Innovative Thought Forum

ENVIRONMENT AND CLIMATE CHANGE

Proceedings of a Seminar

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PREFACE

While thanking you all to be able to come on this very wet morning in Delhi, I welcome you to the seventh brainstorming meeting on the important topic of Environment and Climate Change. We already had six meetings on subjects like Land and Water, Agriculture, Nutrition and Food Security, Healthy India, Indian Higher Education System, India's Energy Security. The topic of Environment encompasses all the sectors and activities from residential, commercial, industrial, agriculture and others. In the quest of quick industrial development mainly in the developed countries of the world, environment was neglected till adverse & hazardous effects of the development surfaced out. In India also the adverse effects of environment were noticed like air and water pollution and changing weather and climate patterns affecting agriculture and resource availability. The respective governments took a note of these problems and made remedial policies. Poor implementation, however, could not carry out the desired mandate.

India has always been an active participant to the global efforts for clean environment and has been a signatory to Kyoto protocol and the climate conference at Copenhagen. The respective Indian Governments have been actively supporting the programmes of the UNFCC. Under the auspices of the previous government eight National Missions were finalized to counter the climate change. These missions are National Solar Mission, National Mission on Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Eco-system, National Mission for Green India, National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change. One of the most visible missions has been in solar space where a target of 20 GW for solar power by the year 2022 by the UPA government, has been revised to 100GW by the present NDA government. Paris agreement signed by India plans to reduce its carbon emission intensity – emission per unit of GDP by 33-35% from 2005 levels over 15 years. It also aims to provide 40% of installed electrical capacity by 2030 from non-fossil fuels. This means that India has to shift significantly from polluting coal based power generation to renewable energy sources.

I had a chance of casting a course on waste business management at the Indian Institute of Management Ahmedabad (IIMA). Having dealt with waste in depth, I am convinced that each type of waste can be converted to useful resource with application of suitable technology, process or knowledge. The economic viability can be looked into after successful demonstration of the technology. One of the most successful examples of converting waste into a very useful product is the fly ash. India produces over 200 millions tonnes of fly ash annually. It used to be a huge problem to dispose it earlier. However, now a day nearly 60% of fly ash is used for producing various kinds of building products and as a part of road construction etc.

There are many such instances of circular economy where a large variety of waste are convertible into useful resources.

In the ancient Vedas, there are several references to environment protection, ecological balance, weather cycles, rainfall phenomena, hydrologic cycle and related subjects. Several of the challenges posed by the problems of environment degradation can be resolved by adhering to the teachings of Vedas. While we progress we should not harm the others. In the quest of doing

business, it is our duty to take care of the climate and the environment. Unfortunately, consumerism has taken over many of our activities. We should be aware of old Indian philosophy and adhere to the principles of the same. We need to combine the philosophy of ecology and economy.

I once again thank you for coming here and contribute to the deliberations. As we proceed there will be several thought provoking ideas, where the opinion of each of you will enrich the discussions.

S.B. Dangayach

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Chapter 1: Indian Views on Environment

Bajranglal Gupta

When one talks of environment, then the formats of the environment, namely, external and internal should be considered. I will deal in my talk today on the internal environment. With respect to the outer environment, the two main considerations have been the space and the nuclear. We know very well now that the outer space has become much polluted. Bhartiya thought of Indian philosophy had understood a holistic and integrated approach to deal with the external and internal relationships between the external and internal environment. We have so far in the modern times have dealt with the problems of external environment only.

In India, our Mahrishis had explained well the meaning of internal environment. They felt that the basic problem lies in the inner. Atma ka Paryavaran has been the motto of environmental cleanliness. According to ancient Indian learned people, the problem lies in the inner environment of the soul. The word pollution is not available in Shastras. The words that are available in Shastras are Vikrati and Vishamsthiti. Why does such a situation arise?. It is due to disgusting conditions of mental and intellectual health of a person.

The ancient Indian Philosopher, Charak has dealt with the problem of environment very well. According to him, human being is like Brahmand, where Lokpurush and Purush are constituted by six elements namely, Prithvi, Jal, Vayu, Agni, Aakash and Avyukat Brahm (Chetna). When the well known five elements (Prithvi, Jal, Vayu, Agni & Aakash) combine with Chetna, Purush and Lokpurush are created. Imbalance amongst these six elements causes the pollution of environment (Vikrati and Vishamsthiti). The imbalance causes diseases and illness amongst human beings and a condition of Vishamsthiti and Vikrati is created in Bramahand. Why is such a situation created?. It is due to Kal (weather and climate), Arth (Gyanderyan, roop, sparsh odour) and Karam (Kayanik, Mansik and Vachik). If there is an excess or deficiency or mis-proportion of any of these, then a distortion (Vikrat) is created leading to a difficult situation (Visham stithi). Why does it happen?. It happens due to pollution of inner environment, where Buddhi (Intellect or Vivek) gets distorted and Dhriti (Man ki shakti, Dharna and Dhairya) also get misdirected.

Mr. Dangayach in his opening remarks talked of consumerism. The past global financial crisis was the result of consumerism, when people wanted to have more and the banks provided loans to people without confirming their financial paying capabilities. The result was that 40 number of banks and financial institutions went bankrupt. When there is no Sanklap (Determination), Dharma (Will to do) gets weakened. This leads to waste.

Thoughtless consumerism and use of products without need has created a huge quantity of waste, which the earth is not able to bear. The power of the earth to consume waste is over. When money dominates, the tolerance is lost in the dealings and/or in relations. Our Smiriti also gets distorted. These distortions were named as Pragya Apradh. Pragya means intellectual wisdom. When the wisdom and the intellect gets distorted, the inner environment gets polluted.

The reason of the inner pollution is the world view, which is based on the distorted Newton's Cartesian law. In this view, the nature and society are considered as machines and hence there is a basic problem in the approach. Francis Bacon, a British philosopher considered the nature as neutral, while Bible considers nature as a mean of exploitation to harness resources for the comfort of the human beings. These basic views of nature as neutral and a mean for exploitation have been responsible for the

degradation of the environment. According to Indian philosophical view point, the whole nature has been built on one element analogous to Boson, the God particle which has been discovered only a couple of years ago. Indians consider nature as mother, which cannot be exploited; one can only extract limited resources from the mother earth. In our Shastras, lot of importance has been given to the biodiversity, where whatever is taken from the mother earth; the same has to be returned to the earth. The shastras define in detail a total life support system, which is unified. About 86 lacs species have been indentified in Hindu Shastras. The chemicals produced by one group of species are used by the other group so that the whole system is self sustaining.

Modern concept of GDP as a measure of development is itself wrong. In the present day concept, the growth is measured only by the economic growth. This is wrong interpretation. The growth must be measured by the economic as well as environment. There are several examples of this wrong model of growth. Punjab, which has several rivers, is suffering from the shortage of water. A technology was brought to India in the 1965-66 about a new variety of wheat, which required high use of chemical fertiliser and pesticides as well as large amount of water. The result has been an acute shortage of ground water and the growing areas of unfertile land.

In the Indian philosophy, there is a great respect for animals. All our Gods use an animal as carriage (Vahan), like Shiva has Nandi, Ganesh a rat, Vishnu a garud, Durga a lion and Laxmi an owl. When we worship Gods, we also worship these animals. The Indian respect towards animals is defined most appropriately in a Yadurved Shloka " Mitrasyaahm chakhshusha sarvani, Bhutani samikshe shauta; Mitrasyaahm chakhshusha sarvani, samikshe". My eyes see every person, animals, trees and all beings with friendly eyes, you also, therefore, see me with a friendly eye.

The modern world however has become very different. Stephen Hawkins, a famous scientist, said that "we are in danger of destroying ourselves by our own great stupidity".

Another noble laureate pointed out that our thinking cult of progress together with our advancement to exploit nature has led to a suicidal race. Vivekanand has said that all nature is bound by laws of its own and this law can never be broken. If the laws are violated then the nature will be dead instantly. In our Rig Vedas, there is a description of Richa, which says that our Vanaspati (plants, fruits and vegetables) has to be pure; the water should be clean and soft and Akash must be swatch (clean). The Vedas teachings also point out towards outer space that needs to stay clean as well. Our Vedas and Scripts had defined the life and the role of environment extremely well. There was a neat balance between life and environment. We need to revive Vedic practices to spare the mother earth from increasing load of pollution.

Chapter 2: Environmental and Climate Challenges in India

Shashi Shekhar.

1. Introduction:

The depth with which the subject of environment has been dealt with by Bajranglalji; any talk in this subject now will be really very tough. I am overwhelmed by the way and the beauty with which the subject of sustainability has been discussed by him. I am reminded at this moment of my conversation with Amir Khan on a flight between Coimbatore to Bombay; he had remarked that the subject of climate change has become Mahesh. Mahesh is a destroyer, while Brahma is the creator and Vishnu is the preserver. The destruction created by the climate change is not retrievable. Some people though still believe that climate change is a farce far from reality but actually the climate change is real. The changing weather patterns, floods, droughts and unpredictable hurricanes are all proven and caused by climate change.

2. Environment degradation: A serious Concern.

The ill effects of environment in our daily lives, particularly in India, are all very well known to us. What we eat and what we drink are all mixed with impurities and we have to breathe daily the severely polluted poisonous air. A detailed study for Delhi showed that due to air pollution, the average life expectancy of inhabitants has come down by 7 to 8 years. In India, we tend to work in silos and don't think of comprehensive solutions. This includes for example the production and management of garbage in the country.

Today's state of environment in our country has happened due to greed and stupidity of our policies. In the quest of producing more, we have exploited the nature to full. In our economic analysis, ecological depreciation is not taken in to account. The striking example is that of a project of installing a hydropower plant. A hydropower plant tends to destroy the ecology of a place particularly in a mountain region. I, while in the government, had to fight against the hydropower project in Uttrakhand because of the fragile ecology of the region. In my opinion the commissioning of this project has been a blunder. After the main Tehri dam, a series of more projects were commissioned in Uttrakhand, destroying several sources of Ganga. In the process several properties of Ganga water are gone. Ganga water was known to absorb 25% more oxygen than the other sources of water. Today the quantity & quality of water in Ganga have decreased considerably and it is no longer a source of clear water. Very little water flows in Ganga now from Rishikesh to Allahabad.

In the year 2012, Mega Kumbh took place in Allahabad, where I also participated. A sadhu told me that the place we bath nowadays is no more Prayag. The water in Sangam is Chambal water and some Ganga water is brought from Tehri Dam. We have played systematically with nature he exclaimed.

There are some outstanding ecologists in the country. When they raise their voices, then they are being termed as activists. The ecological degradation in our ravine waters is the same whether it is Narmada, Yamuna or Kaveri. River Kaveri used to be a huge river, now there is no water in Kaveri for almost nine months in a year.

3. Garbage generation and waste management.

We are in a habit of generating lot of waste and dump the same somewhere or at the landfill sites, which are already overburdened. The consistent formation of methane at these landfill sites creates huge amount of air pollution. At this point, I mention the cultural event organized by Shri Ravi Shankar on the flood plains of Yamuna. I had reservations against the event. The event however took place resulting in considerable damage to flood plains of Yamuna .

Why do we throw garbage on the flood plains? There are so many other solutions of handling and managing waste. The wet garbage generated in the household kitchens, restaurants and hotels etc can be used for bio-methanation and producing gas equivalent to 1, 70,000 cylinders of LPG. Dumping wet garbage on the flood plains contaminates aquifers, which provide water to us round the year.

Our riverside eco-system starts from the mountains and the water is a part and product of the whole ecosystems. If one keeps on using water without any limitations, the system gets burdened and dies.

4. The River Ganga.

River Ganga gets its water from Alkananda and Bhagirathi. The upper region from where Bhagirathi originates is full of biodiversity. The properties of water in Ganga are acquired from Bhagirathi, which takes important minerals along with it from the upper region. For irrigation purposes, we divert water from Tehri Dam, which runs on Ganga water. The efficiency of water uses in our country is only 16% and 84% of water is wasted. If the efficiency of water uses can be increased, ¾ of water can flow back in to the river system helping to maintain the whole water ecosystem.

5. Avoidable blunders in the cropping patterns.

Punjab and Uttar Pradesh have largest network of rivers. These regions should never have any water problem. However, due to avoidable wrong cropping patterns, these two states also have the problems of sinking ground water table. Why is paddy grown in these two states? These states used to grow wheat, maize, millets etc, requiring much less water than paddy. Earlier paddy used to be grown is the eastern and southern regions of the country. If the trends to grow paddy in the same proportions continue, Punjab and Haryana may not have any ground water in the next fifteen years. Also due to paddy cropping the food habits of people in northern region have changed. In Himachal Pradesh, people used to eat millets. However, they are eating more rice now, affecting the strength of their lower limbs.

In Tamil Nadu and Karnataka, people are growing sugarcane since the year 1970. The cropping area has increased five times since then. There are several droughts in Karnataka and acute shortage of ground water. As a result, the farmers don't get the expected crop yield and some of them take extreme steps to commit suicide.

6. Energy and Power.

For electricity generation the country is mainly dependent on coal, leading to carbon dioxide emission as well as generation of large amount of fly ash. One loses power at each step starting from generation to transmission and distribution. Why can't we systematically reduce coal and move towards solar and wind? Earlier, the economics was not favourable. But solar and wind generated power in cheaper than the power generated by coal now. These are however fluctuating energy sources. Hence an intelligent integration of coal, solar and wind power is required to match demand & supply and reduce dependence on coal. Once the problem of grid compatible storage is solved, there could be zero dependence on coal.

We have a very fast growing automobile industry at a CAGR of 10%. Presently there are 220 million automobiles on the Indian road and 2 million are added every year. Government has plans to move to electrical vehicles, but we need to have a clear distinct road map for the same. A policy is required to create proper infrastructure and enabling a suitable level filed for all the stakeholders. If this happens, the next generation may be able to breathe better air.

Energy conservation act was enacted by the GOI in the year 2003. After nearly 15 years, there

is no clear policy yet. Energy conservation building code (ECBC) was released in the year 2007. We had decided at that time to build climate conscious buildings and use of waste material like fly ash. The people however, are still building hot cells, which are cooled mechanically at the expense of large amount of electricity. We need a very comprehensive policy to implement energy efficiency in all our sectors of economy.

7. Conclusions.

There is a need to bring sustainability in our approach in Energy, Health and Resources to negate the effects of climate change. Our Vedic scripts like Charak Samhita are store houses of knowledge. Our forefathers had knowledge and they knew to live with perfection. We need to think small but sustainable. The forums like ITF can help to create appropriate policies and educate people to use resources in ecologically sustainable manner.

Chapter 3 : Climate change : Post Paris Agreement.

Inderjit Singh.

1. Important International Events.

Emission of greenhouse gases and the associated adverse effects of climate change have been recognized since the year 1990 by the governments all over the world. Worldwide efforts are under way since then to mitigate Greenhouse gases which cause climate change. The first conference on the issue was organised in the year 1992 at Rio de Janeiro, when the countries agreed to reduce greenhouse gas emissions under the UN Framework connection on climate change (UNFCCC). The participating countries had common but differentiated responsibilities. The first annual conference of the Parties to the framework was held in Berlin in the year 1995. In this conference, US agreed to exempt the developing countries from binding obligations.

The third conference of parties (COP3) was held at Kyoto in the year 1997. In this conference, the developed counties were mandated to cut GHG emissions relative to base line emissions by the 2008-2012 periods. COP6 was held in Bonn in the year 2001, when most countries reached an agreement on terms for compliance and financing. Bush administration rejected the Kyoto protocol and their representatives were treated as observers.

The COP 15 held in the year 2009 at Copenhagen failed to produce a binding post Kyoto agreement. However, the COP declared the importance of limiting the global warming to 2oC. The developed countries pledged a grant of $ 100 million as climate aid to the developing countries. The COP 17 held at Durban in 2011 yielded some positive results in the sense that the participating countries agreed to adopt a universal legal agreement on climate change as soon as possible, and no later than 2015, to implement the same by 2020.

In the COP 21 at Paris in the year 2015, 195 nations signed the accord, facilitating worldwide voluntary actions (INDC'S) by individual countries.

2. The Paris Accord.

According to the fifth assessment report of the UN Intergovernmental Panel on climate change (IPCC), the average global temperature increased by 0.85oc from 1880 to 2012. The mountain glaciers are in alarming retreat and the downstream effects of reduced water supply in the driest months will have repercussions that will transcend generations. The scientists predict potentially catastrophic impacts of the temperature rising to 2oc or above. The World Economic Forum (WEF) cites that the failure to mitigate or to adapt to climate change is a global risk with greatest potential adverse impacts (WEF: Global Risks Report 2016).

The US Department of State's Foreign affairs policy board had warned that "climate change could lead to a humanitarian risk of epic proportions". We are already witnessing the migration of large number of people around the world because of food scarcity, water insecurity and extreme weather and this will set to become the new normal. The Paris accord was hailed by the US president Barack Obama, who said "This is turning point. This gives us the best possible shot to save the one planet we got".

This Paris Agreement aimed to mitigate, adopt and support (Fig.1) all efforts to hold the warming to well below 2 degrees with efforts to limit warming up to 1.5 degree. The accord aimed to achieve net zero emissions by 2050.

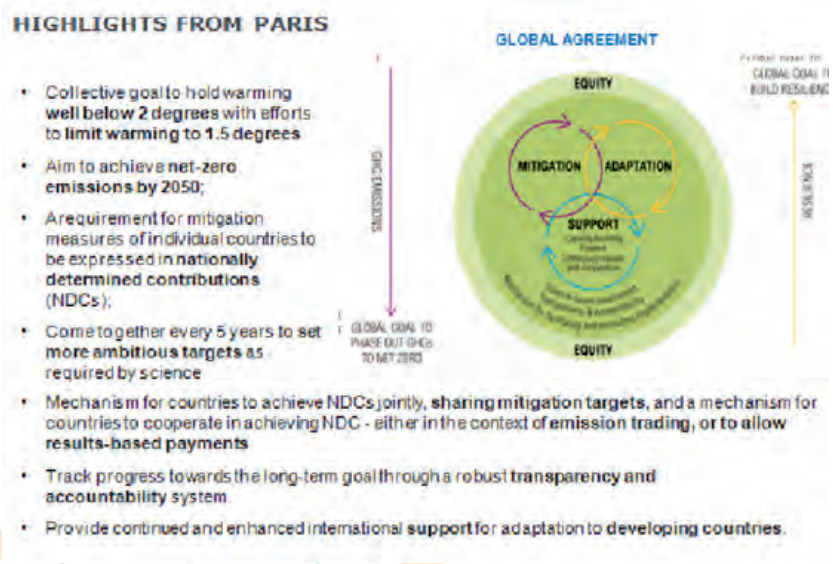


Fig. 1: Highlights of PARIS Climate Accord

The requirements for mitigation measures of individual countries are to be expressed in Nationally Determined Contributions (NDCs). There is an agreement amongst nations to come together every five years to set more ambitious targets as required by the science. The agreement also seeks to track progress towards the long term goal through a robust transparency and accountability system. The nations would like to provide continued and enhanced international support for adoption to developing countries. The NDC targets for top G20 counties are given in Fig.2.

Target Description
Emissions in a range between 398 and 614 MtCO2e by 2025-30
22% reduction against baseline scenario by 2030
37% reduction against baseline scenario by 2030
30% reduction against 2005 absolute emissions by 2030
26% reduction against 2013 absolute emissions by 2030
26% to 28% reduction against 2005 absolute emissions by 2030
26% to 28% reduction against 2005 absolute emissions by 2025
33% to 35% reduction against 2005 carbon intensity by 2030
60% to 65% reduction against 2005 carbon intensity by 2030
40% reduction against 1990 absolute emissions by 2030
37% reduction against 2005 absolute emissions by 2025 and indicative 43% against 2005 by 2030
25% to 30% reduction against 1990 absolute emissions by 2030
41% reduction against business as usual emissions by 2030
21% reduction against business as usual scenario by 2030
130 MtCO2e reduction on annual dynamic baseline by 2030

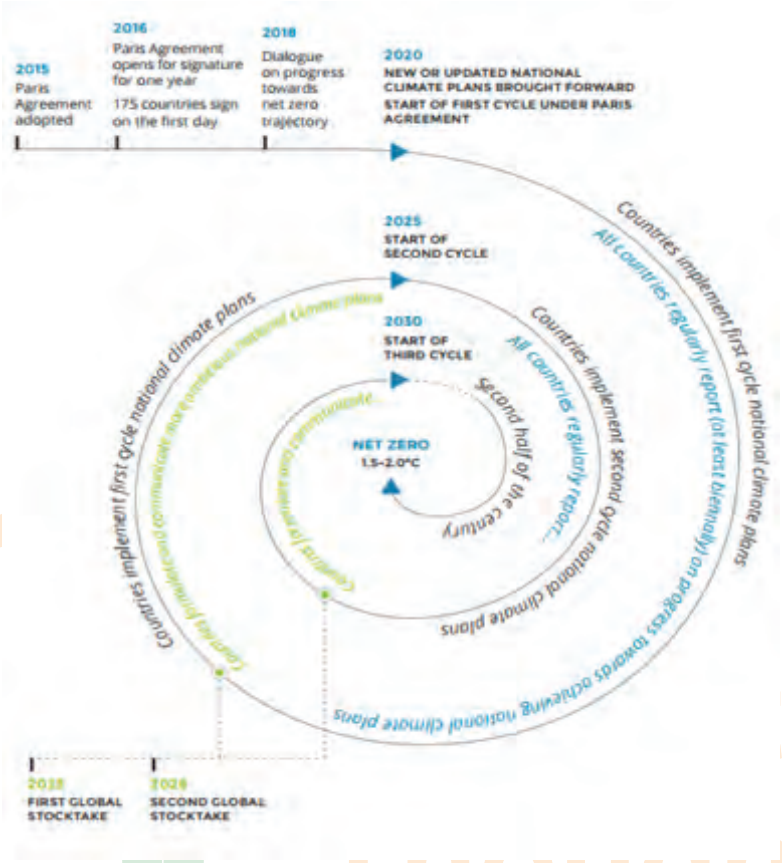


Fig. 2: PARIS Accord: NDP Targets

3. The India's Commitment.

India's NDC goals of Paris agreement are as follows:

- o Reduce emission intensity of its GDP by 33 to 35 present (base 2005) by 2030.
- o 40% installed electrical power capacity from non-fossil fuels by 2030.
- o Create carbon sink of 2.5 to 3 BT of CO2e through forest and tree cover by 2030.
- o Robust adaption strategies for agriculture, water and health sectors.
- o New sources of funds for climate-change action plan.

It is expected that at least USD 205 trillion will be required to achieve 2030 goals. The mitigation strategies of the country include, (a) Renewable energy utilization of 175 GW (Solar 100, wind 60 & hydro 5 & biomass 10), (b) establishment of international solar alliance of 121 nations to focus on solar power, (c) smart grid mission to bring efficiency in transmission network and reduce power losses, (d) establishment of green energy corridor to ensure evacuation of renewable power, (e) National mission for enhanced energy efficiency (NMEEE), to strengthen the market for energy efficiency creating a conducive regulatory policy regime and (f) scaling up the market based energy efficiency trading such as Perform, Achieve and Trade (PAT) for large scale and energy intensive industries.

Additional carbon mitigation strategies that are being adopted by the GOI are:

- Zero Effect, Zero Defect (ZED) policy to rate medium and small scale industries on both

quality and overall environmental impact.

- Smart cities mission to build cleaner and sustainable cities.
- Waste to energy capacity to be enhanced by providing market development assistance.
- Atal mission for Rejuvenation and Urban transformation for 500 cities and focus on ensuring basic infrastructure services by adopting climate resilient and energy efficient policies and regulations.
- Safe, smart and sustainable green transportation system (Dedicated freight corridors, solar power in Indian Railways, Mass Rapid Transit System, Green Highways Policy, National Electrical Mobility Mission)
- Abatement of pollution: introducing stringent programmes and amendment in existing acts to address the problem of environment pollution.

4. Adaption Strategy and Financing.

The adaption strategies and mitigation of GHG emission include:

o National Mission on Sustainable Agriculture (NMSA) for enhancing the food security and protection of natural resources like land, water & biodiversity.

o National Agro forestry Policy (NAP) to encourage and expand tree plantation in complementary and integrated manner with crops and livestock.

o National Water Mission (NWM) to conserve and minimize wastage, and ensuring equitable distribution through integrated water resources development management. Watershed development programmes to replenish and recharge groundwater will be given priority.

o Formulation of health Mission to evolve strategies for mitigating, containing and managing the adverse effect of climate change on human health.

In order to adopt the above strategies, considerable finances will be required. The government will mobilize domestic sources, international sources, as well as seek public private partnerships to achieve the set targets in the climate action plant. The government has created Nation Adaption Fund (NAF) and National Clean Energy Fund (NCEF) on the domestic front. The NAF supports adaption measures in agriculture, water, forestry etc. For NECF, the coal cess in India is INR 50 per ton of coal. This is carbon tax to create funds for supporting research and innovative projects in clean energy technologies.

International sources of funding are Green Climate Fund and Multi-lateral Funds. The former has been established by the UNFCCC as a mechanism to assist developing counties in adaption and mitigation practices. Multi-lateral banks such as World Bank and ADB have commitments to increase funding towards climate change mitigation and adaption in developing countries.

Public Private Partnership (PPP) has been emerging as an important mechanism to finance large scale adaptation and mitigation projects.

5. Risk and Opportunities.

There are both risks and opportunities in the business of climate change. The main risks are:

- Physical and operational risk: Extreme climate events will have impact on direct and indirect facilities, employees, supplies etc. There will be pressure on the management to mange emissions across the value chain.
- Input Material Risk: Reduced availability of natural resources and raw materials (water, minerals, commodities etc) due to degradation. This may result in increasing cost to the carbon companies
- Market Risk:. Environmental awareness among the consumers is leading to decreasing market demand and there would be pressure to disclose environmental & financial risks the business faces.
- Reputational Risk: Failure to deliver the expectations of key stakeholders including the investors. This can damage brand and reputation.
- Regulatory Risk: There could be increasing impact of stringent energy and environment policies and laws demanding penalties for non-compliance. Along with risks there are enormous business opportunities originating from the public policies for climate change. Potential intervention areas for meeting India's NDCs are renewable energy, energy efficiency, cities and transport. The Government of India has facilitated the implementation of renewable energy projects by allowing 100% FDI. The government has provided policy as well as financial support to facilitate solar and other renewable energy projects.
- Policy Support: Wheeling, banking and third party sales and buyback facility by states.
- Special incentives for export from India in renewable energy technology under renewable sector specific SEZ..
- Renewable Purchase Obligation (RPO) prescribing purchase of solar energy to promote renewable energy with an aim to reach up to 8% of total electricity consumption by March 2012.
- Financial Support: Excise duties and concessions on inputs on components and equipments required to set up a solar plant.
- 10 years tax holidays for solar power projects.
- Reduced wheeling charges as compared to those for conventional energy.
- Subsidy of 30% of the project cost for off-grid photovoltaic and solar thermal projects.
- Loans at concessional rates for off-grid applications.

Similarly there are opportunities to invest in energy efficiency, smart cites and electrical mobility.

Energy Efficiency

- The National Mission for Enhanced Energy Efficiency (NMEEE) aims to create a conducive regulatory and policy regime, aiming to save 19,598 MW and fuel savings of around 23 million tons each year once it is fully implemented
- India has launched the Energy Conservation Building Code (ECBC) as an important step towards promoting energy efficiency.

- India's market-based trading Perform, Achieve and Trade (PAT) scheme, aims to improve energy efficiency in the industry sector.
- The micro small and medium enterprises (MSME) sector will receive a boost from the Zero Effect, Zero Defect (ZED) initiative, under the Make in India programme
- Clear opportunity for businesses to take an early lead
- Incentives to deploy low carbon technologies
- The micro small and medium enterprises (MSME) sector will receive a boost from the Zero Effect, Zero Defect (ZED) initiative, under the Make in India programme
- Requirement to comply with both national and international efficiency standards
- Energy efficiency labeling programs

Investment in building energy efficiency programs

Smart Cities

- In 2015, the Government of India recently launched two ambitious projects - Smart City and Atal Mission for Rejuvenation and Urban Transportation (AMRUT)
- It has already been mandated that 10% of the smart cities' energy requirement will come from solar energy and at least 80% buildings should be energy efficient and green buildings.
- Push from government to encourage energy efficient technology like Solar electric vehicle charging station and transmission of surplus power generated by the station back to the local power grid
- Emphasis on the Public Private Partnership (PPP) model encouraging the private sector to mobilize capital, technology and other resources required to finance Smart Cities

Scope for business to invest in transportation (Electric Mobility)

- Government of India aims to become 100% electric vehicle nation by 2030
- 64% savings in energy demand in 2030
- 37% reduction in CO_2 emissions in 2030
- 156 million tones of oil equivalent reduction in petrol & diesel consumption in 2030
- Inter-ministerial committee suggestion for Government to purchase 270,000 EVs (including 20,000 buses)
- National Electric Mobility Mission Plan 2020 - Set a target of 6-7 million electric vehicles sales in India by the year 2020
- Faster Adaptation and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME-India) - Support hybrid/electric vehicles market development and its manufacturing eco-system to achieve self-sustenance by 2020
- Automotive Mission Plan (AMP) 2006-2016 - Lays out 10 year roadmap for automotive industry to become destination of choice for design & manufacture of automobiles and

automotive components

- Differential tax slab for EV under GST
- Technology Platform for Electric Mobility (TPEM) - Grant-in-aid funding generally up to 60% and with user-industry partners (vehicle & component manufacturers) for 5 areas (Lithium Battery, Charging Infrastructure, Driving Cycle & Traffic Pattern, motors & drives and Light weighting of xEVs)
- Alternative Fuels for Surface Transportation Program (AFSTP) - Outlay of 95 crores and this incentive was provided to OEMs that gave at least one year warranty and were setting up at least 15 service stations across India
- Government proposes to provide free charging facility for first three years
- 100% FDI support

5. Investments in Clean Energy

It is expected that by 2026, worldwide clean energy investments will increase up to 200 billion dollars (Fig.3).

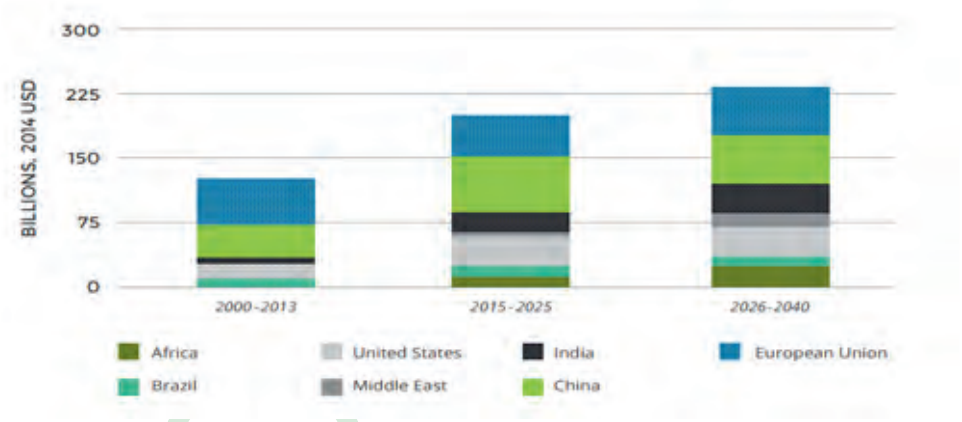


Fig.3: Annual Clean Energy Investments

The key consideration for business are given as:

- Carry out scenario planning on a 2°C future to understand the potential risks and opportunities
- Adopt scope 1,2 and 3 emissions reduction targets aligned to the 2°C goal
- Report separately on scope 1, scope 2 and scope 3 emissions
- Report share of renewable energy in total energy usage
- Analyze energy efficiency historical and present trends
- Compare performance within the sector and peers
- Adopt renewable energy and/or energy efficiency targets
- Assess the vulnerability of assets, operations and supply chain to extreme weather events

- Develop mitigation strategy to reduce exposure to extreme weather events.
- Adopt new metrics related to the capital expenditure spent in low carbon R&D activities and emerging technologies (e.g., renewable energy, energy efficiency, carbon capture and storage)

In order to achieve a sustainable business model the key points one has to keep in mind are:

- Identity sustainable opportunities with in one's sector and take lead.
- Switch to clean energy and energy efficient technologies.
- Identity potential legal, commercial & reputational risks related to energy and environment and create internal funds in advances.
- Engage with policy makers to stay updated and participate on development of regulatory framework.
- Enhance climate resilience and ensure resource and capability to implement actions.
- Review and improve systems to measure, manage, report and reduce overall emissions.

Chapter 4: State of India's Environment.

Chandra Bhushan

1. Indian Vedic View

Whenever we start discussing about the problems of the country, very often one speaks of Shastras and recites some passages from the same. I have also read some of these scripts. This is true that our Vedic scripts contain very good knowledge, some of which makes a very good sense even today. However, with reference to environment, there are ancient traditions, which are not suitable for the modern life. Our scripts are more than two thousand years old, when the Indian population was very small, about 2 crores, and many of the writings don't match with the crowded modern world.

2. The Changing World Scenario.

In the year 1986, the IPCC made a projection according to which the 40% GHG emissions were attributed to population and 60% to the GDP. The present world's population is 7 billion and it is difficult to predict, when will it stabilize? The Indian population is still rising and the population of Africa, which is presently one billion, will start to increase soon.

3. The Human Greed.

The root cause for the degradation of environment is the human greed. Is greed inherent to human nature? There are two paths to the development. Like animals, the humans use to be self sustaining using resources of nature that will keep regenerating. However, greed is inherent to human nature. The growing human population destroyed the self sustain habitats of Mohenjo-Daro and Harappa. To protect environment, humans need to control their greed.

4. GNH the indicator of Growth.

Normally GDP has been taken as a parameter for the economic growth of a nation. In Bhutan, however, Gross National Happiness (GNH), is a philosophy that guides the government of Bhutan. The term was coined in the year 1972 during an interview by the British journalist for Financial Times at Bombay airport when the king of Bhutan, Jigme Singye Wangchuk said "Gross National Happiness is more important than the Gross Domestic Product". In the year 2011, the UN General Assembly passed Resolution "Happiness towards a holistic approach to development" urging member nations to follow the example of Bhutan and measure happiness and wellbeings and calling happiness a "fundamental human goal". In 2012, the fist World Happiness Report was issued and 20th March was declared the International Day of Happiness. The four pillars of GNH;s are (1) suitable and equitable socio-economic development; (2) environmental conservation; (3) presentation and promotion of culture and; (4) good governance. The nine domains of GNH are psychological well being, health, time use education, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience and living standards.

5. Linking of the Rivers.

There has been a serious discussion in our country about interlinking of rivers. These people, in my opinion don't understand the ecology. If such a plan is to be implemented the government has to acquire 56 lacs hectare of land, almost an impossible task considering the pace with which the land is acquired for all public projects in our country. Land prices will also increase significantly during the execution of such a project.

6. The Global Temperature.

The Paris agreement tends to restrict the global temperature to 1.5oC or below. This is going to be gigantic task. Even meeting a target of 2oC will be difficult. For certain seasons, the global temperature has already exceeded 1.5oC. In winter in India, it is close to 2oC or 2.5oC. The impact of seasons on global temperature in the IPCC report is very optimistic. Many of the assumptions are not correct, like a normal monsoon. There is nothing like a normal monsoon now. The IMD now-a-days only predicts rains below or above average. The sketches of IPCC don't consider temporal and spatial changes in the weather patterns.

There are many people, who still don't believe in climate change and the resulting weather patterns and catastrophe. Many bureaucrats say that it is natural to have droughts flood and earthquakes. The truth however is that the climate change is agreed upon in general. We have not yet estimated the grave situation in India. India needs to work on mitigation as well as adaption strategies. Also apart at the national level, we need to work at the regional and district levels. Meeting the targets of Paris agreement is not difficult. India will reach the same even without making any special effort. India's coal consumption is likely to peak at 1 billion ton/a, against 700 million ton/a presently. However, the government should avoid increasing coal use as soon as possible.

7. Conclusion

The dangers of climate change are real. Many regions are in danger of destruction. Can the world come together to avoid the disaster in waiting? However, the world looks more polarised than even before. We should not hope for intensive international collaboration. Local actions are required to tackle the dangers of climate change.

Chapter 5 : Resource Efficient/Sustainable Buildings – Opportunities for Action in India.

Sameer Maithel.

1. Environmental Impact of Buildings.

Buildings use materials of different kind and energy for construction as well as during the operation over its life time. In the manufacturing of materials as well as for production of energy, each of the processes is associated with environmental as well as greenhouse gas emissions. The complete cycle of a building from materials' mining to demolition is exhibited in Fig.1.

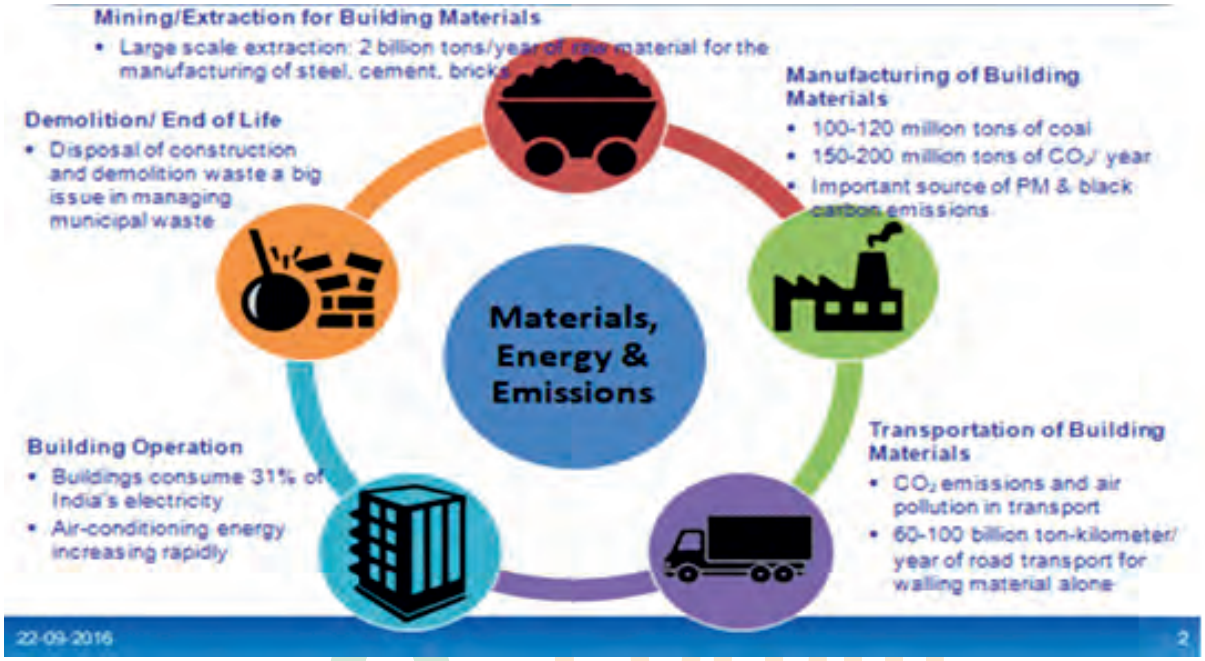


Fig. 1: Environmental Impacts of Building Construction in India

Buildings are constructed to protect the human beings from the extremes of climate and to provide them thermal comfort. About 1.2 crore housing units are to be constructed under the Prime Minister's Awas Yojna (PMAY) by the year 2022 in the urban areas in the country. These buildings are going to be small flats with high density of occupants, who are not able to afford any air conditioning.

In the composite and hot-dry climate of India, peak room temperatures may reach 40oC or above in poorly designed buildings. Situation is going to be worse due to higher ambient temperatures, global warming and urban heat island effects. A study of MIT (2017) projected that by the year 2100, 70% of Indian population would be exposed to 32 degrees of wet bulb temperatures and 2% of them even up to 35oC. Presently only 2% of Indian population gets exposed to extremes of 32o wet bulb temperatures.

2. Examples of Resource Efficiency.

There are several solutions that have been implemented in buildings demonstrating resource efficiency and use of marginal energy during the building use. In public office building at Jaipur, simple design measures have resulted in 40% reduction of electricity consumption compared to BAU. The measured EPI is 43 kWh/m2a and with only 1.5% increase in the construction cost (excluding PV) and a payback in 3 years. About 20% of total electricity demand has been generated on site (Fig.2).

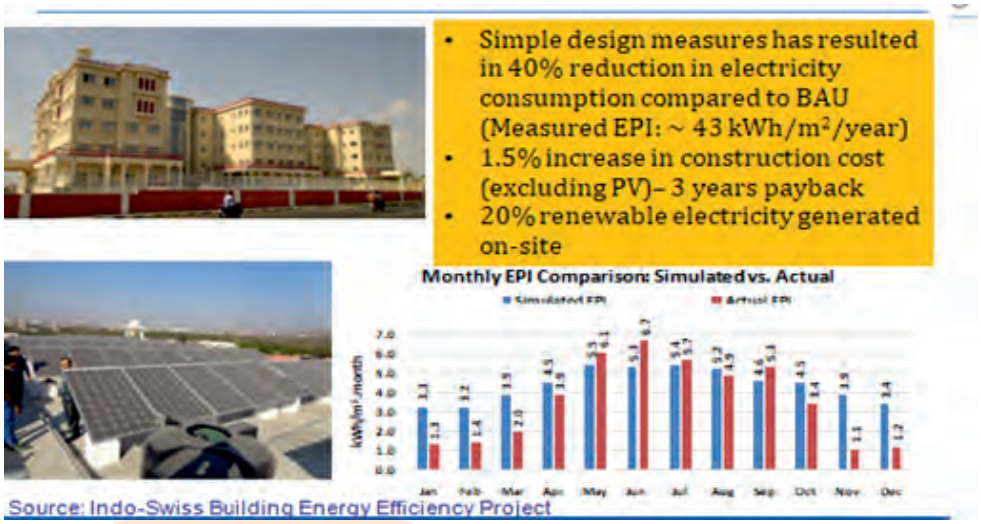


Fig. 2: Public Office Building Jaipur

The other example is that of Infosys building (Fig. 3)

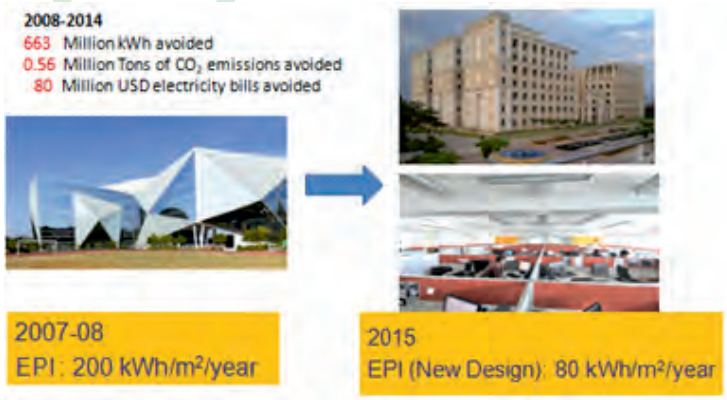


Fig. 3: Infosys Building of 2007 and 2015

3. Building Envelope Design.

Fig. 4 shows the percentage of heat gains through various building components, namely, walls, windows and roofs. The higher is the glass area (high WWR), larger is the heat gain.

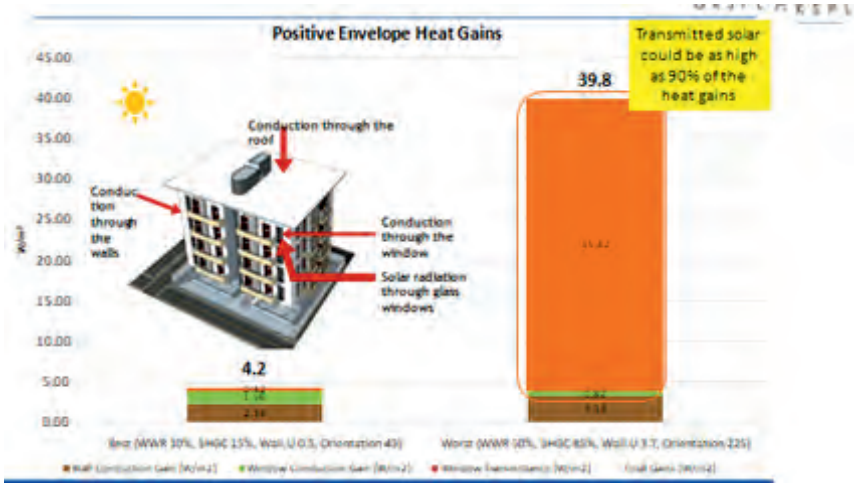


Fig. 4 : Heat Gains through Different Building Components

The transmission heat gains can be reduced considerably by moving external moving shade for windows (Fig.5).

Fig. 5: Movable Shades Over Buildings

A natural wind ventilation tower has been provided in the PMAY housing project at Rajkot (Fig.6).

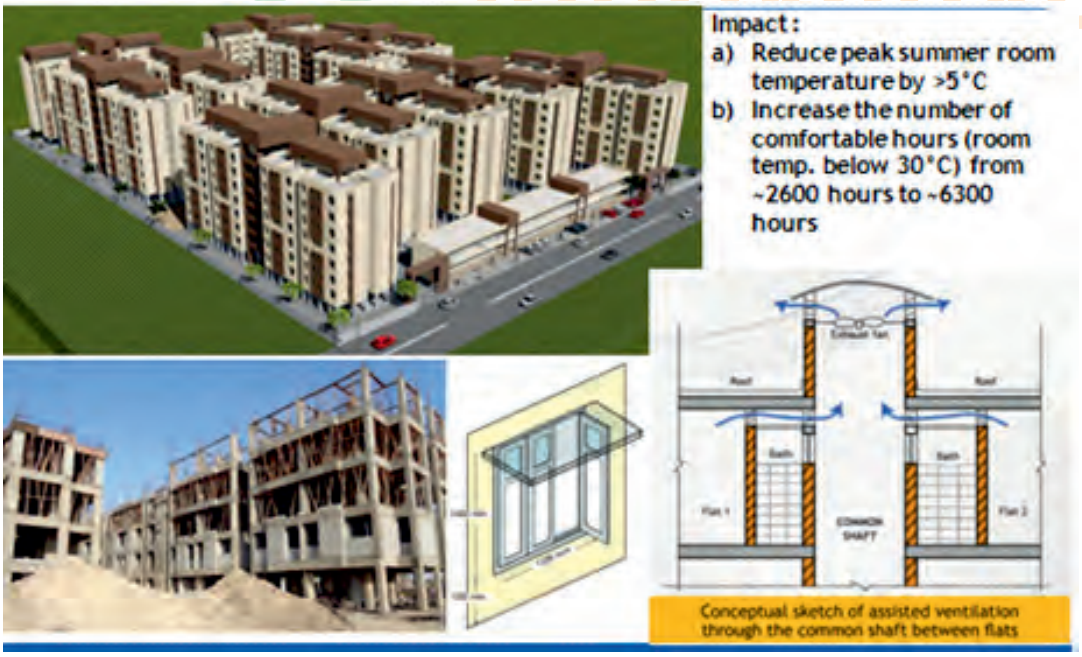


Fig. 6: PMAY Housing Project at Rajkot: Wind Tower driven Ventilation

This reduces the peak summer temperature by more than 5oC and increase the number of comfortable hours (room temperature below 30oC) from 2600 to 6300.

4. Embodied Energy

Besides operation energy for heating, cooling and other day-to-day activities, building has embodied energy due to the energy consumed in the processes involved in maturating building materials and subsequently their use in buildings. The results of a detailed study for embodied energy are given in Fig.7.

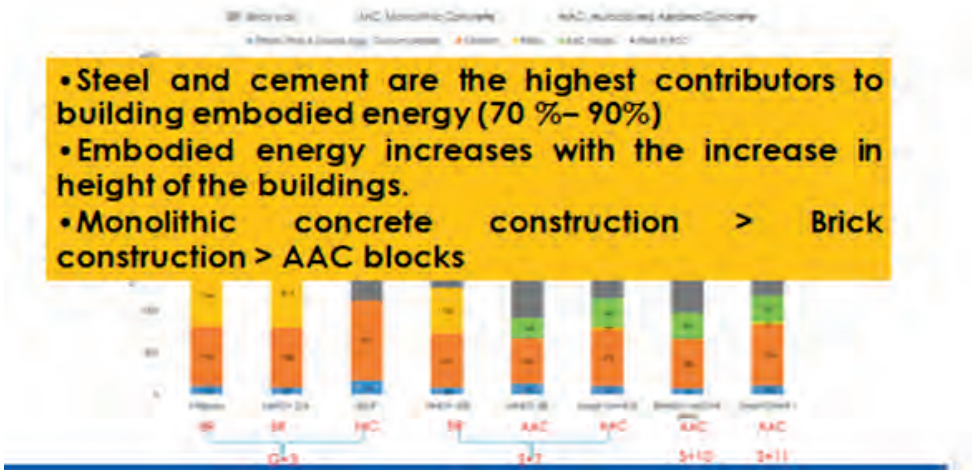


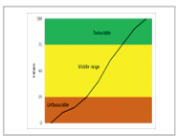
Fig. 7: Embodied Energy for Affordable Housing Rajkot

It is observed that steel and cement are the highest contributors to building embodied energy (70%-90%). Embodied energy also increases with increase in height of a building. Also monolithic concrete construction has more embodied energy than brick construction. The autoclave aerated concrete blocks require less energy than the corresponding brick works.

A project of low rise affordable housing in Bawana (Delhi) shows that it possible to reduce the steel consumption in buildings by 65-70%. The use of cement is reduced by 40% and up to 50% reduction in clay use for brick prodcuti0on. The buildings have been provided with window shades and thermal mass. They have no lifts and hence the maintenance costs are very low. One can use hollow clay bricks that can be fired in normal kilns to save clay (40-50%), coal (30-60%) and emission of carbon (50-80%) providing better insulation in walls and fast construction. There is a need to regional approach to resource efficient building materials. Some resource efficient parameters of building materials are given in Table 1.

Resource Efficiency Parameters

Parameters	Mined Raw Material	Utilization of waste materials	Primary Energy - manufacturing	CO_2 emission - manufacturing	PM emission - manufacturing	Thermal Conductivity
Units	Kg/m³	%	MJ/m³	t CO_2/m³	gm/m³	W/m-K
Solid burnt clay-FCBTK (Baseline)	1760	0%	2080	0.19	1888	0.52-0.85
Solid burnt clay flyash - FCBTK	1619	8%	1872	0.17	1888	0.52-0.85
Solid burnt clay-Zigzag kiln	1760	0%	1680	0.15	368	0.52-0.85
Perforated burnt clay - Zigzag Kiln	1584	0%	1512	0.14	331	0.50-0.68
Hollow clay blocks - Tunnel Kiln	815	0%	1275	0.12	178	0.17-0.2
Autoclaved Aerated Concrete blocks	224	75%	1276	0.14	151	0.13-0.20
Cellular Light Weight Concrete	338	67%	1003	0.15	210	0.13-0.15
Pulverized Fuel Ash-Lime bricks	450	70%	1025	0.08	83	0.54-0.70
Pulverized Fuel Ash-Cement bricks	711	55%	811	0.12	161	0.54-0.70
Solid Concrete blocks	2153	0%	774	0.12	167	1.0-1.9
Hollow Concrete blocks	1615	0%	581	0.09	125	0.7-0.9
Compressed Stabilized Earth Blocks	1976	0%	653	0.10	139	0.46-0.93
C&D waste bricks	540	75%	1533	0.24	327	1.0-1.9



Chapter 6 : Air Pollution in Indian Cities

Gazala Habib.

1. Introduction.

Most of the Indian cities have highly polluted air far exceeding WHO and NAAQ standards as reported by the Greenpeace. Besides average high concentration of particulate matter, there has been seasonal increase in the same in cities like Delhi, Kanpur, Hyderabad, Raipur, and Mumbai. Considerable contribution to the PM comes from vehicular exhaust, road dust, biomass burning, industry smoke and power generation from coal. The studies are however, based on limited data set of water soluble ions, trace elements and sometimes elemental and organic carbon. The studies conducted are area specific and don't represent the overall pollution of the cities. The selection and set up of monitoring site may also influence the result. Fig. 1 shows that the contribution to pollution varies with space and time in any of the places.

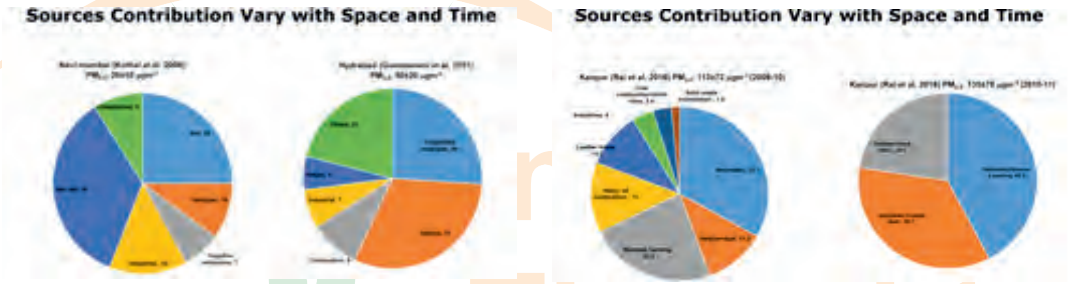


Fig. 1 : Pollutants levels vary with space and time

2. Air pollution and its effect.

The pollutants, which are caused by multiple complex chemical reactions, impact human health severely on one hand; it is a source of global warming on the other. For Delhi inhabitants, the particulate matter in the air is of serious concern. At IIT Delhi, we have initiated detailed measurements of air pollutants (Fig.2) and used gravimetric as well as chemical characterization of the pollutants.

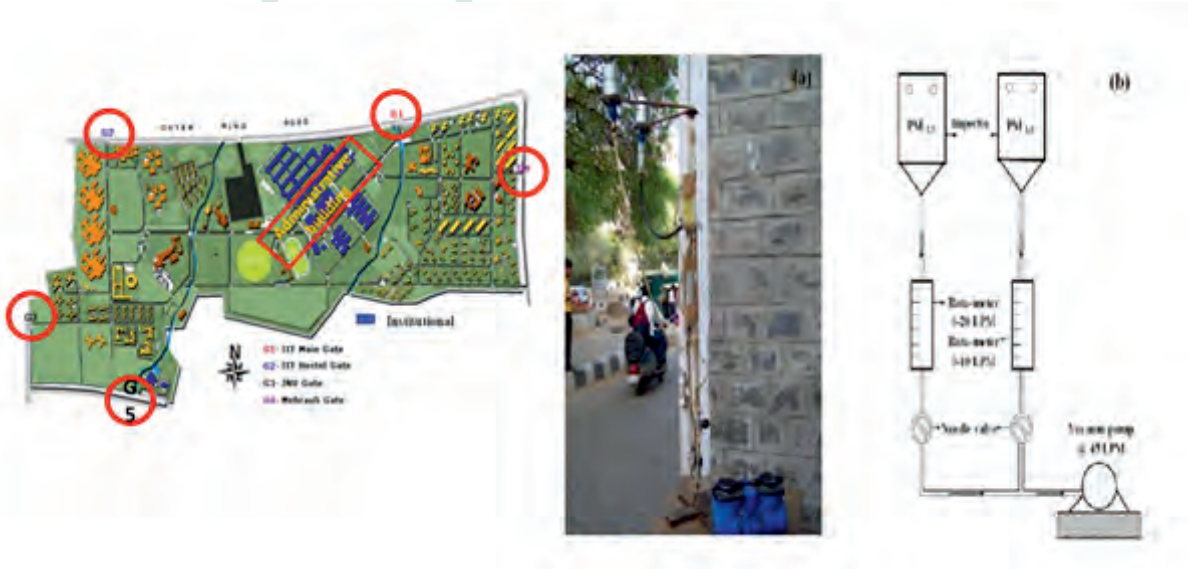


Fig. 2: Sampling Site and Method

The PM1.0 concentrations at the road level and at an elevated site are shown in Fig.3 at various hours of the day and night.

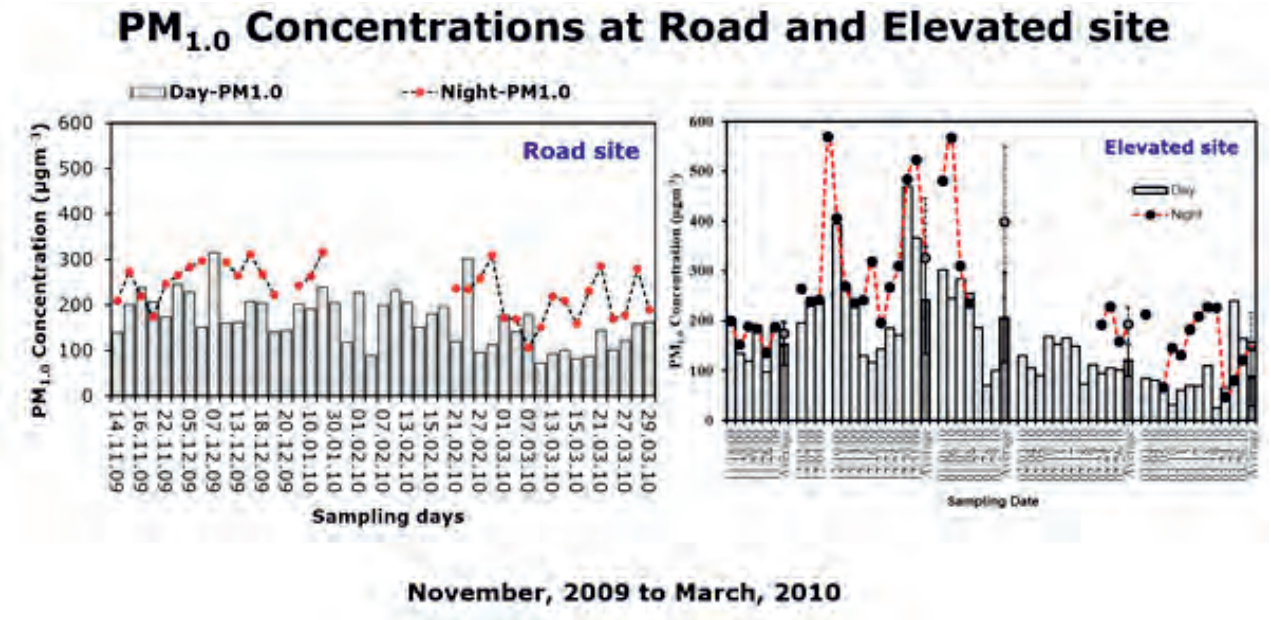


Fig. 3: PM 1.0 Concentration

The meteorology parameters, namely, temperature and relative humidity along with SO4 and NO3 concentrations are plotted in Fig.4.

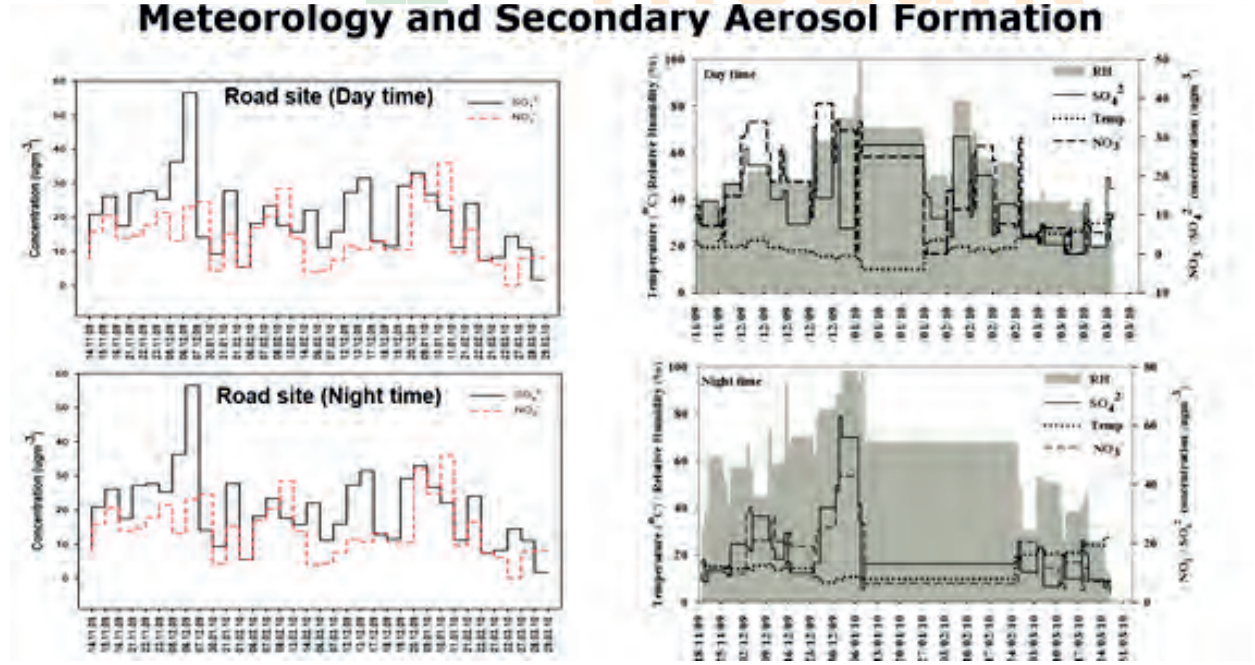


Fig. 4: Measured Meteorology and Aerosol Parameters

Fig.5 shows the concentrations of trace metals again at the road level as well as on an elevated site.

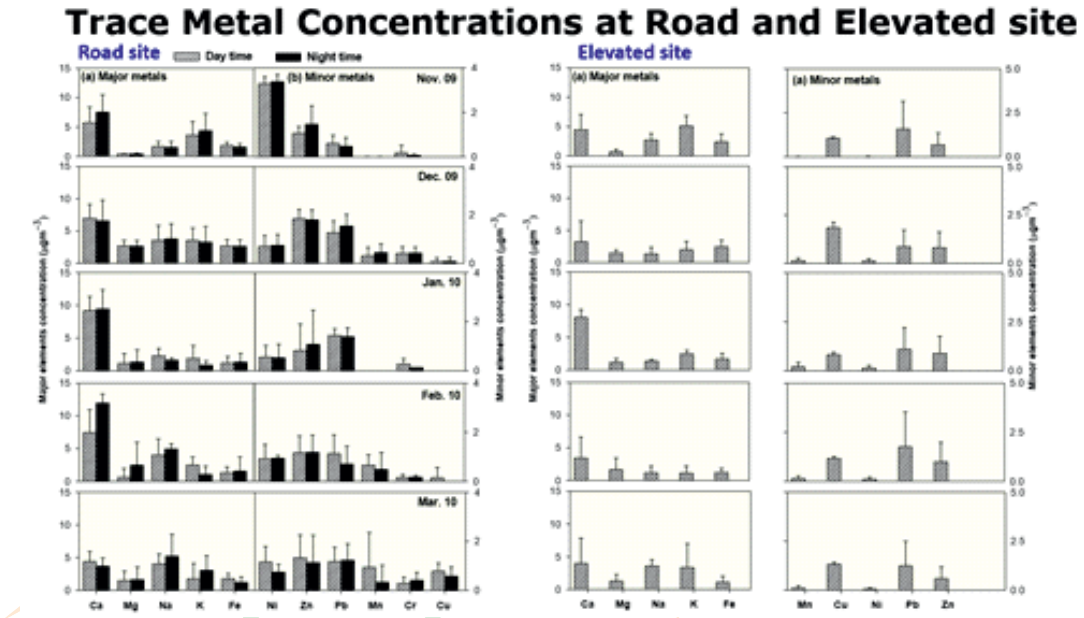


Fig. 5: Trace Metal Concentration at Road and an Elevated Level

3. Sources of air pollutants & Risk.

Various pollutants at the road level and at the elevated level are sketched in Fig.6. Secondary aerosols are the dominating sources of pollutants both at the road site as well as at the elevated site.

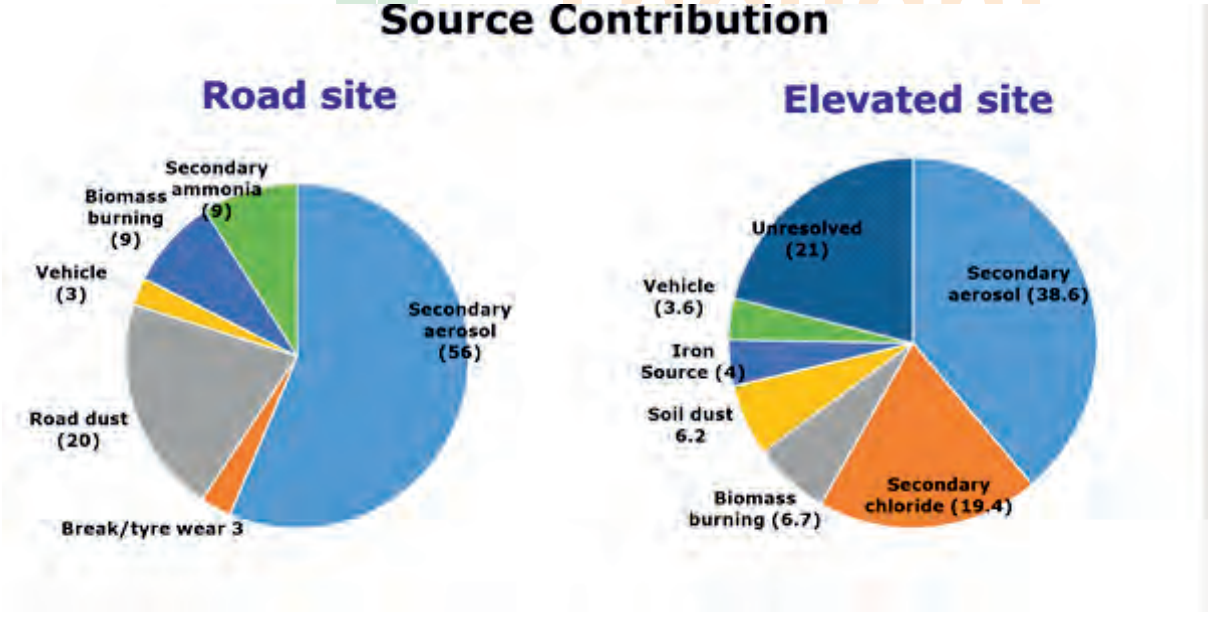


Fig.6: Causes of Pollutants and Secondary Level Aerosols at Road and Elevated Sites

The potential risk estimation can be assessed by the following equation.

$$ECR = \frac{C \times ET \times EF \times ED \times IUR}{AT}$$

Where C = average concentration of element species (µgm-3)

ET= exposure time (12 h day^{-1}), EF is the exposure frequency (days year^{-1})

ED = exposure duration average time, 24 years,

AT = average time for carcinogen (70years×365days×24hday^{-1}).

IUR = Inhalation Unit Risk (µg/m3)$^{-1}$of the element, obtained from the USEPA database, Integrated Information Risk System (https://www.epa.gov/iris)

The total ECR values at the road site as well as at the elevated site are shown in Fig.7.

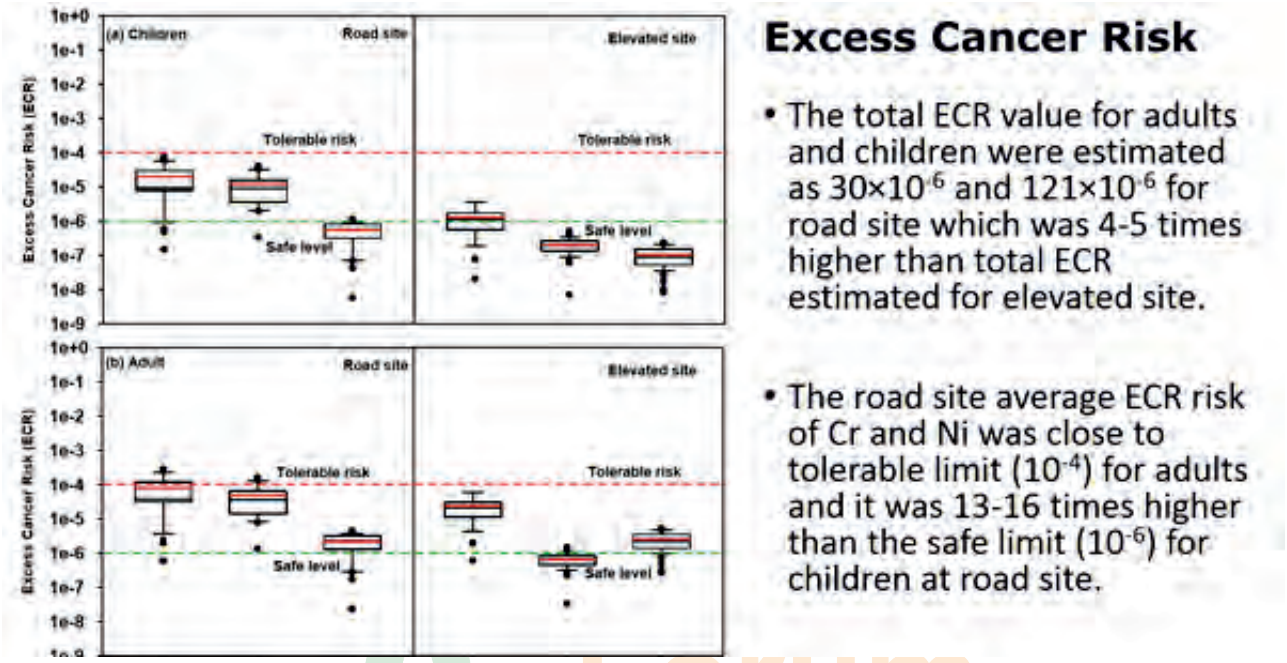


Fig. 7: Total ECR Values at Road and Elevated Sites

The total ECR value for adults and children are estimated as 30 x 10-6 and 121 x 10-6 respectively for road side, which is 4-5 time higher than total ECR estimates for elevated site.

The road side average ECR risk of Cr and Ni was close to tolerable limit (10-4) for adults and it was 13-16 times higher than the safe limit (10-6) for children at road side.

4. Road side ultrafine and fine particulates and cardiovascular disease

In the developed countries, the fine and ultrafine particles were associated with arrhythmia and Ischemia through measurements of blood pressure and heart rate variability. In India, many studies have reported links between aerosols and respiratory illness. The exposure to biomass exhaust has found to result in cardiac illness. So far nobody has focussed on ambient concentration of ultrafine (1-100nm) and fine aerosols (100-2500 nm) with cardiac risk. It has been reported that Indians are more prone to cardiac vascular diseases than any other ethnic group due to smaller coronary arteries.

5. IIT Studies: Effect of PMs on human health

A methodology, in analogy with the American Thoracic Society and Australia Division of Health World Limited was used to correlate the effect of particulate matters on human health. The methodology is given in Fig. 8.

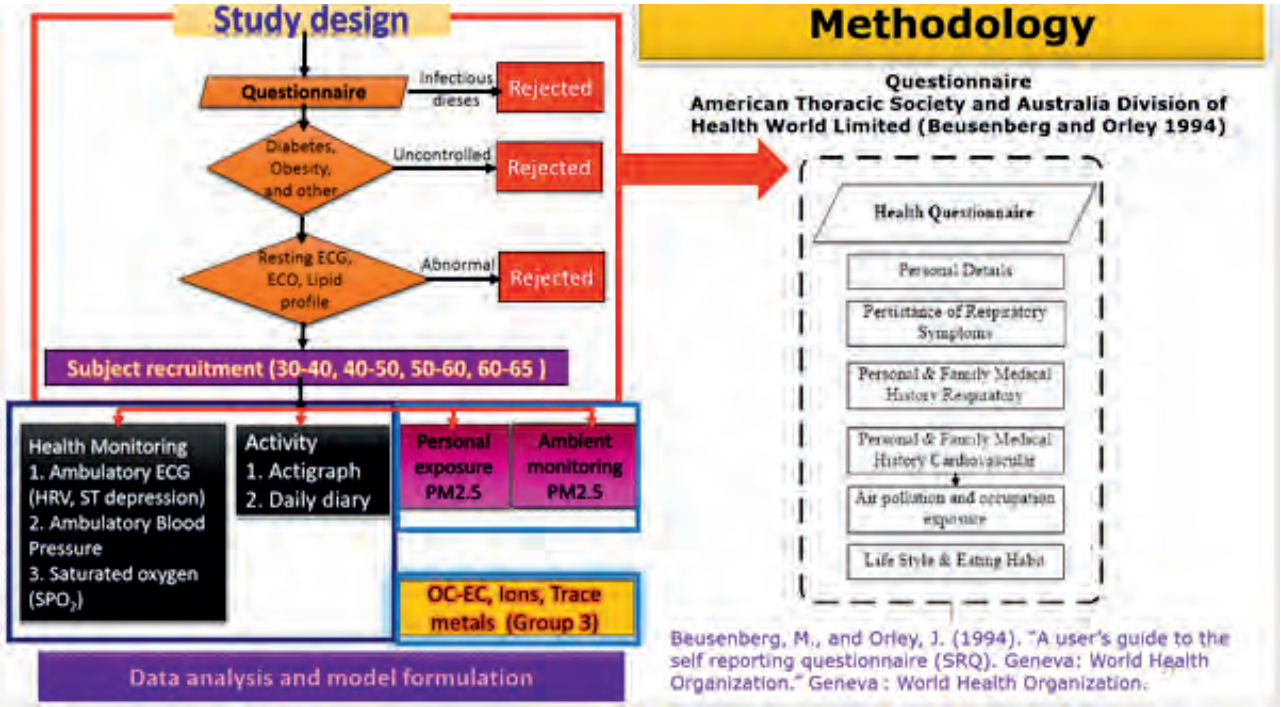


Fig. 8 : Methodology for Studying The Effect of PMS on Human Heallth

The sampling locations were confined to 5 campus gates of IIT Delhi. The aerosol monitory tools were Mini-wide range Aerosol spectrometer and 4-stage personal cascade impactor. The health parameters were ECG halter system, BP monitor and a pulse oximeter. The sampling was done from July 2016 to August 2017. The subjects age varied between 20-45 years with a total number of 62 (3 subjects per week) and 120 samples were collected for the PMs. The characteristic parameters of participants are given in Table 1.

Table 1: Characteristics of Participants

Total Subjects	**62**	
Age	Mean	31±7 (18-43)
Sex, n (%)	Male	62 (100)
Civil Status, n (%)	Single/Married	21 (34)/41 (66)
Occupation, n (%)	Security Guards	62 (100)
Height (cm)	Mean±SD	167±8
Body Mass Index (BMI) kgm^{-2}	Mean±SD	24±4 (not obese)
Pulse rate (beats/min)	Mean±SD	79±9
sPO2 (%)	Mean±SD	98.4±0.7
Blood Pressure (sys/dia)	Mean±SD	129±16/82±12
Respiratory Disease, n (%)	Yes/No	1 (2)/61 (98)
CVD, n (%)	Yes/No	0 (0)/62(100)
Family history of Respiratory illness, n (%)	Yes/No	5 (8)/57 (92)
Air Pollution Exposure, n (%)	outdoor	62 (100)
Smoking (Active) Habits, n (%)	Non Smoker/Ex-Smoker	45 (73)/17 (27)
Smoking (Passive), n (%)	Exposed/Not Exposed	26 (42)/ 36 (58)
Alcohol Drinking Habits, n (%)	No/ Rarely	43(69)/19(31)

The PM2.5 concentration from July 2016 to Dec. 2016 is shown in Fig.9.

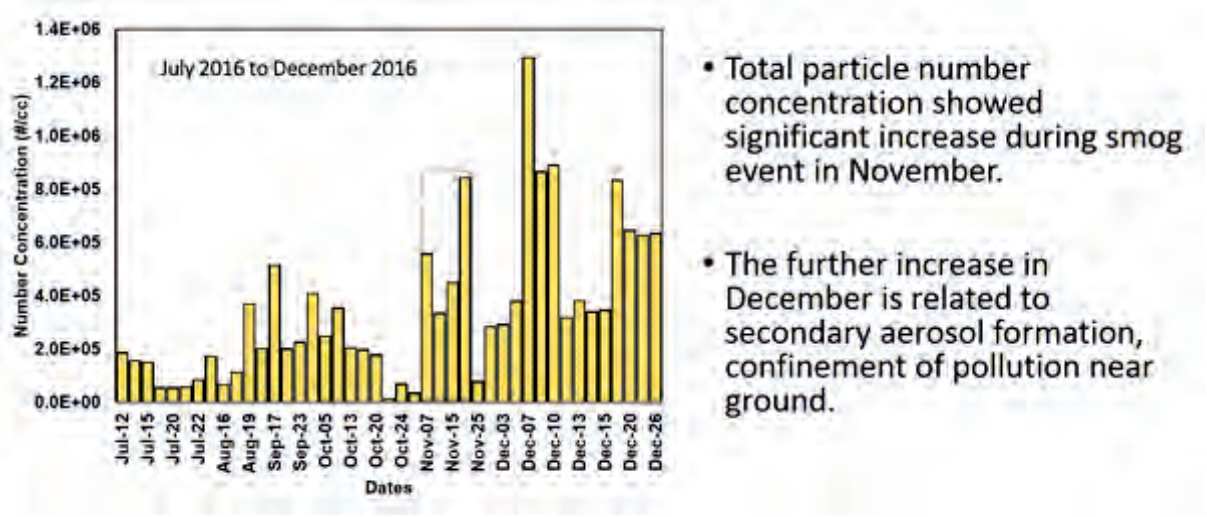


Fig. 9: Measured PM 2.5 concentration

The personal expose mass concentration for the same period is given in Fig. 10

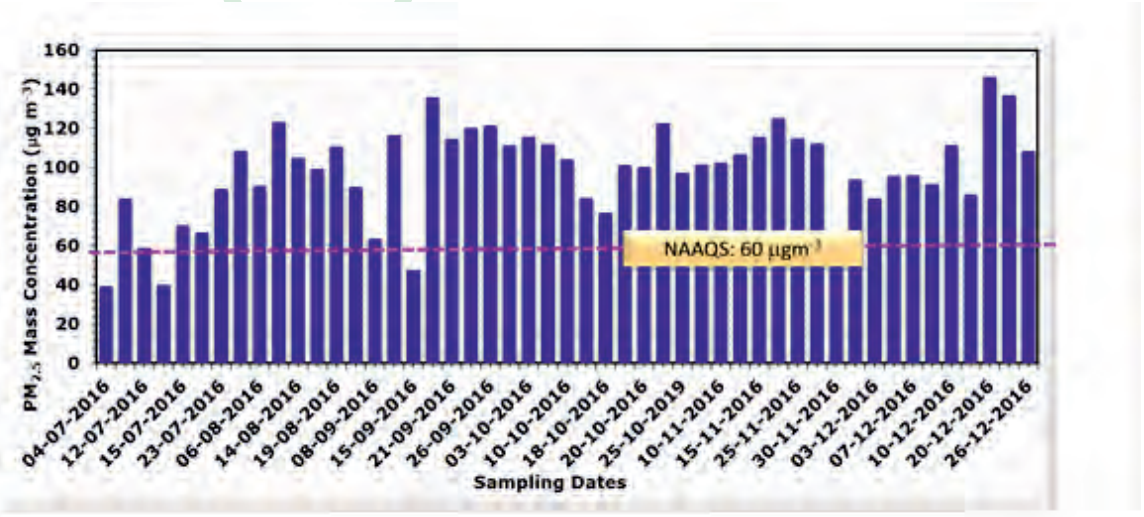


Fig. 10: Personal Exposure Mass Concentration

The measured standard deviation of normal to normal beat and PM concentration is shown in Fig. 11.

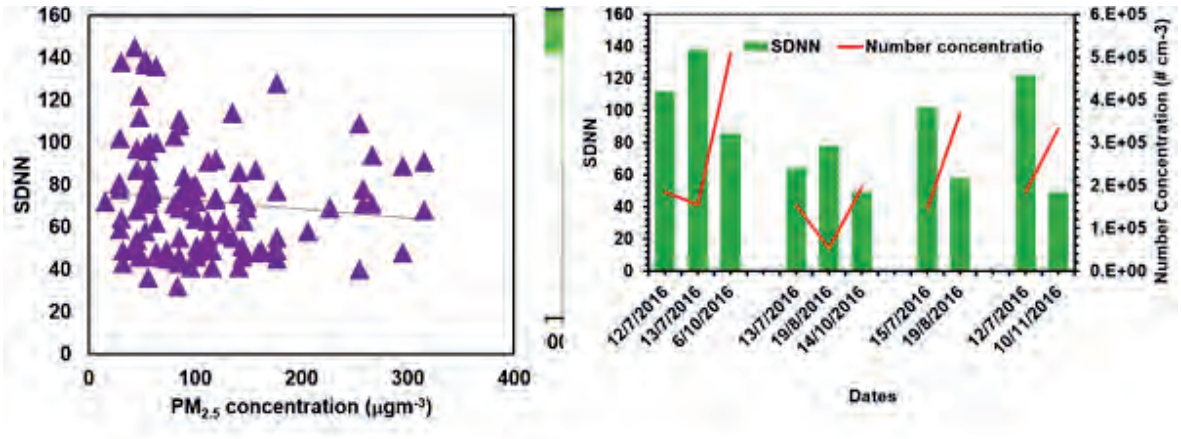


Fig. 11: Standard Deviation of Normal to Normal Beat Concentration

The low to high frequency ratio and PM2.5 concentration are plotted in Fig.12.

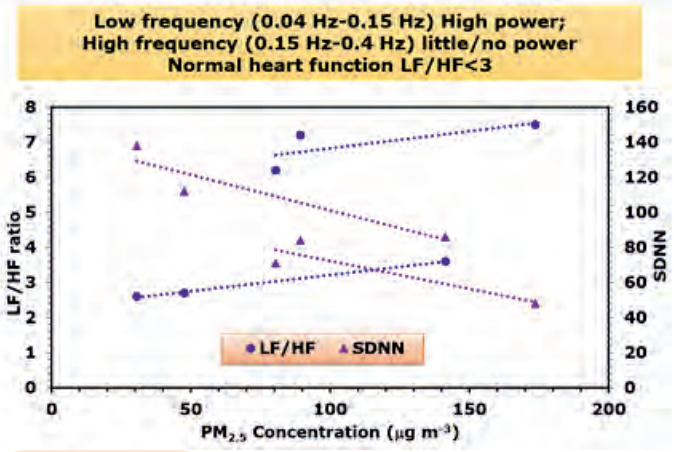


Fig. 12: Low to High Frequency ratio and PM 2.5 Concentration

The odd ratio of ECG parameters with respect to threshold PM concentration is plotted in Fig.13.

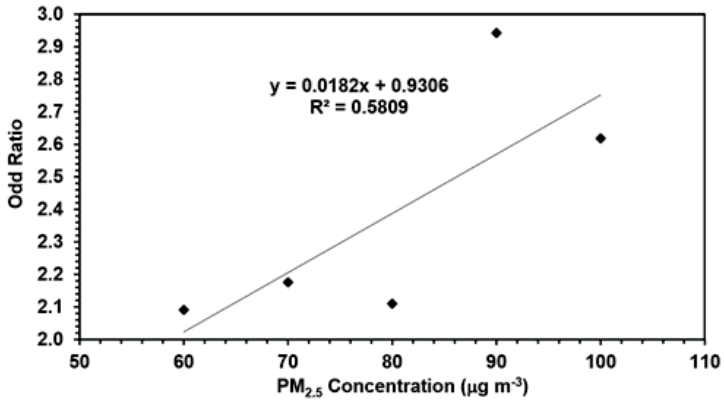


Fig.13: Odd ratio of ECG parameters with respect to threshold PM concentration

5. Fine PM from light Duty Vehicles.

A portable dilution tunnel was designed (Fig.14) to measure find PM2.5

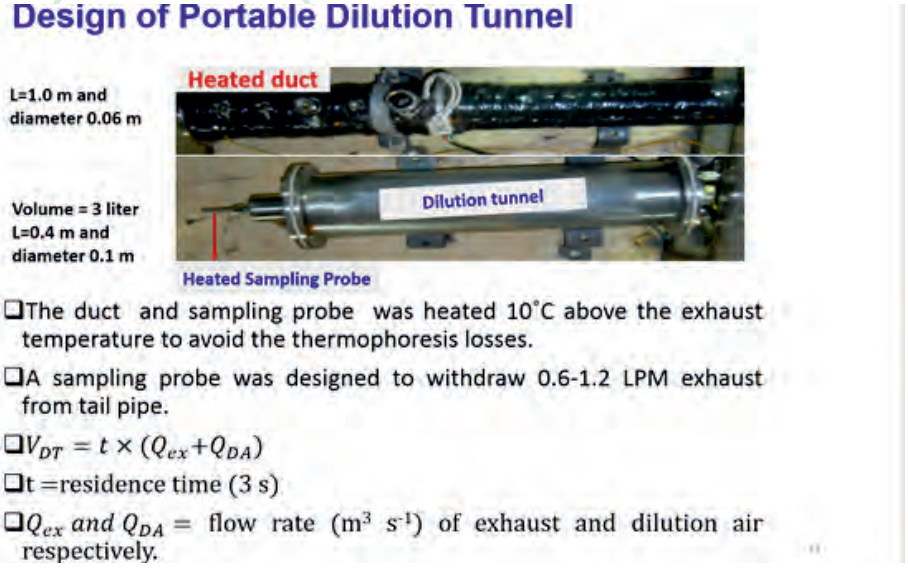


Fig.14: Design of Portable Design Tunnel

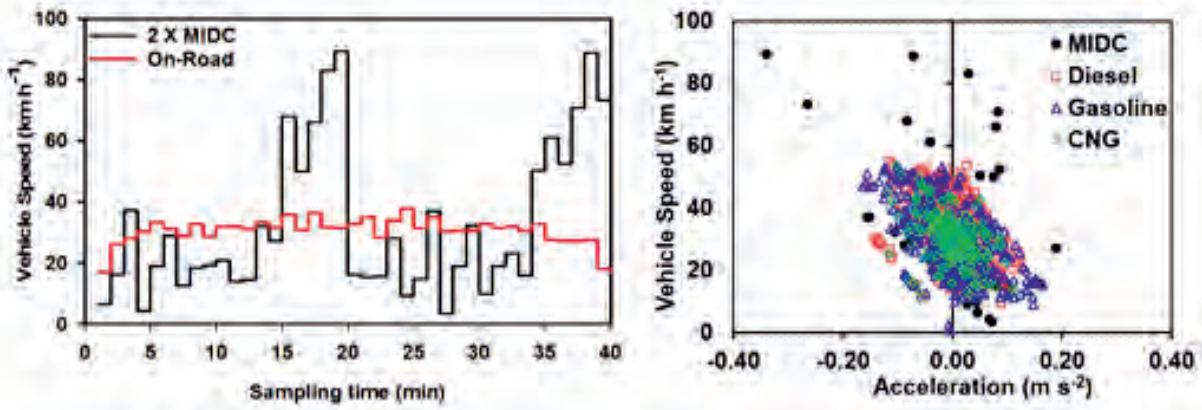
The characteristics of selected vehicle s for measurements are given in Table 2.

Characteristics of Selected Vehicles for On-road Emission Measurement

Vehicle Model	Bharat Stage Norms	Year	Engine Technology	After-treatment devices	Engine Capacity (Liter)	Odometer Reading (km)	Exhaust Temp. (°C)	Temp. (°C) at end of dilution tunnel	Dilution ratio
4W-Diesel									
Innova (N=3)	BS-II	2004	CRDI	EGR[a]	2.4	185032	80 ± 4	39 ± 3	52 ± 9
Indica (N=4)	BS-III	2007	CI	EGR	1.4	86384	79 ± 10	36 ± 7	47 ± 6
Swift Dzire (N=3)	BS-IV	2012	CRDI	EGR+DOC	1.2	128454	80 ± 3	32 ± 6	51 ± 6
Ertiga (N=6)	BS-IV	2014	CRDI	EGR+DOC	1.3	33127	77 ± 4	36 ± 2	52 ± 7
4W-Gasoline									
Zen (N=3)	BS-II	2001	SI	TWC+EGR	1.0	127294	80 ± 3	36 ± 3	57 ± 3
Swift Dzire (N=3)	BS-III	2008	MPFI	TWC+EGR[b]	1.2	85454	79 ± 5	42 ± 2	69 ± 2
i10 (N=3)	BS-IV	2010	MPFI	TWC+EGR[c]	1.2	46550	79 ± 12	39 ± 7	69 ± 1
4W-CNG									
Optra (N=3)	BS-III	2006	SI	TWC+EGR	1.2	114944	82 ± 10	42 ± 3	61 ± 1
i10 (N=3)	BS-IV	2010	MPFI	TWC+EGR[c]	1.2	46956	70 ± 10	31 ± 1	65 ± 2
3W-CNG*									
Bajaj (N=3)	BS-II	2008	SI	Carburetor+TWC	0.8	48543	65 ± 3	34 ± 1	43 ± 5
Bajaj (N=3)	BS-III	2015	MPFI	Carburetor+TWC	0.8	14817	61 ± 2	31 ± 1	46 ± 4
2W-Gasoline*									
Caliber (N=3)	BS-I	2001	SI	Carburetor	0.12	47709	66 ± 6	33 ± 2	57 ± 3
Activa (N=3)	BS-II	2009	SI	Carburetor+TWC	0.12	28543	69 ± 4	31 ± 1	44 ± 1
Activa (N=3)	BS-III	2014	SI	Carburetor+TWC	0.12	2973	67 ± 5	34 ± 2	42 ± 2

Note: **N**= Set of experiments; **CNG**=Compressed Natural Gas; * For 2W and 3Ws, AEMS was used at no-load and free wheeled on jack, followed MIDC (modified Indian driving cycle) and run at idle, 20 km/h, 30 km/h and 40km/h. Total sampling time was 36 min for every experiment and each cycle was repeated after every 6 minutes, **BS**=Bharat Stage; **EGR**=Exhaust Gas Recirculation; **TC** = Turbocharger; **DOC** = Diesel Oxidation catalyst; **TWC** = Three way catalytic convertor, [a]**EGR** with cooler for diesel vehicle, [b]**TWC+EGR** with oxygen sensor heating capabilities for cold-start operation, [c]**TWC+EGR** with coupler catalyst

The driving profile is as given in Fig. 15.



- MIDC is similar to New European Driving cycle (NEDC) which is used in Europe and some other countries.
- The NEDC has also been criticized for unrepresentative of real world driving pattern because it comprised of very soft acceleration, considerable run on constant speed cruise, and a lot of idling events (Alves et al. 2015a; Fontaras et al. 2008).

Fig. 15: Driving Profiles of the Vehicles

The measured concentration of PM2.5 EC and OC is given in Fig. 16 and those of

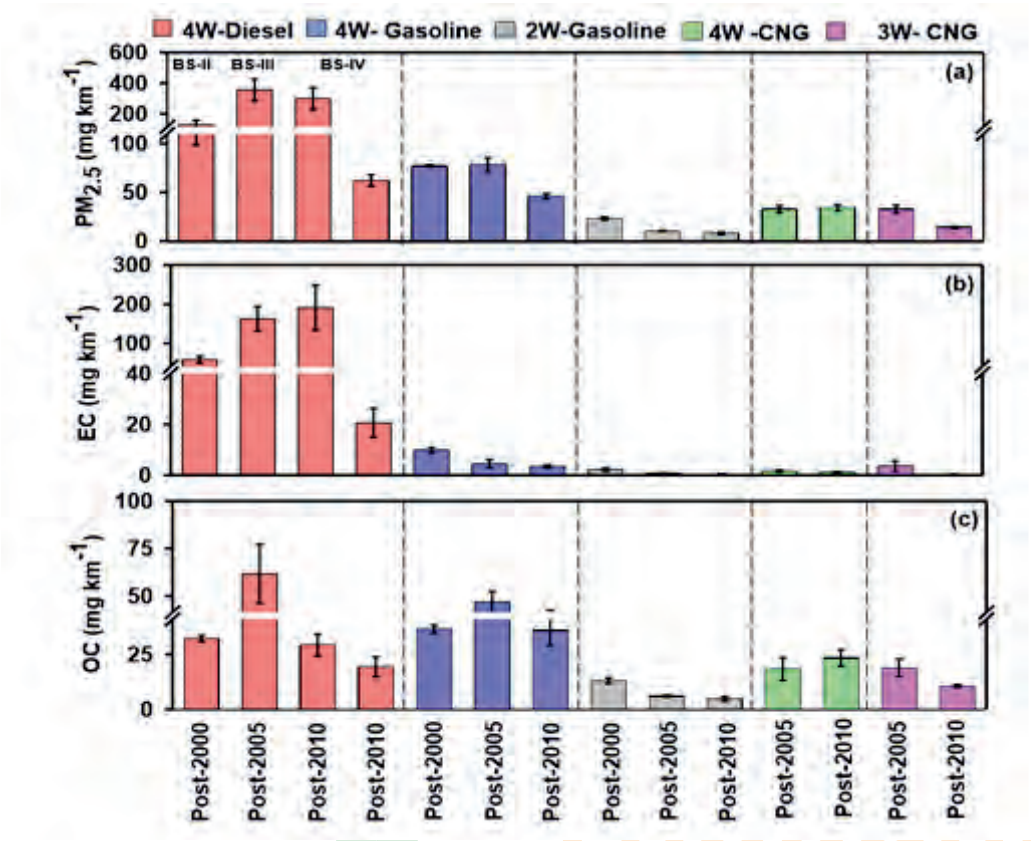


Fig. 16: Measured Emission Factors ofPM 2.5, EC and OC

CO, CO2 and Nox in Fig. 17.

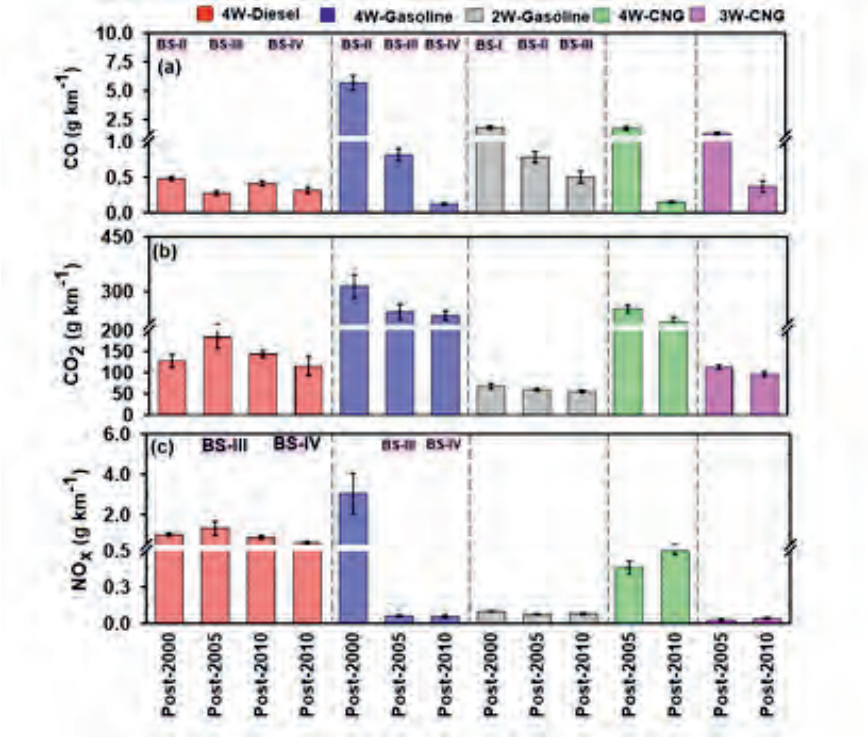


Fig 17: Emission Factors of CO, Co2 and NOx

The emissions were estimated buy the following expressions:

Total emissions (Ggy-1) $\boldsymbol{Ep,a,k}=\sum_k \boldsymbol{F_{k,a}}\times\boldsymbol{EFp,a,k}$,

Where EF is the **Fuel based emission factor**

EF= F(g/Km)x Vehicle mileage(Km/l)/ Fuel density(Kg/l)

and the fuel consumption

$$F = \sum_k N_k \times V_k \times F_d / F_{ek}$$

N_k = on road vehicular population.
V_k = Litre capacity of vehicle use of fuel K
F_d = Distance travelled.
F_{ek} = Vehicular mileage.

6. Results.

The spatial distribution of aerosols due to vehicles in India is given in Fig.18

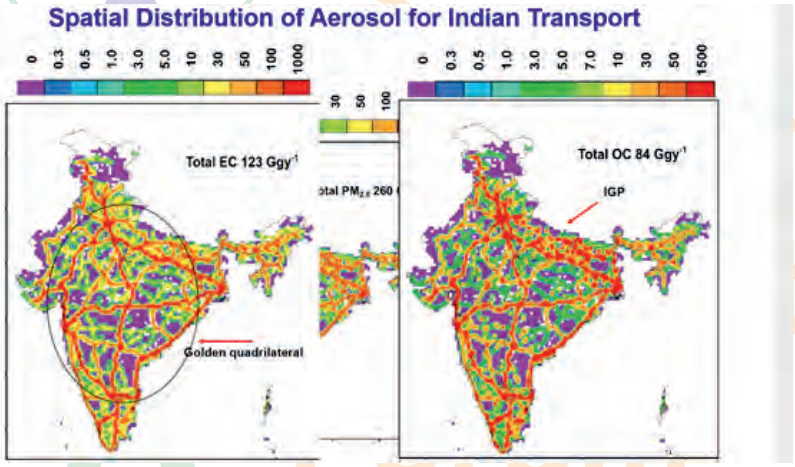


Fig. 18: Spatial Distribution of Aerosols In India

and those of Co_1, Co_2 & No_x in Fig. 19

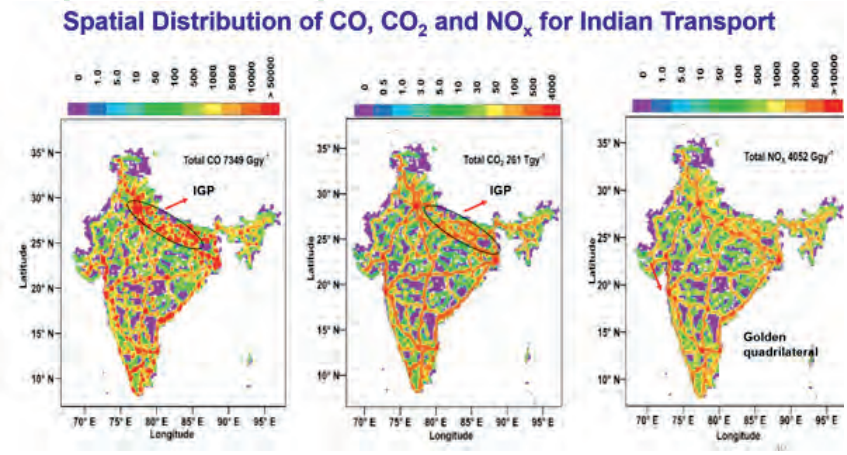


Fig.19: Spatial Distribution of CO, CO2 and NOx in India

It is observed that the concentration of PM2.5 was Gg/a in the year 2013, where as the emitted carbon (EC) was Gg/a and the OC 84 Gg/a. The PM2.5 is more due to diesel vehicles, whereas OC was higher for the gasoline vehicles.

Chapter 7 : Climate Change Actions in Gujarat: Perspective and Progress.

Swetal Shah.

1. Vision of Government of Gujarat.

Considering the effects of climate change, the government of Gujarat has created a department to act as a bridge with in various ministries in the government and between the government and society for addressing climate change issues. The department is supposed to work enabling low carbon pathway for Gujarat's economic growth that would meet people's aspiration with equity and inclusiveness. The mandate of the department are (1) co-ordination at both the state and national level for policy support, (2) encourage R&D on climate change, (3) maximise use of green technology, (4) evolve new strategies for environmental conservation, (5) education, awareness and capacity building and (6) promulgate policies for renewable sources of energy. The strategies of the state government include mobilizing private investment and to facilitate peoples' participation. The government intends to generate strategic knowledge for informed decision making.

2. Adaptation and Mitigation

The action plan of Gujarat state is in synchronization with National Action Plan (NAPCC) as well as to facilitate self initiatives. The later include the establishment of Asia's first and largest solar park at Charanka, India's largest natural gas grid and India's largest water grid infrastructure. The RE policy of Gujarat in accordance with natural policies are:

- Solar Power Policy 2015.
- Wind Power Policy 2016.
- Waste to Energy Policy 2016.
- Small Hydro Policy 2016.
- Bio-energy Tariff 2016.

3. Action Plan.

Nine major sectors have been selected for state action plan on climate change. These sectors are agriculture, water, health, forests, sea-level and coastal infrastructure, energy efficiency and renewable energy, urban development, vulnerable communities, and green jobs. In each of these sectors, priorities have been given as follows:

Agriculture:

> Impact assessment at different levels of food system.

> Agriculture risk management.

> Building resistance in ago-ecosystem.

Water:

> Use of low carbon and less intensive technologies.

> Inter-basin water transfers.

> Strengthening community level institutions

> Recycling of water.

Health:

> Epidemic early warning systems

> Climate proofing of health infrastructure

> Heat stress management.

> Vector control activities and vector borne disease mapping.

Forest:

> Enhance carbon sequestrian potential

> Energy plantation and fodder banks

> Greening Gujarat: Focus on social forestry.

Sea level rise & coastal infra:

> Sea land studies.

> Coastal infrastructure; Risk assessment and protecting.

> Renewable energy systems in ports & shipyards.

Energy Efficiency & Renewable Energy:

> Promote private investments in renewable sector.

> Energy audits of power plants, renovation and modernization of low performance power plants.

> Promote use of green technologies,

> Comprehensive utilization of Solar potential.

Urban Development:

> Promote green buildings.

> Promote energy efficiency & water conservation in cities.

> Solid waste management.

> GHG emission inventory.

Vulnerable Communities:

> Create climate change safeguards for women, landless labour, and marginal workers, tribal and other vulnerable communities.

Green Jobs:

Promotion and R & D of green technologies, so that they become new economic drivers for charity employment opportunities. The government of Gujarat had allocated Rs.2116.33 crores for the year 20016-17 and enhanced it to Rs.5121.16 crores for the year 2017-18.

4. Salient Features of Renewable Power Policy.

The present installed solar power capacity in the state is 1267 MW and it is likely to grow four times in the next financial year. The scheme is operative up to March 2020 and all plants covered under GBI will continue to get benefits up to 25 years. The electricity generated from the plants will be exempted from electrical duty. The consumer can retain the benefits under CDM. The charges for transmission and wheeling will be one same terms as for an open access consumer.

The wind power policy of the state was revised in the year 2016 and it will be valid for five years (up to 2021). The wind power purchase rate has been fixed at Rs.4.15/kWh; however it is being revised. The government has reserved the waste land for wind power projects at the lease rate of Rs.10000 per hectare. The present installed wind capacity is 5318 MW.

All the renewable power generation namely, solar, wind, mini-hydro and waste to energy have the identical benefits as for solar power, except for the fact that only for wind the rate has been fixed; while for all others, the electricity tariffs will be based on competitive bids to be invited by Power purchaser Board on a generic tariff to be decided by the Gujarat Electricity Regulatory Commission (GERC).

In the residential sector, any solar capacity is allowed irrespective of the sanctioned load. A bi-directional meter will be installed in all solar homes to measure the net power consumer by the home users. Banking of energy will be for one billing cycle and there will be no wheeling or transmission charges. The Renewable Purchase Obligation (RPO) will be credited to the concerned DISCOM. A line diagram for net metering is given in Fig. 1.

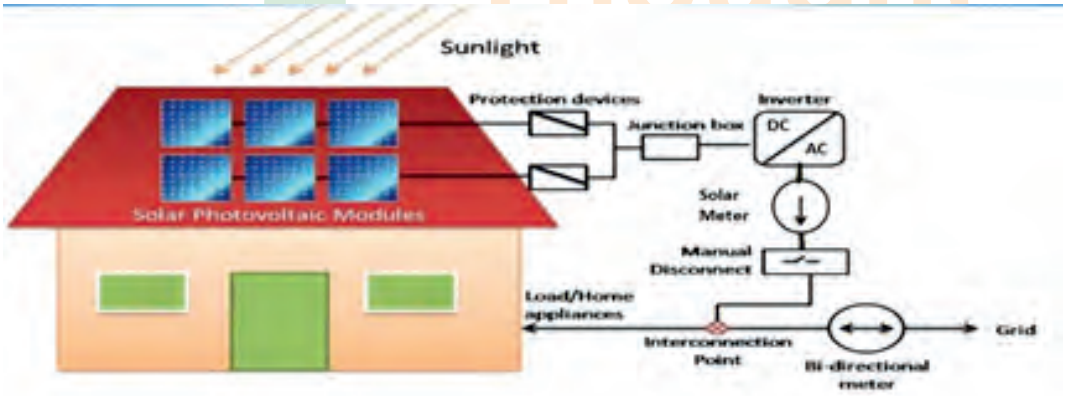


Fig.1: Line Diagram of Net Metering

The government of Gujarat provides a subsidy of Rs.10000/KW, subject to a maximum cost for Solar PV installation, which has been fixed at Rs.69000/kW. This cost includes the cost of SPV panels, inverter, meter, installation & commissioning inclusive of five years CMC & boxes etc. The connectivity charges to the grid are Rs.1500 per application. The ministry of New and Renewable Energy of the GOI provides 30% subsidy to all solar roof projects without any capacity. For Gujarat, the Central Financial Assistance (CPA) has been provided for installations up to 50 MW in the state. There are 110 MNRE channel partners, who have agreed to provide solar roof top PV system at the fixed maximum cost, i.e Rs.69000/KW.

5. Waste to Energy.

In order to support Mahatma Gandhi Swachchata Mission, the Government of Gujarat has provided several incentives for implementation of MSWM rules scientifically and to create competitive and feasible waste to energy production. A provision has been made to provide Rs.3crores for viability gap funding of waste to energy project. The projects on WTE tend to find out best practices and feasible technologies for MSW in the Indian conditions.

6. Small Grants Programme (Laghu Sahay Yojna)

In order to support individuals and grass root level initiatives for climate change and adaption, the GOG has provide the following incentives to projects costing less than Rs.10.00 lakhs.

- Subsidy of 30% of total project cost or Rs.2.5 lakhs whichever is less.
- Provision of Rs.2.5 crores for 2017-18 financial year.
- Conveyance with other Govt. schemes possible.
- 15 major areas of cross-cutting subjects have been identified
- Environment to traditional practices, local innovation, conservation of natural resources.

7. Subsidy to battery operated two wheelers.

The State Government provided subsidy for battery operated two wheelers to school and college students from class 9th onwards. A subsidy of Rs.10,000 per vehicle is provide irrespective of the model. The prices of vehicles range from Rs.25000 to Rs.50000. The scheme is operable presently in 5 cities namely, Ahmadabad, Vadodra, Surat, Rajkot and Gandhinagar.

8. Institutional Arrangements for Gujarat SAPCC.

The institutional arrangement of the State Action Plan for climate change in Gujarat is explained in Fig.2.

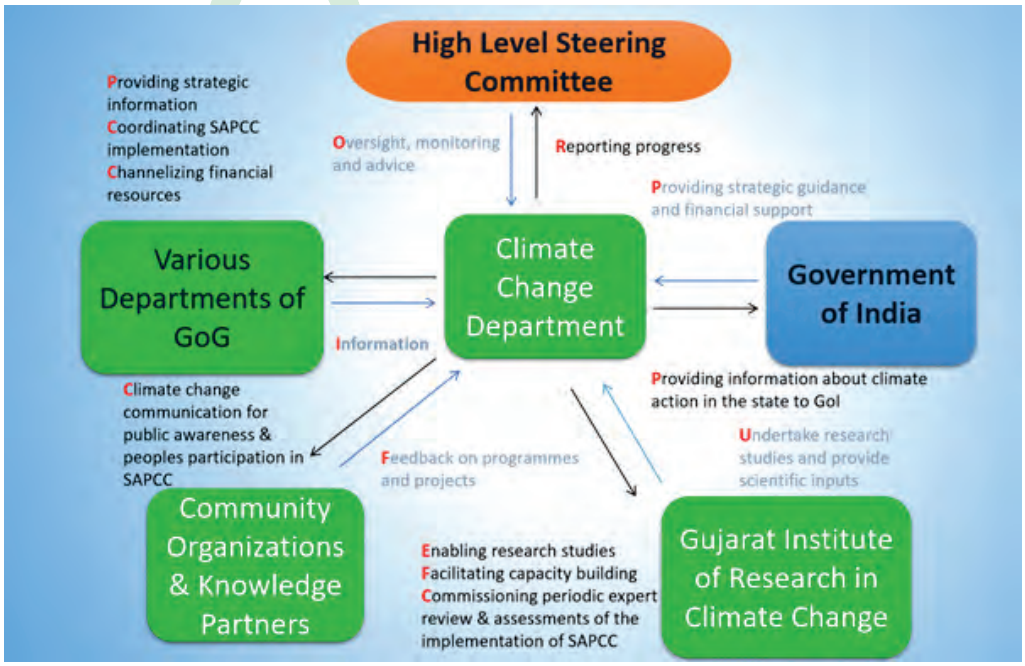


Fig. 2: Institutional Arrangement for Gujarat SAPCC

The resource wise installed power capacity in Gujarat has been given in Table 1. Table 2 provides the share of renewable power in the state.

Table 1 : Installed Power capacity in Gujarat				
Source	**2002**		**2017**	
	MW	**%**	**MW**	**%**
Coal & Lignite	5599	64%	16007	52%
Gas	2196	25%	6705	22%
Hydro	547	6%	772	2%
Nuclear	315	4%	559	2%
Renewable	99	1%	6671	22%
Total	**8756**	**100**	**30714**	**100**

Table 2: Share of Renewable Power in Gujarat by Source

	MW	**%**
Wind	5318	77.8%
Solar	1267	21%
Biomass	41.2	1%
Mini-hydro	9	0.2%
Total	**6635.2**	**100.0**

9. Way Forward & Opportunities

Gujarat focuses on research, innovation, technology and implementation for climate change project. For research various steps taken by the government are:

- Creation of strong baseline data.
- Downscaling of various climate change projection at 1km x 1 km scale.
- Identification of vulnerable pockets w.r.t

CC impacts on specific eco-system, bio-diversity and key store, flagship species implementation

- Charging stations for electric vehicles.
- Integration of CC subject in school and college curriculum
- Adaption of projects in 3 specific domains – water, agriculture and bio-diversity.
- Climate change fund of Gujarat (CCFG)

The above action plan provides various opportunities like:

> Consulting & contracting for different CC projects.

> Development of shelf on projects.

> Climate financing, viz, learning from CDM

The effort needs a holistic approach requiring convergence of various government schemes. One needs to develop:

> Improved communication for climate response.

> Smart solution and integration of sustainable development / CC adaptation and mitigation in smart city development mission .

> Urban resilience addressing adaption concerns of marginalized, poor, exposed labours.

> Target and outcome based approach for specific groups.

> Promotion of Indian customized solution to other similar stakeholders in African Countries.

Chapter 8: Climate Change and Food Security.

A.K Sikka.

1. Climate Change is Real

In spite of the fact that some people still believe that climate change is a hoax, it is well proven that climate change is a reality. Fig.1 shows the increasing CO2 concentration in the atmosphere since 1955 to 2015. Recent conference of the IPCC at Bonn warned that global temperature could rise up to 4oC by the end of the century. The adverse effect of climate change in India can be clearly observed. There are no long term trends of rainfall in India with remarkable regional variations. The number of rainy days has decreased considerably. A temperature rise of 0.6oC has been observed during the last 100 years, but it is expected that by the year 2100, the global temperature may rise up to 3.5 or even 5cC. During the last decade, there has been increased frequency of heat wave, cold wave, draughts and floods. The sea level has been rising at a rate of 2.5 mm per year since 1950 and the Himalayan glaciers have been retreating fast.

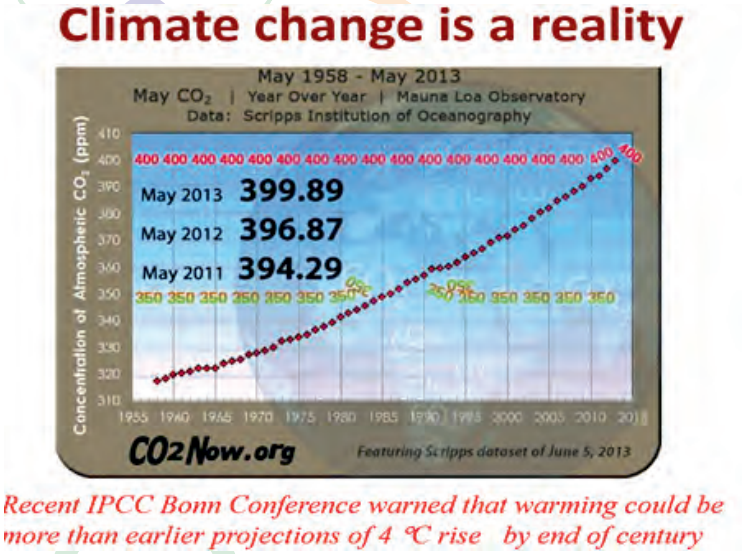
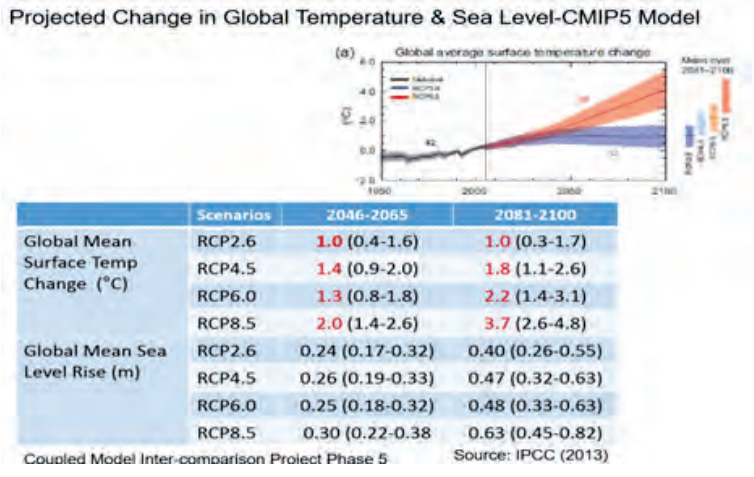


Fig.1: Trends of CO2 Concentration in Atmosphere

There has been marked decrease in the crop yields in rice, wheat and corn due to increased temperature during winter. The projected change in global temperature & sea level are shown in Fig. 2. The corresponding precipitation changes are given in Fig.3.



	Scenarios	2046-2065	2081-2100
Global Mean Surface Temp Change (°C)	RCP2.6	1.0 (0.4-1.6)	1.0 (0.3-1.7)
	RCP4.5	1.4 (0.9-2.0)	1.8 (1.1-2.6)
	RCP6.0	1.3 (0.8-1.8)	2.2 (1.4-3.1)
	RCP8.5	2.0 (1.4-2.6)	3.7 (2.6-4.8)
Global Mean Sea Level Rise (m)	RCP2.6	0.24 (0.17-0.32)	0.40 (0.26-0.55)
	RCP4.5	0.26 (0.19-0.33)	0.47 (0.32-0.63)
	RCP6.0	0.25 (0.18-0.32)	0.48 (0.33-0.63)
	RCP8.5	0.30 (0.22-0.38	0.63 (0.45-0.82)

Coupled Model Inter-comparison Project Phase 5 Source: IPCC (2013)

Fig.2: Global Temperature and Sea Level Changes

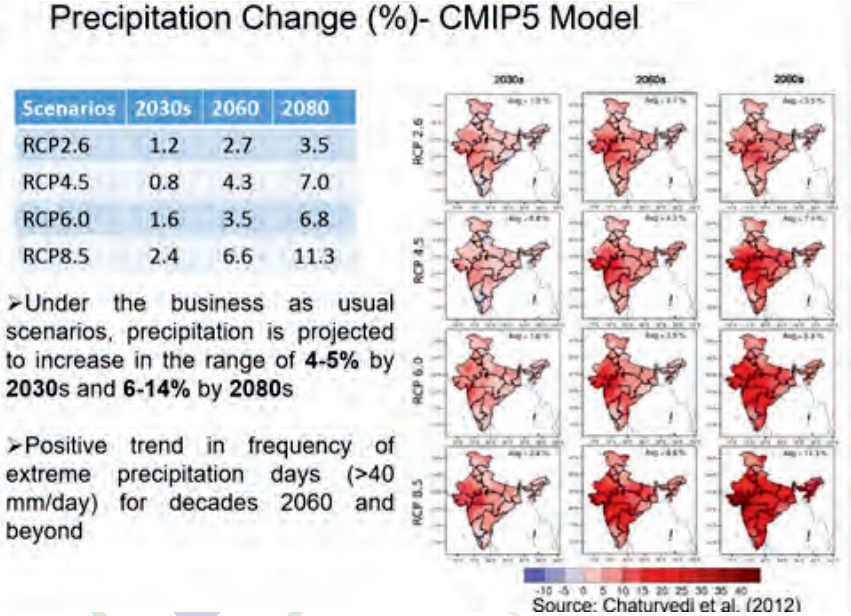


Fig. 3: Expected Precipitation Changes in India

2. Indian Agriculture Sector.

India has only 2.3% of total world's land area and only 4.2% of fresh water resources. However, it is home to 16% of world's population and 17% of cattle. The agriculture supports livelihood for 52% of workforce and contributes 14% to GDP. Indian agriculture is key to nation's food security supporting increased population from 361 million to 1180 million between 1951 & 2010. The net sown area has increased from 119 Mha to 140 Mha, though there is still untapped potential of 60% of NSA. There is a challenge to produce 345 MT by 2030 from the sown area of 141 Mha or less. There are 80% marginal landholders, who posses 36% of agriculture land. Our major agro-ecosystem, crops and production system are shown in Fig.4.

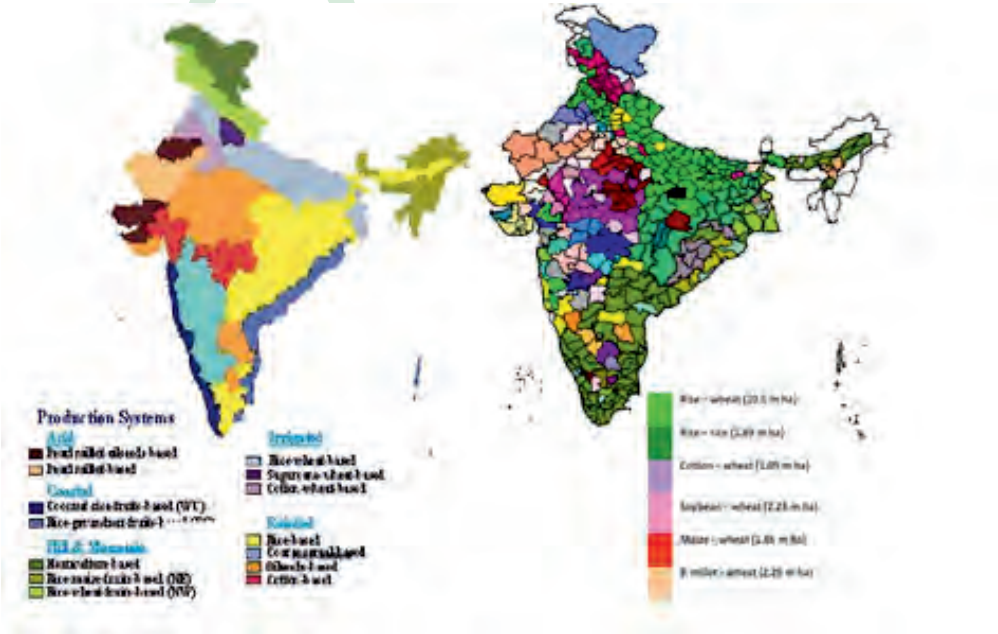


Fig. 4: Major Agro-eco System, Crop and Production Systems

Water is essential to agriculture. The various water resources are annual rainfall (1190mm) providing a quantity of 4000 BCM out of which only 1122 BCM is the estimated utilizable water. The rain fed area is about 83 Mha (16%) whereas 60 Mha (40%) is fed by groundwater. Irrigation uses 83% water, which may reduce to 72% by 2025. We need to therefore, develop increased water use efficiency and water productivity as response to growing challenges. Fig.5.

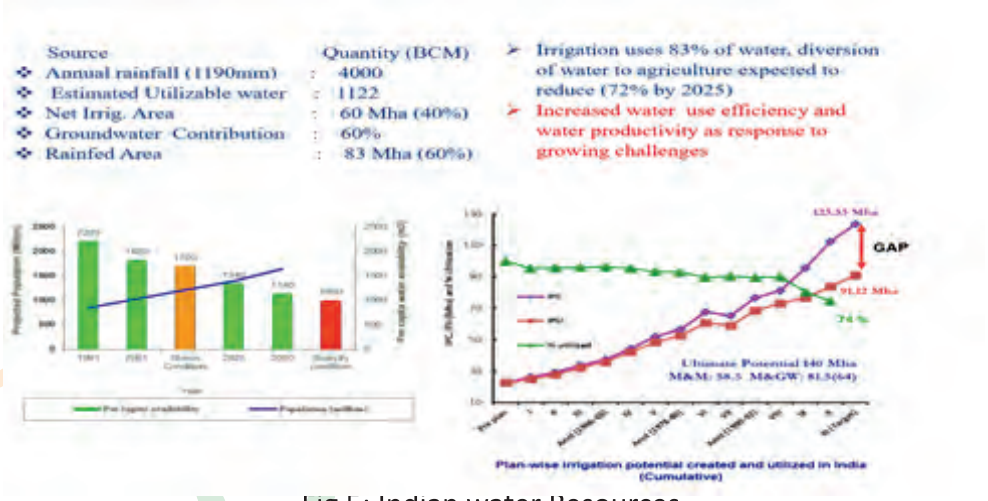


Fig 5: Indian water Resources

3. Key issues in Crop Production.

Due to climate change, there are several issues that the crop production is facing. Increased temperature, heat and cold waves affect crop production. Extreme rainfall events (excess or scare), cause floods or droughts reducing water availability for agriculture. High temperature causes increased evaporation and hence more water demand. This also results in increased incidences of pest and diseases. There is rapid oxidation of soil organic carbon and its effect on soil fertility.

Crop simulation models predict the impact on yields of wheat and rice in the year 2030 (Fig.6).

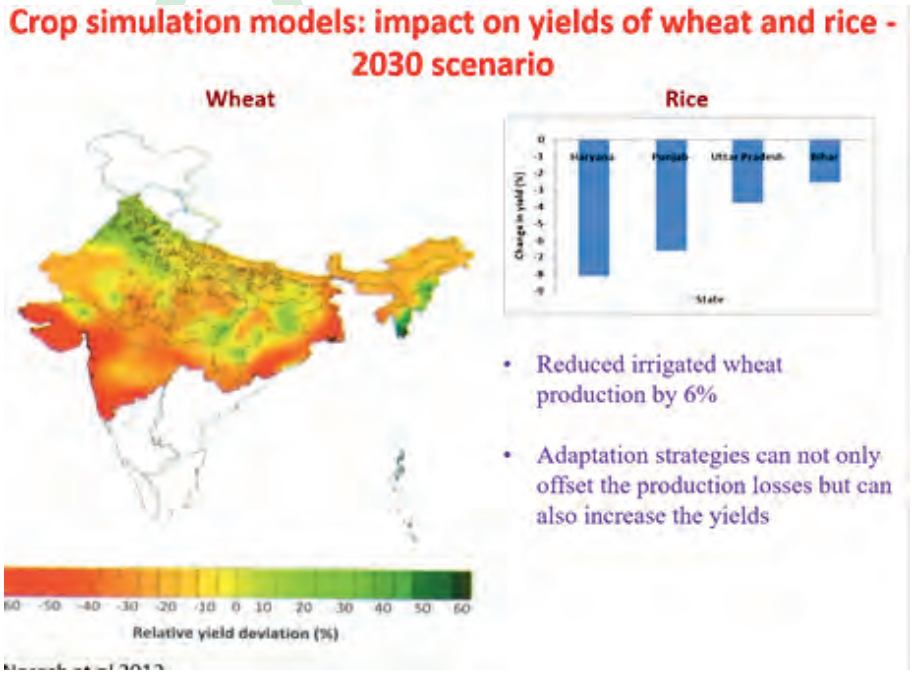


Fig. 6: Predicted Crop Yield Reductions by 2030

It is observed that wheat production could reduce by 6% unless adaption strategies are implemented. The effect of high temperature and CO2 percentage on various crop yields is given in Table 1.

Table1: Effect of High Temperature and CO2 Concentration on Crop Yield.

Effect of high temp. & CO_2 on crop productivity

IARI

Crop	Effect of increased temp. ^{0}C (% reduction in yield)				CO2 fert. effect (%)	Threshold temp. for net loss
	+1 ^{0}C	+2^{0}C	+3^{0}C	+4^{0}C	560 ppm	
Rice	5	10	15	20	15	3.0
Wheat	10	20	30	40	15	1.5
Chickpea	5	10	15	20	22	4.5
Groundnut	8	16	24	32	20	2.5
Green gram	6	12	18	24	20	3.0
Mustard	4	8	12	16	20	5.0
Potato	6	12	18	24	20	3.5

The production of fruits and cash crops like cashew will also be affected due to climate change. The apple cultivation which require adequate snow fall, may have to be shifted to higher elevations. The yield of peach, plum and pear is not affected much. The cashew crop is highly influenced by unseasoned rainfall as happened in March 2008. The tea crop in mid hill regions also show decreasing yield with increasing temperature and decreasing rainfall.

4. Milk Production and Pest Distribution.

The global warming also impacts milk production in cattle. The estimated annual losses in milk production in India are estimated to be 1.6 million tons by 2020 and 15 million tons by 2050 in the business as usual scenario.

Based on Eco-climatic India values, the dorsal incidence is expected to increase in the North-East region and decrease in Eastern and Southern states (2050 scenario). Some impacts of cold wave in North in 2006 and heat wave in Andhra (2003) on crop yields are shown in Fig.8 and Fig.9 respectively.

5. Climate change & water Resources.

The adverse impact of climate change on water resources in various Indian regions is summarised in Table 1 and the increased runoff and soil loss across different agro-ecological regions are given in Fig. 8.

Table1: Impact of Climate Change on Water Resources

IMPACT OF CLIMATE CHANGE ON WATER RESOURCES IN INDIA (2100)

Region/Location	Impact	Reference
Indian sub-continent	• Increase in monsoon and annual runoff in the central plains • No substantial change in winter runoff • Increase in evaporation and soil wetness during the monsoon and on an annual basis	Lal and Chander, 1993
Orissa and West Bengal	One-meter sea level rise would inundate 1700 km^2 of prime agricultural land	IPCC, 1992
Indian coastline	One-meter sea level rise on the Indian coastline is likely to affect a total area of 5763 km^2 and put 7.1 million people at risk	JNU, 1993
All India	Increase in potential evaporation across India	Chattopadhyay and Hulme, 1997
Central India	Basin located in a comparatively drier region is more sensitive to climatic changes	Mehrotra, 1999
Kosi Basin	Decrease in runoff by 2-8%	Sharma et al. 2000, a,b
Southern and Central India	Soil moisture increase marginally by 15-20% in monsoon months	Lal and Singh, 2001
Damodar basin	Decreased river flow	Roy et al, 2003
Rajasthan	An increase in ET	Goyal, 2004
River basins of India	General reduction in the quantity of the available runoff, increase in Mahanadi and Brahmini basin	Gosain and Rao, 2006
River basins in northwest & central India	Increase in heavier rainfall and reduction in number of rainy days	Singh et al, 2008

It is estimated that the stream flow could be reduced by as much as 11.4% with 4oC rise in global temperature with maximum decrease (12%) during monsoon and minimum of 2.7% during pre-monsoon season. There could be 10% decrease in rainfall, which will result in decrease of 22.9% in the annual stream flow. The

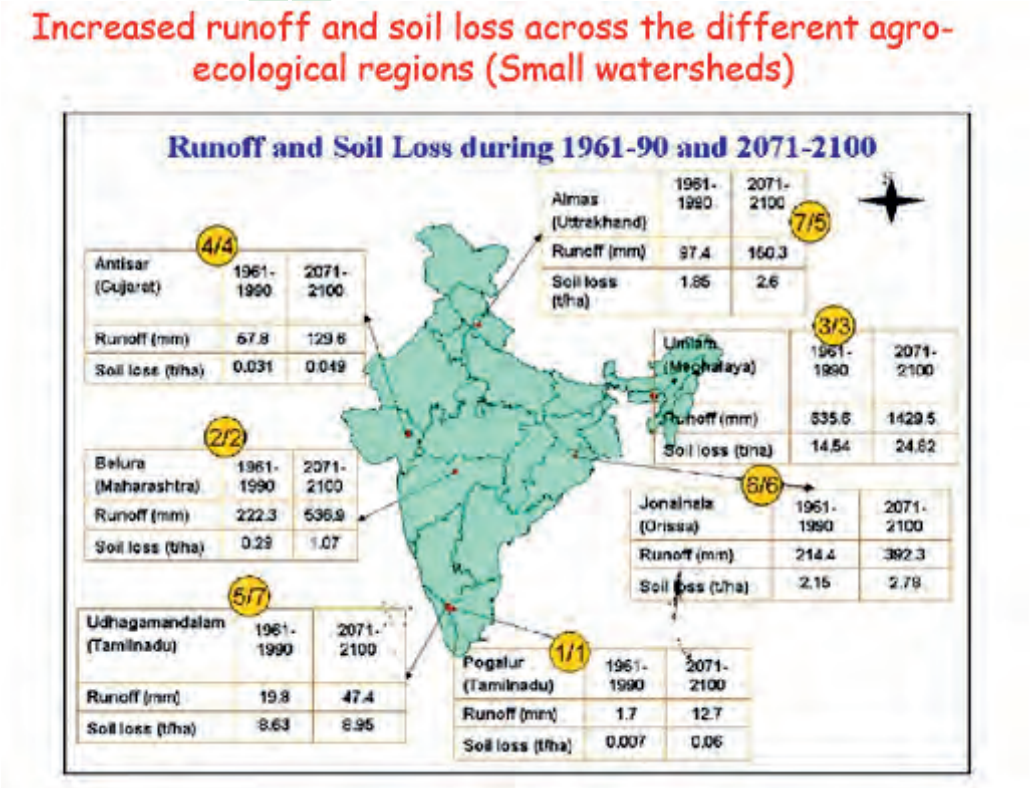
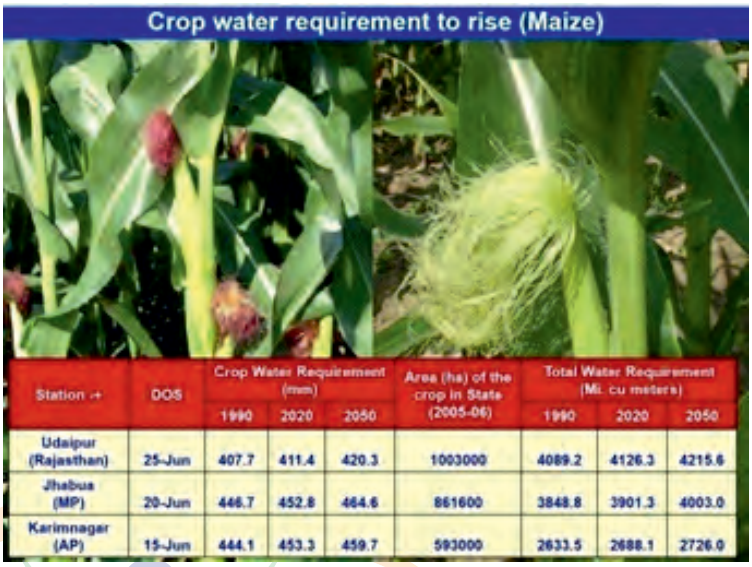


Fig.8: Expected Runoff and Soil losses in Different Agro-ecological Regions of India

maximum decrease of 25% will occur during monsoon period. It is expected that water requirements for crop production will increase as per estimates given in Fig. 9 for maize as an example.



Station ->	DOS	Crop Water Requirement (mm)			Area (ha) of the crop in State (2005-06)	Total Water Requirement (Mil. cu meters)		
		1990	2020	2050		1990	2020	2050
Udaipur (Rajasthan)	25-Jun	407.7	411.4	420.3	1003000	4089.2	4126.3	4215.6
Jhabua (MP)	20-Jun	446.7	452.8	464.6	861600	3848.8	3901.3	4003.0
Karimnagar (AP)	15-Jun	444.1	453.3	459.7	593000	2633.5	2688.1	2726.0

Fig. 9: Increased Crop water Requirements

6 GHG Emissions from Agriculture.

The agriculture sector in India contributes about 18% to the total GHG emission in India, the reasons for methane and Nox emissions are as follows:

Methane emissions:

- Burning of crop residues 1.6%
- Livestock manure management 0.8%
- Rice cultivation 24.2%
- Enteric fermentation 73.4%

Nox emissions:

- Burning of crop residues 4.1%
- Live stock manure management 0.07%
- Soils 95.8%

Various approaches to reduce GHG emissions are:

- Efficient water and fertilizer management in rice
- Improved live stock and feed management
- Organic manures, minimal tillage and residue management.
- Nitrification inhibitors, such as neon coated urea, and fertilizer placement practices.
- Energy management in agriculture – better designed machinery and conservation practices.
- Managing land use: bio fuel plantation, agro-forestry currently available technology can cope with short term impacts as given in Fig.10

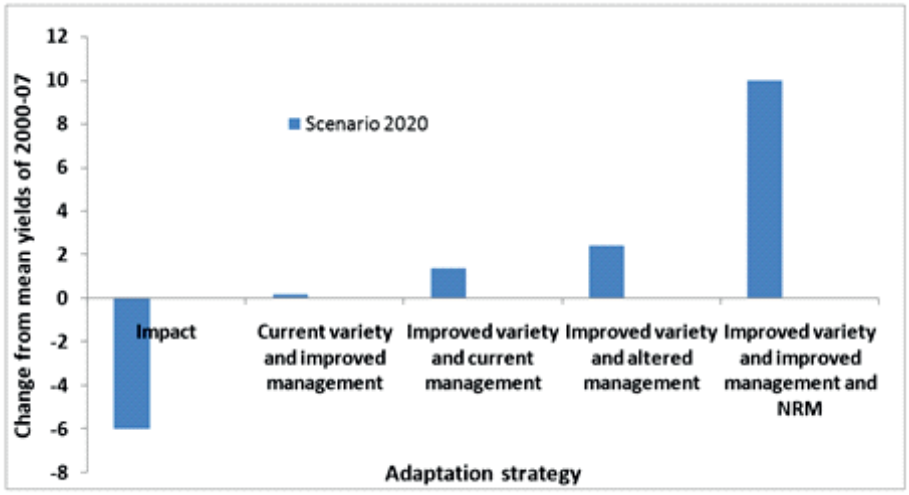


Fig. 10: Short term Strategy to cope with Climate Change

There are National Initiatives on Climate Resilient Agriculture (NICRA) with the following project components:

- Strategic Research
- Technology Demonstration
- Sponsored / competitive research.
- Capacity building.

There have been detailed plans for sensitive and vulnerability of crop yields to climate change. Various regions in India have been identified for the same. Various research institutions namely, IARI and CRIDA, have been supported with state of art equipment for surface monitoring as well as for satellite data reception system. The Institutions will monitor Real Time Crop Health, Crop environment, crop statistics and disaster events. The collected weather and crop data will be used for modelling and crop advisories. Technology demonstration will take place in vulnerable districts as shown in Fig.11.

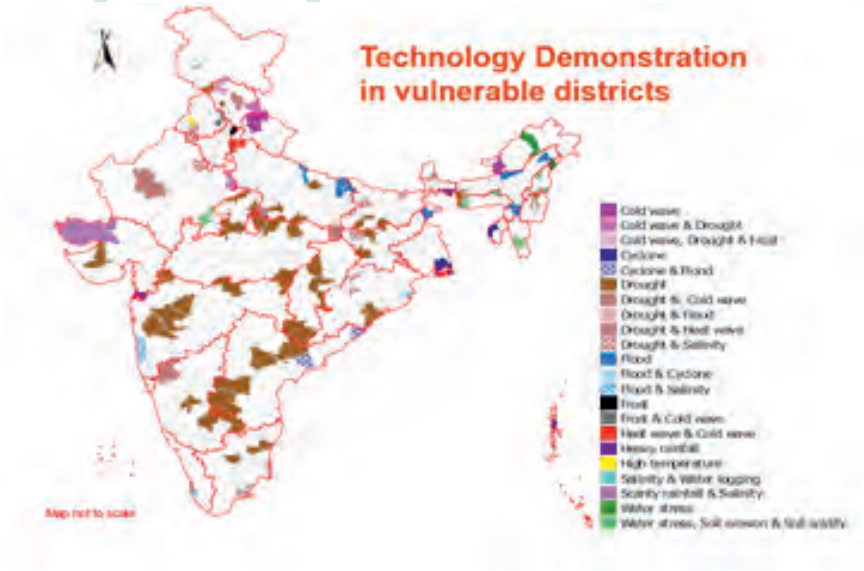


Fig. 11: District Selected for Technology Demonstration

The technology demonstration modules are given in Table 3.

Table 3 Technology demonstration modules.

Natural Resources	Crop Production	Livestock & Fisheries	Institutional Interventions
Soil health improvement, in-situ moisture conservation, water harvesting and recycling for supplemental irrigation, improved drainage in flood prone areas, conservation tillage, artificial ground water recharge, and water saving irrigation methods.	Drought/temperature tolerant varieties, advancement of planting dates of rabi crops in areas with terminal heat stress, water saving paddy cultivation (SRI, aerobic, direct seeding), frost management through fumigation, community nurseries for delayed monsoon, custom hiring centres for timely planting, location specific intercropping systems	Use of community lands for fodder production during droughts/floods, improved fodder/feed storage methods, preventive vaccination, improved shelters for reducing heat stress in livestock , management of fish ponds/tanks during water scarcity and excess water	Institutional interventions either by strengthening the existing ones or initiating new ones relating to seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing group, introduction of weather index based insurance and climate literacy through a village weather station will be part of this module

Agriculture development needs knowledge integration across disciplines (Fig. 12) and system analysis (Fig.13).

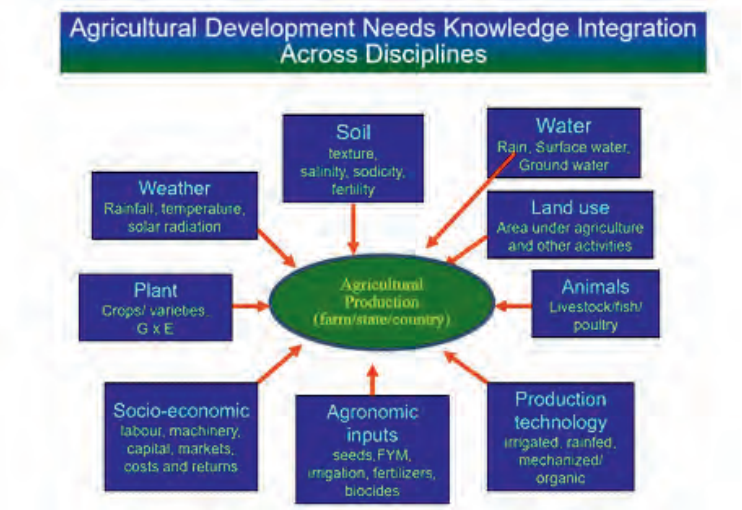


Fig. 12: Integrated Agriculture Disciplines to Combat the Challenge of Climate Change on Crop Yield

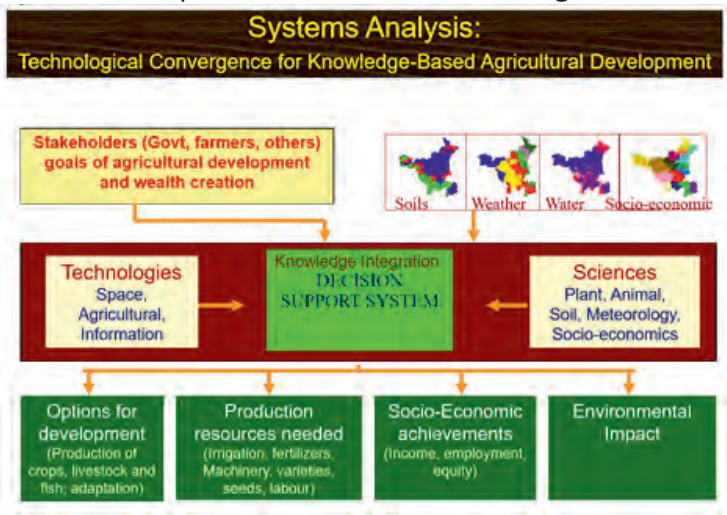


Fig. 13 : System Analysis Schematics for Knowledge Based Agriculture

Innovative Thought Forum

List of Speakers

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