgenesis is the genetic modification via horizontal transfer of genes from unrelated and / or sexually incompatible with the recipient organism. For example, Bt crops have the Bt toxin producing gene from a bacterium.

GMO versus LMO

The genetic material of GMO was altered using genetic engineering techniques. LMO is a term used in Cartagena Protocol of Biosafety. The definition of LMO uses two terms viz. *living* and *modern biotechnology*. This implies that LMOs include *living organisms* which have been modified either by genetic engineering or by any other tool of modern biotechnology. Thus All GMOs are LMOs but all LMOs are not GMOs. For instance, organisms produced by the fusion of cells from different taxonomic families are products of modern biotechnology but not genetic technology. Such organism would fall in LMO but not in GMO.

Issues with GM Crops

The debate on safety and need for GM crops, particularly GM food has been lingering since 1990s. The Biotech firms as well as scientists have spent a lot of time and money to convince the people that there is really nothing to worry about it. Non-food Bt Crops were introduced with relatively lesser resistance but Food crops have faced stiff resistance around the world. Thus, globally the countries are divided in the use of GM Crops. It has estimated that in US, 60% of the processed food in supermarkets contains Genetically Modified ingredients. Since 1990s, the farmers in U.S., Canada and Argentina have been growing the corn, cotton, soybean etc. varieties that were genetically

engineered.

Initially, there were no strict regulations on initial stages of testing for such crops. They even allowed commercial application without even labelling requirements. However, with increased awareness on environmental and health risks associated with such crops, things have changed.

On the other hand, European countries are more cautious. EU came up with the labelling requirements as early as 1997. It was followed by a moratorium on registration of new varieties of GM crops till such time as greater consensus and understanding were achieved. Similarly, Australia, Brazil, Japan and UK made labelling compulsory.

Rationale

Rationale behind GM seeds is that the conventional methods of breeding that brought the Green Revolution had hit a plateau. Excessive use of fertilizers and water has led to soil degradation, salinity and alkalinity. So, the GM seeds with further quality improvements were seen as a solution. Other reasons cited were the increase in farmer's net income by reducing overall costs and increasing output.

However, introduction of GM crops has been slow and tardy because of some basic issues *viz. human health, weeds, biodiversity, non-targets, soil health and terminator seeds.*

Our country has so far allowed on one GM Crop viz. Bt cotton, that too *because it is not a food crop*. Bt Brinjal had been at centre stage for last few years. Recently, GM Mustard has become a new focus GM crop in India.

The reactions around the world have slowed the pace with which the biotech companies would have introduced various crops. But still, the biotech companies are lobbying and pushing for their introduction. The more they push, the more people become concerned about the safety of these crops.

Key Concerns

The key concerns can be summarized in the below questions.

- What impacts could GM crops have on the environment and wildlife?
- Can the Insect resistant crops affect non-target insects? What will happen if such insects develop resistance to the toxin?
- Could the herbicide resistant plants produce uncontrollable weeds or so called "super weeds"?
- They increase the yield but will be economical? Will the farmers become extremely dependent on biotech companies?
- How they would affect the soil health and soil organisms?
- What will happen to plant (an animal) biodiversity?

Human Health

- By inserting genes from organisms which have never been eaten as food, new proteins are

introduced into the human and animal food chains. There is concern that these could cause allergic reactions or other health effects.

- Many GM crops contain genes which provide resistance to commonly used antibiotics such as ampicillin. There is concern that these genes could be passed from food to bacteria in the guts of humans and animals.

Terminator seeds

One of the major issues with the GM crops is that the biotech companies (despite a global moratorium via UN Convention on Biological Diversity) can resort to the *Genetic Use Restriction Technology* (GURT) and produce the terminator seeds which makes crops die off after one harvest without producing offspring. This would force the farmers to buy new seeds for each planting, which reduces their self-sufficiency and makes them dependent on major seed and chemical companies.

The above argument has been countered on the premise that today many crops depend on their yield due to hybrid seeds. These seeds are the product of two inbred parental lines, which, when crossed, produce hybrids of a high quality. If farmers plant seeds from these hybrids they will eventually lose the quality of the parents. This implies that the farmers need to buy Hybrid seeds every season or they knowingly would risk low yield by their own planted seeds.

Legal Framework around GM Crops

Globally, the Convention on Biological Diversity (CBD), particularly its Cartagena Protocol is related to GM crops. The basic focus of Cartagena protocol is *Biosafety*. This protocol is based upon the premise that the LMOs have become ingredients of an increasing number of products, including foods and food additives, beverages, drugs, adhesives, and fuels; and there is a need of international framework on Biosafety including risks to biological diversity. The first important provision under this protocol is that it allows governments to signal whether or not they are willing to accept imports of agricultural commodities that include LMOs. If they want it or not want it, they can communicate their decision via a **Biosafety Clearing House**, a mechanism set up to facilitate the exchange of information on and experience with LMOs.

Second important provision is that the export commodities which have LMOs as ingredients should be cleared labelled.

The third important provision is of stricter *Advanced Informed Agreement* procedures, which apply to seeds, live fish, and other LMOs that are to be intentionally introduced into the environment. In these cases, the exporter must provide detailed information to each importing country in advance of the first shipment, and the importer must then authorize the shipment.

The objective of the above three provisions is to ensure that the recipient countries have both the

opportunity and the capacity to assess risks involving the products of modern biotechnology.

Moreover, the Cartagena protocol adopts the precautionary principle and allows the countries, particularly developing countries to have a say in balancing public health against economic benefits.

Another protocol of CBD i.e. *Nagoya Protocol* is focussed around Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization. When a microorganism, plant, or animal is used for a commercial application, the country from which it came has the right to benefit. Such benefits can include cash, samples, training and research participation and other profits.

Legal Framework on GM Crops in India

Since as early as 1980s, the government of India has shown an interest in the area of farm biotechnology. To identify priority areas and to develop a long term plant, the government established National Biotechnology Board (NBTB). In 1986, it was transformed in Department of Biotechnology, under the Ministry of Science and Technology. The Government research institutes have been involved in biotech research for a variety of the crops. In our country, the GM crops are regulated under the following:

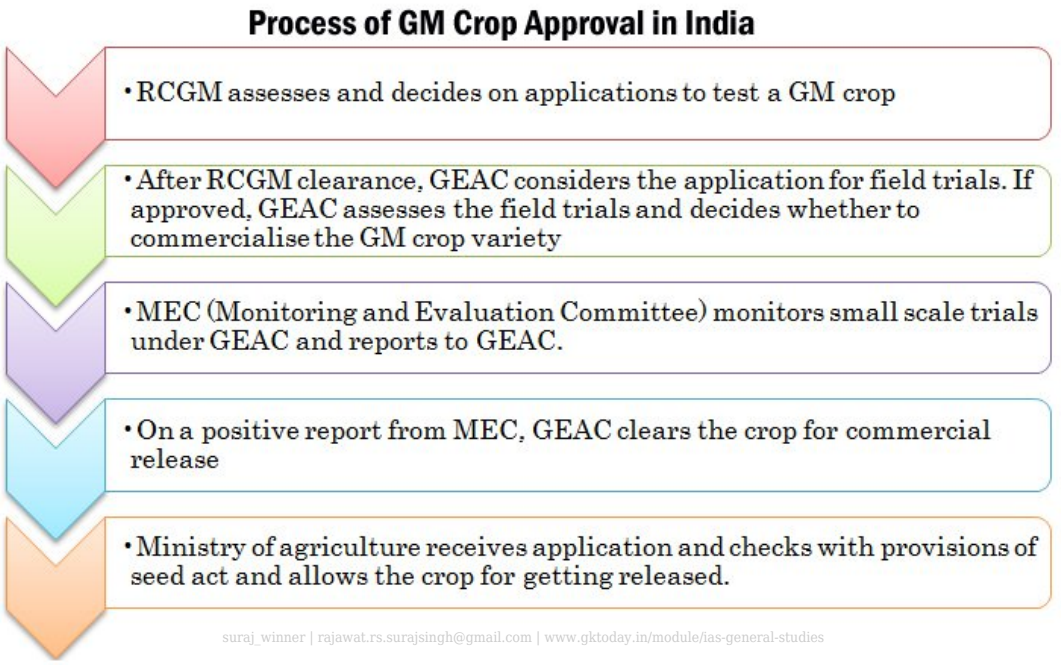
Environment Protection Act and GEAC

All transgenic crops in India require environmental clearance under 1989 "Rules for Manufacture, Use, Import, Export and storage of hazardous microorganisms/Genetically Engineered Organisms or Cells" notified under the Environment (Protection) Act, 1986. Via these rules, a *Genetic Engineering Approval Committee* (GEAC) was established in 1989, as apex body for this matter. The rules 1989 are also known as *Biosafety regulatory framework*, which were issued by MOEF in 1989 and amended from time to time. This framework covers areas of research as well as large scale applications of GMOs as well as hazardous microorganisms which may not be genetically modified. The rules cover activities involving manufacture, use, import, export, storage and research. The structure of various competent bodies under this framework is as follows:

At every institutional level, an *Institutional Bio safety Committee* (IBSC) headed by the Vice-Chancellor oversees the safety needs of the research.

There are committees at the *district, State and Central levels*, including the Review Committee on Genetic Manipulation (RCGM), State Biotechnology Coordination Committee (SBCC) and District Level Committee (DLC) for handling of various aspects of the rules. *GEAC* is the apex body. It is the clearing house for all GM crops in India.

The following graphics shows how a GM crop is released in India.



National Biological Diversity Act 2002

National Biological Diversity Act 2002 has provisions to deal with the possible risks associated with the application of modern biotechnology. The apex body constituted under this act is National Biodiversity Authority (NBA). As per this act, all foreign nationals require approval from NBA for obtaining Biological Resources. All Indian individuals/entities are required to seek NBA approval before transferring knowledge / research and material to foreigners. Prior approval of NBA is needed before applying for any kind of IPR based on research conducted on biological material and or associated knowledge obtained from India. Thus, non-citizens, non-residents, and body corporate not registered in India or with non-Indian shareholders need NBA's approval for accessing biological resources of India under section 3 of this act. People in the region and communities, growers and cultivators of biodiversity, and vaids and hakims do not need NBA's approval. On state level this act makes provisions for state level biodiversity board.

Biotechnology Regulatory Authority Bill

The government had also introduced in April 2013 the *Biotechnology Regulatory Authority Bill,* which proposed to give easy access to GM crops in India. The bill is in cold storage as of now.

Complexity of Legal Framework: Case Study of Mahyco

Despite of such complex system of Biosafety regulatory framework, our capacity to deal with various issues is limited mainly due to shortcomings in the *laws, constraints of financial and institutional nature*

and vastness of India's primary economy.

The deficiency of our country's regulatory framework around the GM crops was first revealed in 1998 when Maharashtra Hybrid Seeds Company Ltd. (Mahyco) started field trials of Bt Cotton in nine states and no one exactly knew which authority allowed it to do so. The authority to sanction these trials was GEAC as all transgenic crops in India require environmental clearance under 1989 rules. However, it was reported that Mahyco proceeded with letter of authority from RCGM and did not consult the state level committees.

Moreover, it was never clear whether Bt Cotton was safe or not. But anyhow, initial formal sector studies found the positive agro-economic effects of Bt Cotton. These studies were reported in the Parliament from officially sanctioned field trials of Bt cotton. The studies were confirmed by the advocates of the Bt Cotton that it resulted in increased yield because of superior bollworm control; bringing down cost of bollworm control and thereby raising the net incomes of the farmers. Thus, official approval of Bt Cotton was granted in March 2002, and Bt Cotton became the first GM crop approved in India. Mahyco became the first Indian company to commercialize transgenic cotton hybrids in India in 2002.

Similarly, the problems with the NBA act 2002 is that it does not say anything on Public Institutions and many of its provisions overlap with that of Environmental law and rules released under it.

Thanks to RTI act and Indian Judiciary which directed the government to make public within 10 working days all the relevant data on genetically engineered brinjal, okra, mustard and rice which have been approved for multi-location trials. The decision established the position that if a GM food causes allergies or contains toxins, the government cannot refuse to disclose such bio-safety information on the grounds that it involves commercial confidence or trade secrets and that it will compromise the competitive position of the biotech company concerned.

Issues Related to BT Cotton

Bt cotton, a transgenic plant which produces an insect controlling protein Cry1A(c), the gene for which has been derived from the naturally occurring bacterium, *Bacillus thuringiensis* subsp. kurstaki (B.t.k.). The cotton hybrids containing Bt gene *produces its own toxin* for bollworm attack thus significantly reducing chemical insecticide use and providing a major benefit to cotton growers and the environment.

Please note that Bt cotton contains the three genes viz. Cry1Ac, NPTII and AAD inserted via genetic engineering techniques.

- The Cry1Ac gene, which encodes for an insecticidal protein, Cry1Ac, derived from the common soil bacteria *Bacillus thuringiensis subsp. kurstaki* (B.t.k.).
- The NPTII gene and the AAD gene encode for the NPTII and AAD proteins and they are

used as a selectable marker and have no pesticidal activity and are not known to be toxic to any species.

Rationale of Use of Bt Cotton

Bt refers to the *bacterium Bacillus thuringiensis* which naturally produces a chemical harmful only to a small fraction of insects, most notably the larvae of moths and butterflies, beetles, and flies, and harmless to other forms of life. To produce the GM Cotton, the gene coding for Bt toxin (Cry-1-ac) has been inserted into cotton, causing cotton to produce this natural insecticide in its tissues. By this, the larvae are killed by the Bt protein in the GM cotton they eat. This eliminates the need to use large amounts of broad-spectrum insecticides to kill various pesticides.

Extent of Use

Bt cotton was planted on an area of 25 million hectares in 2011. This was 69% of the worldwide total area planted in cotton. GM cotton acreage in India grew at a rapid rate, increasing from 50,000 hectares in 2002 to 10.6 million hectares in 2011.

The total cotton area in India was 12.1 million hectares in 2011, so GM cotton was grown on 88% of the cotton area. This made India the country with the largest area of GM cotton in the world. The U.S. GM cotton crop was 4.0 million hectares in 2011 the second largest area in the world, the Chinese GM cotton crop was third largest by area with 3.9 million hectares and Pakistan had the fourth largest GM cotton crop area of 2.6 million hectares in 2011. Australia is the country with the fifth largest GM cotton crop in the world.

Other countries using GM cotton are Argentina, Myanmar, Burkina Faso, Brazil, Mexico, Colombia, South Africa and Costa Rica.

Introduction in India

We have already discussed that all transgenic crops in India require environmental clearance under 1989 rules notified under the Environment (Protection) Act, 1986. Since Bt cotton is a genetically modified plant, it was never clear whether it was safe or not. The initial formal sector studies conducted by the Industry and Government most likely found the positive agro-economic effects of Bt Cotton. These studies were reported in the Parliament from officially sanctioned field trials of Bt cotton. The studies were confirmed by the advocates of the Bt Cotton that it resulted in increased yield because of superior bollworm control; bringing down cost of bollworm control and thereby raising the net incomes of the farmers.

Thus, official approval of Bt Cotton was granted in March 2002, thus Bt Cotton became the first GM crop approved in India. *Mahyco became the first Indian company to commercialize transgenic cotton hybrids in India in 2002.*

Commercial cultivation in Bt cotton was launched in Six States viz. Andhra Pradesh,Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu.

The GEAC had accorded conditional approval for introduction of three Bt cotton hybrids namely BT MECH 162, BT MECH 184, BT MECH 12 after detailed evaluation on the efficacy and safety of the product. Some of these conditions were as follows:

- The crops were approved for a period of 3 years (2002-2005)
- Every field where Bt cotton is planted shall be fully surrounded by a belt of land called 'refuge' in which the same non-Bt cotton variety shall be sown. The size of the refuge belt should be such as to take at least five rows of non-Bt cotton or shall be 20% of total sown area whichever is more. To facilitate this, each packet of seeds of the approved varieties should also contain a separate packet of the seeds of the same non-Bt cotton variety which is sufficient for planting in the refuge defined above.
- Each packet should be appropriately labelled about the Bt seeds in vernacular language
- MAHYCO will enter into agreements with their dealers/agents, that will specify the requirements from dealers/agents to provide details about the sale of seeds, acreage cultivated, and state/regions where Bt cotton is sown.
- MAHYCO will prepare annual reports and submit the same in electronic form to GEAC
- MAHYCO will develop plans for Bt based Integrated Pest Management and include this information in the seed packet.
- MAHYCO will monitor annually the susceptibility of bollworms to Bt gene
- MAHYCO will deposit 100 g seed each of approved hybrids as well as their parental lines with the National Bureau of Plant Genetic Resources (NBPGR).

What is MECH?
The natural gene cry 1ac has been further modified by Monsanto Inc., USA. The transgenic cotton varieties containing this improved gene have been branded "Bollgard" by Mahyco. Mahyco has produced Bt cotton lines by back-crossing the Bt lines of Monsanto with existing cotton hybrids. These lines have been named MECH (Mahyco's early cotton hybrid) with a number suffixed such as 12, 162, 184 and 915.

Biosafety assessment by Government / Mahyco

The following are some of the relevant conclusions obtained after the various studies conducted by safety assessment of the Bt Cotton Hybrid seeds. These conclusions have been sourced from an environment ministry document

- The pollens of the Bt Cotton Hybrids are able to pollinate mostly within a range of 2 meters and only 2% of the pollens are able to reach a distance of 15 meters thus the chances of cross pollination with Non-Bt hybrids are meagre. Thus, there is essentially no chance that the Bt gene will transfer from cultivated tetraploid species such as the Bt hybrids to traditionally

cultivated diploid species.

- There was no substantial difference found between Bt and non-Bt cotton for germination and vigour, indicating that there is no substantial difference between transgenic Bt and control non-Bt cotton with regard to their weediness potential.
- Bt cotton hybrids do not have any toxic effects on the non -target species such as sucking pests (aplvels, jassids, white fly and mites). The beneficial insects (lady beetle, spiders) remained active in both Bt and non Bt varieties.
- Bt protein was not detected in soil samples indicating that Bt protein is rapidly degraded in the soil on which Bt cotton is grown. The half-life of the Cry 1AC protein in plant tissue was calculated to 41 days which is comparable to the degradation rates reported for microbial formulations of Bt. Thus there was no possible risk of accumulation of Btgene in the soil
- There was no significant difference in population of microbes and soil invertebrates like earthworm and Gllembola between Bt and non-Bt soil samples.
- There is no change in the composition of Bt and non Bt seeds, with respect to proteins, carbohydrates, oil, calories and ash content.
- No significant differences in feed consumption, animal weight gain and general animal health were found between animals fed with Bt cotton seed and no cottonseed. No significant differences were found between animals fed with Bt and non Bt cottonseed.
- Cry 1AC gene and protein are not found in refined oil obtained from Bt cottonseeds. Bt cotton seed meal is nutritionally equivalent, wholesome and safe as the non-Bt cottonseed meal.
- The transgenic Bt Cotton plant was developed by incorporating Bt gene into it. Therefore it was desirable to assess that no other gene including cre recombinase gene which is an integral component of the so called "terminator technology" is present in Bt cotton. A study was carried out by The Department of Genetics, University of Delhi to check the presence/absence of such gene in the Bt cotton. The PCR analysis showed the absence of "terminator gene" in Bt cotton hybrids.

Controversies and Farmer Distress Issue on Bt Cotton

The environmentalists, farmers, scientists and political parties raised concerns over environmental issues, bio-safety measures, and health implications of the Bt Cotton. The growing number of farmers committing suicides in some cotton growing states has re-ignited the protests against the Bt Cotton. The question was: *Is Bt Cotton connected to farmer's suicides?* Arguments in favour and against this have flooded in media. Here is our version of analysis on this debate.

Undoubtedly, Bt technology has been responsible for farmer distress in the country. There are two

main arguments being this. *Firstly,* indiscriminate use of Bt hybrids instead of Bt straight. *Secondly,* problem of later maturing hybrids.

Indiscriminate use of Bt Hybrids

The Bt Technology does just one thing – to protect the crop from boll worms and few other caterpillars. Nothing else. Bt Cotton is available in two forms viz. Bt Hybrids and Bt straight (non-hybrid). Soon after its launch, India became a market playground of companies where ***thousands*** of brands of the Bt hybrids became available. Farmers found it impossible to make an informed decision from the randomly available brands. If we compare it with the rest of the world, we find that Bt cotton is available *only as a few straight varieties elsewhere*. Thus, the first mistake India did was to allow the Bt Hybrids rather than limited Bt Straight varieties. The indiscriminate use of Bt hybrids was for a great length responsible for distress among cotton farmers in rain-fed areas.

Late Maturing Hybrids

In India, *Cotton is an important rainfed crop*. Most of the Bt hybrids are of 180-to 200-day duration and are *not suitable for rain-fed conditions*. Since the Hybrid seeds are costly, they are sown late, only when the farmers ensured that there is adequate soil moisture. The boll formation in the late sown maturing hybrids suffers from severe moisture stress because it takes place much later after the rains recede. This ultimately results in low yields. Instead, the advantage with straight varieties would have been that farmers can reuse farm-saved seeds and can take the liberty of early dry sowing, even before the onset of the monsoon, without having to worry about the risks of poor germination and re-sowing. Then, many of these hybrids are susceptible to sap-sucking insects, leaf-curl virus and leaf reddening, adding to input costs.

The above two are major reasons as to why Bt Cotton is not directly connected with farmer suicides or with enhanced requirement of fertilisers or water. The problem is with late maturing hybrids that do not perform well owing to the late-season moisture deficit in shallow soils, especially when they are sown late. Farmers in rain-fed regions were / are compelled to choose from a long list of Bt hybrids, most of which are late maturing, sucking pest-susceptible hybrids, that are unsuitable for rain-fed regions.

But despite that, there is no doubt that the Bt technology has brought down the use of pesticides by about 50% and declined infestation of the boll worm. However, Bt cotton has not led to increase in cotton yields significantly. Cotton yields increased by about 60 per cent in three years between 2002 and 2004 when the area under Bt cotton was a meagre 5.6 per cent and the area under non-Bt cotton was 94.4 per cent. The yields did not increase significantly more than the pre-Bt era even until 2011 when the Bt cotton area touched 96 per cent.

Issues around Bt Brinjal

Bt Brinjal is a GM crop created by inserting Cry 1Ac gene from the soil bacterium *Bacillus thuringiensis* into Brinjal. The insertion of the gene gives Brinjal plant resistance against lepidopteron insects like the Brinjal Fruit and Shoot Borer (*Leucinodes orbonalis*) and Fruit Borer (*Helicoverpa armigera*). Upon ingestion of the Bt toxin by the insect, there would be disruption of digestive processes, ultimately resulting in the death of the insect.

The Bt Brinjal seed was also developed by Mahyco or Maharashtra Hybrid Seeds Company in collaboration with Monsanto. The GEAC had approved permission for field trials of Bt Brinjal in 2009. The rationale behind the approvals was to bring down the economic cost of brinjal production in the country. As per studies, the Shoot Borer and Fruit Borer cause up to 20% damage in the crops. The introduction of Bt Brinjal would add to annual production and it would be good for farm economy in the country.

However, since Brinjal was a food crop, the furore over permission to field trials was overwhelming. Despite of the claims of the company that it has done all Biosafety tests, there were concerns over potential health hazards and problem of terminator seed in Brinjal (which would compel farmers to by seeds from Monsanto). The matter reached to Supreme Court and an expert committee, appointed by Supreme Court recommended a 10-year moratorium on field trials of all genetically modified (GM) food crops and a complete ban on field trials of transgenics in crops which originate in India. The result was that the government imposed a moratorium on field trials of Bt Brinjal in 2010.

Meanwhile, in 2013, Bangladesh gave nod to the commercial cultivation of Bt brinjal, making it the first South Asian country to cultivate the genetically modified food crop. This brought apprehensions among the environmentalists in India who fear that, given the porosity of Indo-Bangladesh border, the transgenic crop could leak into India's environment. They have requested the Government to take all measures to safeguard food and seed supply, apart from bio-diversity. Requests have also been sent to Environment Ministry to take all steps to prohibit any illegal or unintentional transfer of Bt brinjal or seeds through the border with Bangladesh. Environmentalists have written to the Ministry urging Indian government to explore all options under the Cartagena Protocol to ensure that Bangladesh takes all measures to ensure that our diversity here is safeguarded from any trans-boundary movement of this GM food crop.

Various Issues around GM Mustard DMH-11

In February 2016, the Genetic Engineering Appraisal Committee (GMEC) deferred the decision to allow the commercial production of another GM crop viz. Mustard DMH-11. The new variety was developed by Centre for Genetic Manipulation of Crop Plants at Delhi University.

What is GM Mustard?

Hybrid variety of a crop is obtained by crossing of two genetically diverse plants of same species and it can give higher yields than their parents. But mustard cannot be *naturally hybridised because it is a self-pollinating plant having both male and female reproductive parts in a single flower*. But researchers have created hybridised mustard using GM technology. The GM hybridised mustard, as it is claimed, gives up to 30% more yield than the present best varieties.

Researchers have used "barnase / barstar" technology for genetic modification. A barnase gene is isolated from a soil bacterium called *Bacillus amyloliquefaciens*. The gene can code for a protein that impairs the pollen production in a plant making it male-sterile. This male-sterile variety is crossed with a parent variety having a gene called 'barstar' to block the action of barnase gene. The resulting variety, having both foreign genes, is a fertile plant and it can increase yield of the crop.

Why a hybridised mustard variety is required?

Researchers and promoters of GM Mustard argue that India imports Rs.60,000 crore worth of edible oils every year. There is an urgent need to reduce dependence on imports and raise domestic crop yields of mustard, which in turn raises production of edible oils domestically. To improve yields, hybridisation is a potential technique as it is successfully demonstrated with many other crops.

Why there is an objection for its introduction?

The main reason for its objection is in use of GM technology for hybridisation involving use of alien genes. Though GM technology is already commercialised in India through Bt cotton, it is argued that cotton is not a food crop whereas mustard is largest edible oil yielding crop of India. Its introduction may adversely affect human and animal health. They also argue that the reason for increased imports of edible oils is because of reduction in import duties and that in turn discouraged domestic production by companies. It resulted in reduction of cultivation of the crop by farmers. There was similar opposition to introduction of Btbrinjal, another GM crop approved by the GEAC in 2009.

What are arguments in favour of its introduction?

The use of GM technology through Bt cotton has increased the country's cotton production by more than 2½ times since it was first planted in 2002. There are no evidences to show the adverse impact on human and animal health. Cotton-seed yields not just fibre but also oil and oilcake that are fed to animals. That makes it no less than a food crop. And also India imports soyabean oil and rapeseed oil that are mainly GM varieties.

Current Topics in Environment

T S R Subramanian Committee

In August 2014, the NDA Government had set up a high-level committee to review the six environment laws in India and recommend specific amendments to bring them in line with current

requirements. The committee was headed by the former cabinet secretary TSR Subramanian.
The six laws under review were:

- Indian Forest Act 1927
- Wild Life (Protection) Act 1972
- Water (Prevention and Control of Pollution) Act 1974
- Air (Prevention and Control of Pollution) Act 1981
- Forest Conservation Act 1980
- Environment (Protection) Act 1986.

After holding consultations with the stakeholders, the committee has submitted its report in November 2014.

Key Recommendations

1. It has recommended for creation of a new "umbrella" law by subsuming the existing environmental laws.
2. Under the proposed new Environment Law Management Act (ELMA), full-time expert bodies—National Environment Management Authority (NEMA) and State Environment Management Authority (SEMA)—are to be established at the Central and state levels respectively. They should evaluate project clearance (using technology and expertise), in a time bound manner, providing for single window clearance.
3. The existing Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCB)are proposed to be "subsumed" under NEMA and SEMA once the new bodies come into existence.
4. It recommends that an "environmental reconstruction cost" should be assessed for each project. The assessment should be on the basis of the damage caused by it to the environment and damage be dovetailed with the cost of the project. This cost has to be recovered as a cess or duty from the project proponent during the life of the project. An "Environment Reconstruction Fund" is proposed to be established for accumulation of this cost and other penalties recovered from projects.
5. Protected areas and forests with over 70% of the tree coverage should be declared as 'No GO' areas.
6. Compensatory afforestation in the revenue land should be modified to 2:1 from the existing 1:1 ratio. The compensatory afforestation in degraded forest land should be modified to 3:1 from the existing 2:1 ratio.
7. An All India Service with name as 'India Environment Service' may be created.
8. It recommended for removing condition of gram sabha approval particularly for linear

projects like roads, railways or transmission lines.

Current Status

In July 2015, a Parliamentary Standing Committee on Science & Technology has rejected the report. The standing committee said that the recommendations of the committee would result in an unacceptable dilution of the existing legal and policy architecture established to protect our environment. The standing committee also suggested for constitution of a new committee to review the environment laws. However, the union government was looking into the recommendations of committee for its possible implementation.

Coral Bleaching: Reasons and Impacts

Coral bleaching is the loss of intracellular endosymbionts through either expulsion or loss of algal pigmentation. When corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn white.

Reasons for coral bleaching

Both biotic and abiotic factors cause coral bleaching

- Increased or reduced water temperatures.
- Oxygen starvation caused by an increase in zooplankton levels as a result of overfishing.
- Increased solar irradiance (photosynthetically active radiation and ultraviolet band light).
- Changes in water chemistry (in particular acidification).
- Increased sedimentation (due to silt runoff).
- Bacterial infections.
- Coral eating crown of thorns starfish
- Changes in salinity.
- Cyanide fishing
- Elevated sea levels due to global warming.
- Mineral dust from African dust storms caused by drought.

Mass coral bleaching events occur at a regional or global scale and are triggered by periods of elevated thermal stress resulting from increased sea surface temperatures.

Impact

The Intergovernmental Panel on Climate Change (IPCC) sees this as the greatest threat to the world's reef systems. Since countless sea life depends on the reefs for shelter and protection from predators, the extinction of the reefs would ultimately create a domino effect that would trickle down to the many human societies that depend on those fish for food and livelihood. There has been a 44% decline over the last 20 years in the Florida Keys, and up to 80% in the Caribbean reef alone.

Global Warming Potential (GWP)

Global-warming potential (GWP) is a *relative measure of how much heat a greenhouse gas traps in the atmosphere.* It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide.

A GWP is calculated over a specific time interval, commonly 20, 100 or 500 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1).

For example, the 20 year GWP of methane is 86, which means that if the same mass of methane and carbon dioxide were introduced into the atmosphere, that methane will trap 86 times more heat than the carbon dioxide over the next 20 years.

Factors that influence GWP

- The absorption of infrared radiation by a given species.
- The spectral location of its absorbing wavelengths.
- The atmospheric lifetime of the species.

Thus, a high GWP correlates with a large infrared absorption and a long atmospheric lifetime. According to IPCC (Intergovernmental panel on climate change) AR-5 released in 2013, GWP of methane is 86, Nitrous oxide is 268, Carbon tetrafluoride is 4950, HFC is 3790, CFC is 7020 for 20yrs.

Impact of Aerosols on Indian Monsoon

Whenever we hear about Climate Change we usually relate it with increasing levels of greenhouse gases, trapping heat and thereby causing global warming. But this need not to be always the correct predictions, there is growing concern that human activity might also be altering the climate in unpredictable ways. This he does by releasing a large amount of soot and other pollutants into the atmosphere in the form of tiny particles known as aerosols.

Aerosols

It is a tiny particle formed both naturally and anthropogenically; naturally formed aerosols are dust whipped by wind, sea salt, sulphate compounds arise by natural processes and plants release organic materials into the air and aerosols formed by anthropogenic activities are soot, sulphates from the burning of fossil fuel, fly ash from thermal plants & nitrates from vehicular emissions which forms the bulk of the haze.

Aerosols in the atmosphere by natural means are not invariably a bad thing in fact they act like a substrate around which water vapour could condense into droplets and helps to form clouds. But those released by anthropogenic activities in form of pollutes may alter the climate adversely.

Aerosols are short-lived, unlike greenhouse gases that persist and thereby accumulate in the atmosphere for longer period, these fine particles stays aloft in the atmosphere only for one to three

weeks.

They are not evenly distributed around the globe, probably they concentrated near places where they are generated and can also be transported by winds across continents. The quantity and the type of aerosols found in the atmosphere changes from time to time as per seasonal variations.

Experiments on Aerosols & its effects

When aerosols extended its effect on climate change, it was the Indian Ocean Experiment (INDOEX) conducted jointly by scientists and institutions from the Europe, United States, and India in the late 1990s. This experiment highlighted the extents of the problem posed by human pollutants on the climate and found that a thick haze over the Indian subcontinent and the surrounding oceans formed by the mixture of natural and anthropogenic aerosols is affecting climate change over south Asian countries and also affecting monsoon pattern in India.

Aerosols influence on Climate

- Aerosols influence the climate in a number of ways; these fine particles scatter sunlight and stop some of it from reaching the earth's surface.
- The water-absorbing aerosols, such as sea salt and natural sulphates forms more cloud forming droplet that reflects more sunlight back into space and permits lesser light towards ground.

- Due to increased anthropogenic activities the soot particles are released in atmosphere in larger scale that blocks and absorb the sunlight and result into heating of the lower atmosphere and burning off the possibility of formation of clouds.
- This has also dimmed sunlight over South Asia and the northern Indian Ocean by as much as seven per cent between 1930 and 2000.
- It has enhanced the solar heating of the lower atmosphere by about 30 per cent to 50 per cent.
- Bonding of soot with dust might triple the dimming of sunlight and perhaps double the cloud burn-off than if dust and soot had remained separate.

Aerosols and India

- The Indo-Gangetic plain is one of the most polluted regions with the soot concentration in the world.
- In an experiment conducted by IIT Kanpur revealed that the soot concentration at a height of two km was higher than that at ground level in many European industrial areas this was also true with Hydeabad.
- India and China is the two major soot producers due to their population and rapid economic growth.
- Most of the soot above South Asian air comes from the burning of fossil fuel, whereas in India it comes from burning of wood, animal dung, agriculture waste and other forms of

biomass.

- There is seasonal variation in the soot level, soot concentrations over the Indian subcontinent and the surrounding oceans are high principally from November to February.
- Natural aerosols account for nearly three fourth of all aerosols present globally.

As natural aerosols were important in determining the current climate it is the manmade aerosols that are more responsible for climate change in India.

Aerosol and impact on Indian Monsoon

- When scientist introduced the effect of aerosols on climate, the record collected showed that the India's monsoon rainfall was decreasing over the last 50 years due to aerosols.
- The scientist has warned that the frequency of droughts in India could increase in the coming decades if pollution continued unabated.
- Aerosols have dimmed sunlight over the Arabian Sea and have consequently cooled that part of the ocean as compared to the southern Indian Ocean as we know that the rain system gravitate towards warmer side and this has reduced temperature gradient between those two parts of the ocean has slowed monsoon circulation and thereby decreased rainfall.
- The greenhouse gases pushing in one direction and is warming the ocean that results more rain whereas on the other side the aerosols are pushing in another direction for cooler oceans and results lesser rain.
- It is said that in coming years the aerosols might win and in other years the greenhouse effect might prevail. This altercation between the two could produce greater year-to-year variability in monsoon rainfall over South Asia.
- The role of natural aerosols (Dust) must be considered while looking at climate change as they dominant over South Asia and the neighbouring oceans during the pre-monsoon period.
- Incorporation of dust aerosols into a climate model by the U.K. Met Office in its research has made more accurate simulation of the African monsoon systems, this factor must also be considered while studying Indian monsoon system.
- On the ground of the effects of carbon dioxide on climate change is studied, we must adopt the same approach when looking at how aerosols will influence the climate.
- We need to develop a system to understand the role of aerosols in determining climate and the changes in aerosol levels on the complex Indian monsoon.
- It had taken over a century to evolve a consensus on greenhouse gases and global warming; hopefully it won't take that long to find definitive answers to the impact of aerosols.

The solution on reducing aerosol effect on climate can be done simply by cutting pollution, but bringing about such reduction in countries such as India where the large population still depend on

conventional fuel and also the their need to meet the energy for the vibrant economy. Thus the country like India has to find alternative non polluting source of energy to meet its need.

14th Finance Commission & Environment

Aiming to increase forest cover of India the 14th Finance Commission for the first time has recast its fiscal transfer formula, according to it the share of central tax revenues will be distributed between the 29 states on how much forest they have maintained. For this an annual forest finance incentive has kept Rs 55,000 crore ($ 9 billion). Such spending on forest conservation will be the higher than any other country in the world.

Forest-cover shares in 14th Finance Commission

Finance Commission in direction of greening of fiscal federalism has allotted 7.5 percent weight for forest cover. This step envisages benefits for forest-based livelihoods, strengthening capacity to combat climate change & protection of environment. It should be noted that recently, the 14th FC has increased the share of central tax revenues to the states from 32 per cent to 42 per cent for strengthening cooperative federalism.

Criteria & weights for financial devolution to states

Variables	13th Finance Commission	14th Finance Commission
Population (1971)	25.0	17.5
Demographic change (2011)	0	10.0
Income Distance	47.5	50.0
Area	10.0	15.0
Forest Cover	0	7.5
Fiscal Discipline	17.5	0
Total	100.0	100.0

SOURCE: REPORTS OF THE 13TH AND 14TH FINANCE COMMISSIONS

Implications of new Formula

Recognizing the critical role of forests and trees the 14th FC new allocation formula is no longer based merely on population, income & area but also factors in the state's forest cover. According to it the forested states will be proportionately compensated for the opportunity cost of forest area not available for other economic activities and the lesser forested states will be encouraged to enhance their forest cover.

Considering the annual fiscal transfer of about Rs. 55,000 core for forest is much higher than the annual budget of MGNREGA the mega employment program, will compel the state governments to

focus their effort on how to increase their forest cover for ensuring a greater share of the green fiscal pie.

India's Stand on Montreal Protocol

The Montreal Protocol is the international treaty on protection of Ozone layer from the Ozone Depleting Substances and to phase-out its production and consumption by 1 January 2010.

This treaty came in to force in 1987 which was ratified by 197 countries; India became its signatory member on 19th June 1992.

This Protocol has been recognized as the most successful international environmental treaty in history. With International cooperation this treaty has successfully led the phase-out operation of production & consumption of major Ozone Depleting Substance (ODS) viz. CFCs, HCFCs, Carbon tetrachloride (CTC) and Halons globally in span of 27 years.

Hydrofluorocarbons (HFCs) took place of above ODS, which worked as an alternative to CFCs & HCFCs and is now commonly used as refrigerants and coolants in refrigerators and air-conditioners.

Gradually, it was noticed that these HFCs though are not Ozone depleting but possess great greenhouse gas effect and contribute to global warming about 12,000 times more than CO2, CH4. It can also be said that HFCs solved one problem and created another.

How world wants to solve this new problem?

The signatory members of Montreal Protocol have prepared a general agreement to phase-out HFCs on the ground of CFCs & HCFCs phase-out operation conducted decades before. But, India suggested to work on this agreement under Kyoto Protocol, as it was specifically made for reducing greenhouse gasses whereas, Montreal protocol for ODS. But others wanted to opt for Montreal Protocol seeking the urgency of the problem, as it was also a highly successful to figure out this kind of problem before.

Why India did not want to put HFCs under Kyoto Protocol?

If HFCs is added in phase-out program under Montreal Protocol then it will be binding on its signatory members to phase-out HFCs on the other hand if it is added under Kyoto Protocol it puts "differentiated responsibility" on developed and developing countries to cut down greenhouse gas emissions.

Which means, only the 40 rich and industrialised countries in the current climate change regime have to legally phase-out the HFCs. Whereas the others like India and China will not have to mandatorily phase-out HFCs. But if they do so they can claim 'carbon credits' and sell them in the carbon market to earn revenues.

But, during the President Obama & PM Modi's meeting in Washington they together meet at consensus and agreed to cooperate over the issue of phasing out HFCs under Montreal Protocol

which was also the main issue in St Petersburg G-20 summit in September 2013.

India has demanded for establishment of a finance mechanism for developing countries so to claim compensation for the costs of converting chemical plants to adopt new technologies and has asked for a 15-year grace period for developing countries to phase out HFCs and shift to newer technologies.

Water Footprint: Blue Water. GreenWater. Grey Water

Water Footprint is a scientific term which means total amount of freshwater used directly and indirectly by an individual, community or a country over a period of time. It is a geographic indicator which shows the amount of water used/polluted by a group along with the location. The consumption of water by the world has been gradually increasing in the last century with the maximum consumption being done for agricultural purposes.

- The concept was introduced by Arjen Y. Hoekstra in 2002 as an excellent indicator to measure water-use.
- There are three components to of water footprint both for direct and indirect usage calculations. These are Green Water footprint, Blue Water footprint and Grey Water footprint. While the first two account for total consumption but the last one measures the amount of freshwater polluted.
- The knowledge of WF helps organization to study their water-use patterns and gauge the eco-friendly nature of their products and make suitable changes/improvements accordingly. It suggests that the water use as well as the water and also the amount of water contaminated during the industrial processes and is rendered unfit for future use.
- A large part about 70% of world's water consumption happens in irrigation for farming. Thus, WF becomes even more important and thus modelling and measuring water consumption by agriculture will help us devise ways for alternative management and reduction of virtual water component. Virtual water means the total amount of water i.e. the sum total of water use which happened at all stages of product chain. It comprises- green water, blue water and grey water

Green water

It is the purest component and is the water which transpires from the plant.

Blue water

It is the water present on the surface or stored in groundwater reservoirs.

Grey water

It is the water which has been polluted during production process due leaching of various nutrients and pesticides.

Thus regulation of footprint of these types of water becomes imperative for reducing the overall WF of a nation.

Green water footprint

It signifies the volume of rainwater which is consumed in the process of production of various agricultural and forest products. It is a sum of total water lost in evapotranspiration and came down to surface as precipitation and the water which is locked in harvest produce.

Blue-water footprint

It is the volume of both surface and groundwater which has been consumed to produce a final good.

Grey water footprint

It is the indicator of the amount of pollution of freshwater due to production of a product throughout its entire production and supply-chain. It is calculated as the volume of water that is required to dilute pollutants to such an extent that water-quality remains acceptable as per water quality standards.

Heat waves in Telangana, Andhra Pradesh and Odisha in 2015

During the last summer season, the states of Andhra Pradesh, Telangana, and Odisha experienced severe heat waves and there were more than 2000 deaths, making it one of the deadliest in the nation's history.

The reason for occurrence of severe heat-waves is a combination of several factors. A heat wave is a prolonged period of excessively hot weather with temperature in the range of above 40°C in plain areas or above 30°C in hilly regions. The high temperature conditions may also be accompanied by high humidity. During the period of March to July, certain parts of India occasionally face high temperature weather and these spells often migrate from one region to the other region.

In 2015, there were sparse pre-monsoon showers and they were ended abruptly resulting in large parts of India dry and arid. Temperature in May month soared above 40°C and this condition was compounded with El Nino effect that brought high temperature across Asia. A combination of dry winds form northwest India and Pakistan, strong solar radiation, and a favourable anti-cyclone over the Indian sub-continent has triggered the heat wave conditions. The worst affected areas were the states of Andhra Pradesh, Telangana, and Odisha. The Indian Meteorological Department also observed that the east coast of India experienced an upward trend in temperature of about 0.6°C in the last century. It could be attributed to anthropogenic activities and depletion of vegetation, along with increased aridity.

One of the reasons for more number of deaths in the last summer could be high humidity and soaring temperature that increased stress levels particularly among elderly, children, and labourers.

The Compensatory Afforestation Fund Bill, 2015

The Forest (Conservation) Act, 1980 (FCA) governs diversion or use of forest land for non-forest purposes such as industrial or infrastructure projects. A company diverting forest land must provide alternative land for taking up compensatory afforestation. The company should pay for planting new trees in the alternative land provided to the state. The loss of forest ecosystem must also be compensated by paying for net present value of forest (NPV).

In 2002, the Supreme Court of India observed that collected funds for afforestation were underutilised by the states and it ordered for centrally pooling of funds under Compensatory Afforestation Fund. The court had set up the National Compensatory Afforestation Fund Management and Planning Authority (National CAMPA) to manage the Fund. In 2009, states also had set up State CAMPAs that receive 10% of funds form National CAMPA to use for afforestation and forest conservation. However, in 2013, a CAG report identified that the funds continued to be underutilised. The Compensatory Afforestation Fund Bill 2015 was introduced by the government in Lok Sabha on May 8, 2015 to regulate collected funds. The bill is presently under examination by a standing committee.

Salient features of the bill

1. It seeks to establish the National Compensatory Afforestation Fund under the Public Account of India, and a State Compensatory Afforestation Fund under the Public Account of each state.
2. The payments into the funds include compensatory afforestation, NPV, and any project specific payments. The National Fund will get 10% of funds collected and the remaining 90% will go to respective State Fund.
3. The collected funds will be utilised for afforestation, regeneration of forest ecosystem, wild life protection and infrastructure development.
4. The bill also seeks to establish National and State Compensatory Afforestation Fund Management and Planning Authorities to manage the funds.
5. The determination of NPV will be delegated to an expert committee constituted by the central government.

NPV quantifies the services provided by the forest. It includes goods and services (tourism and timber); regulating services (climate change); and none-material benefits (recreation).

Municipal Solid Waste Management

Municipal Solid Waste (MSW) or Urban Solid Waste is a waste that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes, construction and demolition debris, sanitation residue, and waste from streets , institutes such as hospitals,

collected by a municipality within a given area. They are in either solid or semisolid form and *generally exclude industrial hazardous wastes*.

Sources of Municipal Solid Wastes

- Residential Sources such as households
- Industrial sources such as Manufacturing and Chemical plants
- Commercial Sources such as shops, hotels, restaurants, offices
- Institutional Sources such as Schools, Hospitals
- Construction sources such as road sites, building sites
- Municipal services such as landscaping, street cleaning, wastewater treatment plants
- Agriculture such as orchards, crops, dairies, chicken farms, pig farms etc.

Types of MSW

There are five broad categories of the MSW as follows:

- *Biodegradable waste:* This includes food and kitchen waste, green waste (vegetables, flowers, leaves, fruits), paper (can also be recycled).
- *Recyclable material:* This includes paper, glass, bottles, cans, metals, certain plastics, etc.
- *Inert waste:* This includes construction and demolition waste, dirt, rocks, debris.
- *Composite wastes:* This includes waste clothing, Tetra Packs, waste plastics such as toys.
- *Domestic hazardous waste* (also called "household hazardous waste") & toxic waste: This includes medication, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, shoe polish.

Environmental Impacts of Solid Waste Disposal on Land

- Ground water contamination due to leaching of waste dump
- Surface water contamination due to run-off on the waste dump
- Bad odour, pests, rodents and wind-blown litter around waste dump
- Generation of inflammable gas such as methane within the waste dump
- Bird menace above the waste dump affecting flight of aircrafts
- Frequent fires
- Spread of epidemics due to stray animals
- Soil acidity
- Green house gas emission

The problem of Urban Solid Waste Management in India

- It is estimated that 38million tonnes of solid waste gets generated in urban India per year. And the collection efficiency ranges from 70-90% in major metro cities while it lies below 50% in several small cities.

- Hardly any attention is paid to scientific and safe disposal of waste.
- Landfill sites have not been identified in many municipalities and in several municipalities landfill sites have been exhausted.
- Very few urban local bodies have prepared long term plans effective solid waste management.

What steps government has taken to improve the situation?

The Government of India had framed a ***Solid waste policy of India in 2000*** based on Supreme Court directions. Key points of this policy are as follows:

- The policy is based on the principle that the best way to keep streets clean is not to dirty them in the first place.
- It advocates daily doorstep collection of "wet" (food) wastes for composting. The policy says that for wet waste, this is the best option for India not only because composting is a cost-effective process but also because India's soils need organic manures to prevent loss of fertility through unbalanced use of chemical fertilizers.

This policy lays down the rules of *Municipality Solid Waste* disposal. The key points among these rules are as follows:

- Improvement of existing landfill sites.
- Identification of new landfill sites for long-term future use and making them ready for operation.
- Setting up of waste-processing and disposal facilities and provision of a buffer zone around such sites.
- Biodegradable wastes should be processed by composting, vermicomposting etc. and landfilling shall be restricted to non-biodegradable inert waste and compost rejects.
- Ensure community participation in waste segregation (by not mixing "wet" food wastes with "dry" recyclables like paper, plastics, glass, metal etc.) and to promote recycling or reuse of segregated materials.
- Garbage and dry leaves are not allowed to be burnt.
- Biomedical wastes and industrial wastes are not allowed to be mixed with municipal wastes.
- Routine use of pesticides on garbage has been banned by the Supreme Court in 1997.

What needs to be done?

- Strict implementation of Solid waste policy and Municipality Solid Waste rules.
- Civil society participation for monitoring the solid waste management by municipality.
- Involve private players who are in the business of waste recycling.

Bleaching of Whales on Tamil Nadu Coast

In the second week of January 2016, around 80 short-finned whales had beached near Mandapu

village in Tutucorin district of Tamil Nadu. Of them more than 40 whales were dead and the remaining whales were rescued in a joint operation by several government agencies and fishermen, and whales were pushed back to sea. The dead whales were buried near the shore at Tuticorin. Marine scientists say that the short-finned whales are deep water whales. Full details about this particular group of whales are not known. The IUCN Red List of Threatened Species classifies it as 'data deficient'.

Why Whales are special?

Whales are large aquatic mammals. They live fully in water and breathe air through blowholes into lungs. Their sleek, streamline bodies allow them to move easily through the water. Studies on captive whales show they let only one side of their brain sleep at a time, while the other works to keep the animal swimming and surfacing for air. They are warm-blooded. Whales are intelligent and live cultural lives. They are two types of whales. The toothed whales use their peg-like teeth to catch fish, squid, and marine mammals, swallowing them whole. The baleen whales use the filter-feeder system to trap quantities of plankton and other small prey.

How do whales move in sea waters?

Toothed whales use echolocation to sense objects. In echolocation, whales send out high-pitched sound. The sound bounces off the object and returns to whale. Whale's brain process the echo to find the location, size, shape and texture of the object. Baleen whales do not have an echolocation capability. They migrate over huge distances without deviations. But it is still unclear how they find their way in vast oceans.

Why whales get beached?

The exact reason is not known. The stranding phenomenon found with toothed whales. Whales act strangely when they become weak, contracted with a disease, when their migration routes are get disturbed because of ecosystem invasion or for any other reason. Once they faced with any disturbance, the whales which moves in groups get disoriented and eventually ends up getting stranded onshore only to die.

Natural causes:

- An earthquake causes the whales to get disoriented.
- Whales strand when they contract with disease, or weak, they let the waves take control of them.

Human made causes:

- Collision of ships,
- Pollution of the ocean waters,
- Changes in temperature of ocean waters from industrial releases,
- Sound of ships and use of sonar devices in the Ocean, and

- Injuries from fishing nets.

Is it the first time happened?

Whale stranding is neither a recent phenomenon nor uncommon. While dead whales would naturally washed ashore, mass beaching has baffled humans since at least 300 BC. Major short-finned pilot whale stranding episodes reported in 1852 in Kolkata and in 1973 when 147 whales were stranded on the beach in Tamil Nadu.

What could be the reason for whale beaching in Tutucorin?

The reason for Tutucorin incident could be while in search of food, an entire group followed a disoriented leader into shallow waters and beach themselves. The other reasons could be due to climate change, pollution of waters, an undersea earthquake, and hearing loss due to high levels of man-made noise from shipping activity. Gently-sloping shorelines can deceive whales dependent on echolocation for navigation. The Manapad beach is flatter.

What is the impact of SONAR?

Active SONAR release low frequency sound in under water to detect marine vehicles. It is the human version of the echolocation technology. The SONAR waves can cause internal bleeding in the ear and brain tissues, killing or disorienting whales. Sometimes whales may interpret SONAR as an approaching predator, triggering panic and subsequent beaching.

Disappearance of Dead Sea

The Dead Sea, also known as Salt Sea, is located on left side of Jordan and right side of Jerusalem.

The land locked lake boasts of salt levels almost ten times that of oceans. Its salinity is attributed to the fact that there is accumulation of minerals because of no outlet for them. The water level in it is almost constant with inflow from the Jordan River and loss through evaporation. Due to its high salinity, the lake is deadly for marine animals and plant life. Bacteria is the only from of population that live in the Dead Sea. Most of the bacteria that live in it have adapted to high salt levels and some bacteria can live only in Dead Sea as they prefer high level of salt in the water. But it is unknown how many varieties of bacteria live in it. Dead Sea is a famous tourist destination and known for therapeutic for humans. Because of higher density in the water, it increases buoyancy allowing tourists to float atop.

Scientists have expressed fear that Dead Sea may disappear because water from its only water source (the Jordan River) has been rushing out of the Dead Sea more than it is moving into the Dead Sea. And growing sinkholes have been swallowing up the Dead Sea. As the water reduces in the Sea, large amount of sediments and large deposits of salt are collected along the shores. These mineral deposits dissolve with rainwater or runoff from the mountains. As minerals melt, they leave behind empty spaces beneath the surface. Eventually, with no material left, there will be a collapse of ground to form large scale sinkholes. The sinkholes, which have been growing at a rapid pace, are threatening the tourists.

Some scientists proposed that water could be pumped to Dead Sea from the Red sea which is 180 Km away from it. Though it is highly expensive, there is no other way to save the Dead Sea. At least the water from the Jordan River must be allowed to flow freely into the Dead Sea.

Urban Heat Island (UHI) Effect

The growing urbanisation in India has caused rapid changes in land use and land cover within urban areas. These rapid changes have brought a change in the microclimatic conditions particularly with respect to its thermal structure. The phenomenon of increased higher temperatures within city compared to the surrounding rural areas is known as the 'Urban Heat Island' (UHI).

Causes and consequences of UHI

The causes for urban heat island are several. Dense high-rise buildings constructed in urban areas provide multiple surfaces for reflection and high absorption of solar radiation. Urban structures are covered with materials such as concrete and asphalt that have low albedo value causing absorption of more heat. The reduced vegetative cover in urban areas reduces the natural cooling affect from evapotranspiration mechanism. Air pollution form vehicles and industrial activities has an indirect relationship with increasing temperatures in urban areas. Air-conditioning systems and manufacturing activities further discharge heat in to environment. Geographical location of city such as proximity to water bodies and hills play crucial role in formation of urban heat island.

The presence of urban heat island poses threats to human life, animals, plants, regional and global climate patterns. The high temperatures may lead to heat stress deaths and morbidity problems. Plants growth can be effected. It leads to high energy consumption to avoid thermal discomfort, more greenhouse gas emissions, increased air pollution, anomalies in rain pattern etc.

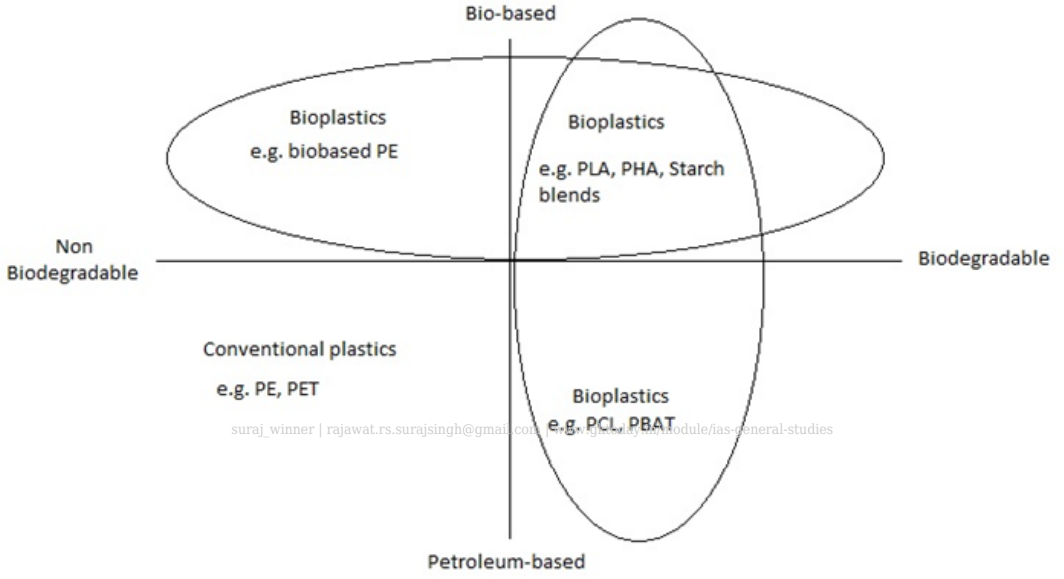
Planting trees and increasing vegetation is the simple way to reduce urban heat island effects. Trees substantially reduce the temperatures by increasing the albedo of the surfaces. Planting more trees directly and indirectly reduces CO2 from the atmosphere. Trees directly reduce CO2 from atmosphere as they use carbon during photosynthesis. Trees indirectly reduce CO2 from atmosphere because their cooling effect reduces burden on power generation. Green roofs and cool roofs having high albedo value surfaces also reduce urban heat island effect.

Bioplastics

Bioplastics are developed as an alternative to the petroleum-based plastics. Increased use of petroleum-based plastics is associated with producing more greenhouse gases. Bioplastics are not just one single product; they consist of a whole family of products with different properties and applications. *A plastic material is considered as a bioplastic if it is either bio-based, biodegradable, or features both properties.*

Bio-based plastics means they are developed form biomass (plants) such as corn, sugarcane, vegetable

oil or wood pulp. Biodegradable plastics are those which possess the characteristics of biodegradability and composability. They can be converted into natural substances like water, carbon dioxide, and compost by the action of micro-organisms in the environment. Biodegradable plastics are either bio-based or petroleum-based. It means expect petroleum-based non-biodegradable plastics all other plastics are considered as bioplastics.



Types of Bioplastics

Bioplastics can be prepared from a variety of materials like starch, sugar, cellulose etc. Cellulose-based plastics are made from wood pulp and they are used for making film based materials such as wrappers. Thermoplastics are starch based plastics. They are used for production of drug capsules as starch has ability to absorb moisture. Polylactic Acid (PLA) is made from the fermentation of starch from crops. It is used for preparing computer and mobile phone casings, cups, bottles and other packaging. Polyhydroxybutyrate (PHB) is used for making bank notes and car parts etc. Polyamide 11 (PA 11) prepared from vegetable oils is used for making oil and gas flexible pipes, and electrical anti-termite cable sheathing etc.

Impact of bioplastics on environment

Bioplastics are better than petro plastics in terms of fossil-fuel consumption, greenhouse gas emissions and energy efficiency. But in terms of cost and applicability, bioplastics are inferior to petro plastics. Bioplastic production requires almost 80% of the energy required to produce common plastic. Biodegradable plastics are easy to recycle and are non-toxic.

In India, the bioplastic market is still at a nascent stage. The demand for bioplastics growing at a slow

rate and it increases with raising awareness among citizens.