DECEMBER 2019

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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Pollution

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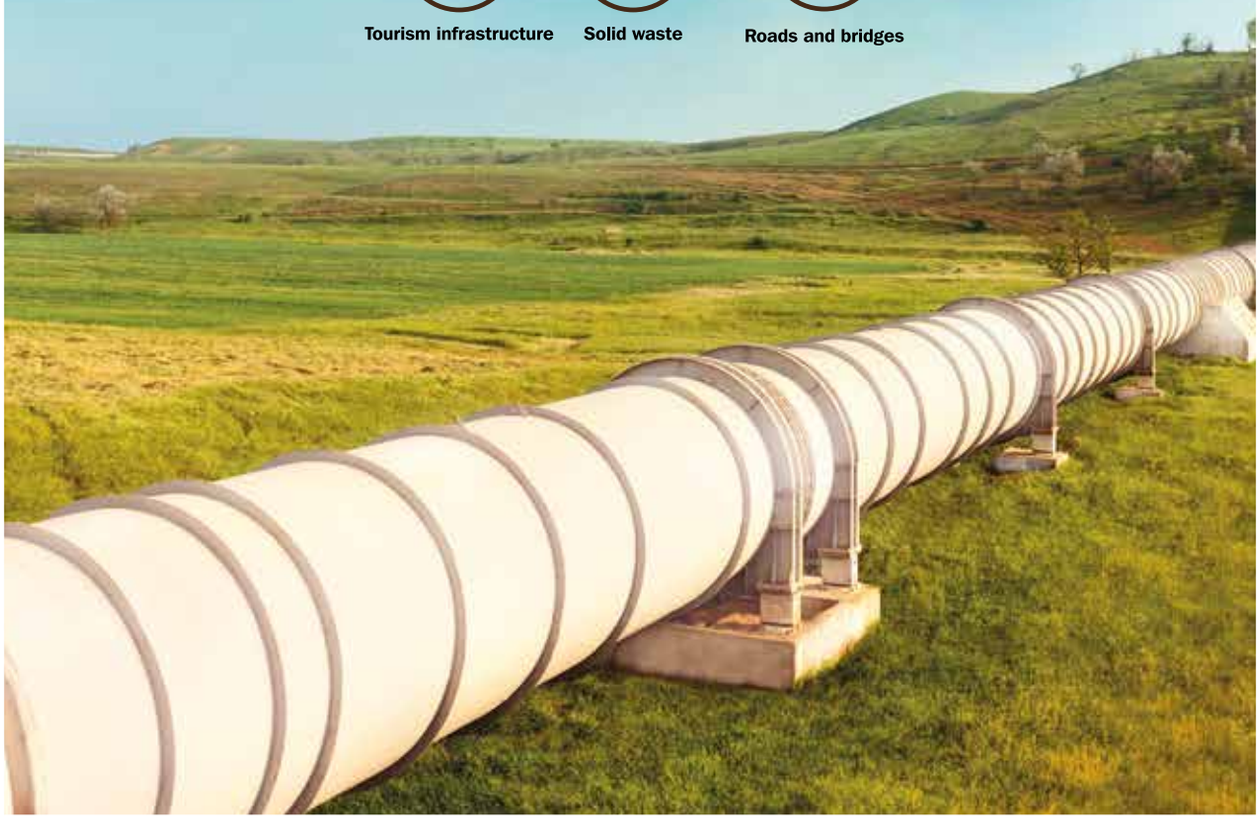

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MESSAGE FROM CHIEF EDITOR

Dear Fellow Consulting Engineers & Readers,

WISHING ALL OUR MEMBERS, READERS & THIER FAMIIES A VERY HAPPY, BRIGHT & PROPEROUS NEW YEAR

The theme for this issue could not have been more appropriate for the season with winter having set in and bringing in its wake the boons and banes associated with it. The boons, everyone likes; it's the banes that need to be ameliorated if not eliminated altogether. As the country marches on the path of development and progress it is up to each individual to contribute in good measure to ensure that they are sustainable and affect the climate only in a positive manner or else the three elements of nature Air, Water and Earth, that are essential for existence of life are the ones which would get adversely affected.

The Air that all living species breathe is an essential element for sustaining life; however, Air Pollution is taking its toll slowly and steadily. It's the masses that do not realize or are unable to do anything about it and some do not want to do anything to even help themselves. The question that then arises is whether the elected representatives, the authorities and the masses themselves, can be so helpless or insensitive as to play with their own lives, that of their kith & kin, their coworkers, the mass of people in their areas and other living beings and organisms, that they prefer to suffer and leave a bleak future for the children and the youth, rather than change the situation. The reason proffered of taking away someone's means of livelihood does not gel when one has to look at what is good for the huge population per se that stands to benefit. Alternative means of livelihood are always there if one really wants to change. Remaining in the mire is not an option. India ought to lead in this and other areas of its own volition and not be tagged by some agency and then reactively do something about it to go up a few notches in rankings.

Vehicles, construction, industries, cooking fires, waste and stubble burning are the major causes of air pollution. While progress is being made it's abominably not up to requirement. Electric vehicles would no doubt cut the pollution substantially but the power generation plants that would be required for them should not add on to it. Hence, even the power for the vehicles must come from renewable sources. The vehicles themselves should be made from materials than can be recycled.

Next to reduce the number of vehicles, the public transportation systems – road, rail, air and water, should be improved and made all pervasive to provide virtually door to door service. The large private vehicles like busses should be reduced over a short period of time. That would remove the issues created by their parking and garaging on public roads and public areas unlike the public transportation systems which have their depots. Road transport vehicles are the next big polluters – and should be made electric, especially the long distances ones. Solar panels could be put on top and sides of the vehicles so that charging is also not an issue except

during monsoons. For that period fast recharging or battery change stations could be suitably provided. The smaller ones operating in the urban and semi-urban areas should be next on the agenda. The pollution levels would reduce considerably. Rail transportation also must be improved to provide speedier movement of people and goods. The success of Metros and Monorails speak for themselves.

Talking of roads and highways, integrated planning and execution must be done. The roadway, pavements, stormwater drainage, water supply pipes, sewerage collection system electrical cables, telephone and communication cables, gas pipelines, must all be planned into by one agency and executed accordingly at one go. All the utilities should be accessible for repairs and/ or additions or upgradation through manholes/ chambers. No digging should be resorted to during the design life of that road. The practice of laying a wearing coat over an existing one must be banned. It is that practice which has been the cause of creating water logging and flooding in built up areas which were always safe earlier. Even in hilly and mountainous terrain this practice has caused untold damage. All this goes on inspite of Court orders stopping the raising of road levels in built up areas to prevent creating conditions which would result in water logging and flooding. Green Engineering and Sustainability require that the materials from the wearing coat and other layers (if they are also being redone) be reused. Infact a survey should be done to see how best to solve the problem of water logging and flooding areawise and not in a piece meal fashion. The economic loss is enormous and so also the hardships that people have to undergo with water logging and flooding every year.

Construction works –are the single large sources of pollution for air, water, earth, noise and cause adverse effects on health of workers and infact all living beings. Mandating adoption and deployment of environmentally sustainable practices and procedures coupled with training of all personnel regardless of rank would go a long way to preventing all forms of pollution to a very great extent. The construction plant and equipment should also be modified to conform to environmental regulations.

Industrial gases - the next big polluters. Although the norms exist, there are still many reportedly emitting gases beyond permissible limits. These need to be strictly checked. Online monitoring ought to be the norm and any infringement should raise an alarm.

Gas for cooking has reached most homes even in the villages. Areas where it has not yet reached, need to be serviced. Alternatively electric cooking stoves should be encouraged. Electrical power supply need not always be sourced from the grid; localised power generation by wind, solar, mini-hydro or other suitable means could meet the needs and may in cases be cheaper. It would minimize the need for long transmission lines and the accompanying issues of loss, theft, breakdown, etc.

Forest fires – Uttarakhand, Amazon, California and elsewhere, bushfires in Australia, jhooming or stubble burning are another major source of pollution. Surely they could be controlled and their effects minimized.

The second element of nature that needs great consideration is Water. Drought situations are an annual occurrence. While schemes have reportedly been launched, the ground reality is different. Many of the water bodies used as sources of water are still polluted. The masses need to be educated more concertedly with respect to how their health and well being is affected.

Many of the authorities concerned, who are empowered to keep the areas under their jurisdiction clean and green, are still not planning and managing pollution issues plus greening the areas. They need to get their act together and enforce it. States enacted laws to curb use of plastics but that fervour has ebbed and thin plastics are back in the market - Plastic pollution continues. Consistent follow up is essential till such time that all traces of manufacturing and distribution are eliminated. Discharge of untreated effluents is also unchecked in many areas. How many years does it take to draw up master plans and then implement them in a time bound manner? Drones should be deployed to monitor projects and polluters.

Storm water drains are only cleaned, if at all, just before monsoon or when an area gets flooded. Gratings are essential to prevent solid material from entering and choking the drains. The drains are formed as rectangular sections cast

in situ however, it would be far better to lay precast rectangular sections with covings at the junctions, which would be of a better quality since their manufacturing process could be closely monitored. Thereafter laying in position and jointing are the critical operations at site. The drains could be provided hard waterproof coatings in the plant so that leaking from the drain which contaminates the ground water all along their length is minimized if not totally eliminated.

Solid Waste is another major challenge. Most shop keepers discard their empty cartons, paper, plastics etc. on to the pavement just outside their shop in the night, creating additional work for the municipal sweepers. They should only be allowed to dump all that in designated bins. The unregulated houses (so called temporary or jhuggi jhopadis) dump their wastes blatantly on the roads outside pucca houses in the vicinity. The authorities do nothing about it; the stench remains the whole night and at times even during the day.

Food stalls are another source of creating filth – the left over, used paper cups, plates, etc. are strewn all over, and the waste water is also sloshed on to the pavement or road. Same applies to flower vendors.

The vehicles parked or garaged on the road over night prevent the road stretch below them from being cleaned. These stretches are major source of breeding mosquitoes, flies, bugs, etc. due to all the waste and dirt accumulating below them.

Those who are charged to maintain the area ought to tour it everyday before the vans pick up the waste. Only then they would be in a position to plan and exhort the people to maintain a clean environment.

Polluting mother earth results in the foodchain being contaminated. Since it is not apparent people do not realize it. However, the results are there to see – illnesses resulting from consumption of food sourced from polluted earth, water and air.

School teachers need to be the first to be educated and made to realise the importance of hygiene so that they can inculcate it in the children they teach. It will then be the children's turn to inculcate clean habits in their parents. The polluters must be made to clean up the area and the system that their habits affect; that would be a lesson and a deterrent for them.

Everyone MUST REALISE that it's the children and the youth - the future generations, who are getting affected the most and hence it behooves on all of us to act to set the environment right and adopt only those practices that have a positive effect on the environment and not add to the pollutants that are naturally occurring.

As Engineers it is our duty to caution and advise the authorities and the masses that growth and development are essential however, they must be done in a manner that does not affect the environment and the people in a way that would not be Green Engineering. Engineers should have the courage of their convictions to be able to speak out as to what the best options are. That takes us again to the all important issue of the long overdue Legislation for Engineers. The bodies that would register the Engineers would become the backbone of the Engineers and enable them to develop and advise holistically.

As Engineers we must pledge to not only reduce Pollution but resort to ways and means to reduce pollution and also go a step forward to devise means to REJUVENATE MOTHER EARTH.

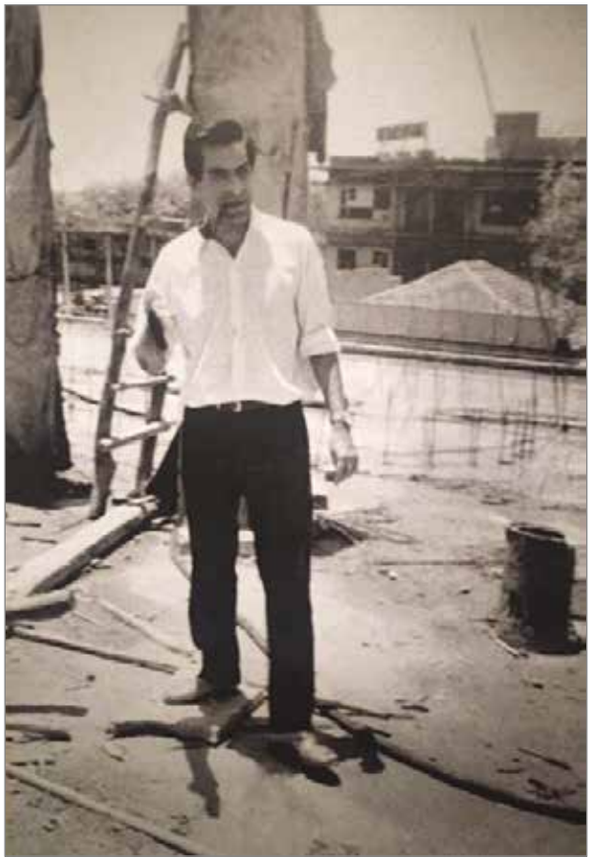
Happy Reading and Learning in 2020

A P Mull

SALUTATIONS
THE INNOVATIVE ENGINEERING RIGOURS OF MAHENDRA RAJ

Sudhir Dhawan

I had been under the impression that with all the interaction over the past several decades I knew Mr. Mahendra Raj pretty well but was astounded after visiting the exhibition of his works at the Kiran Nadar Museum of Art in New Delhi. It was only then that I realised that I did not really know him especially his engineering acumen and abilities.



Mr Mahendra Raj, then

Mr Mahendra Raj, Now

The exhibition is an eye opener on the professional life of Mr. Raj as a Structural Engineer of the hand calculations era much before the computers made their inroads. It gives an overall view of the imposing structural designs done by him. Mr. Mahendra Raj started his consulting practice in 1960. All the major iconic buildings of Delhi having difficult structural forms have been designed by Mr. Raj. As mentioned he belonged to the times when computers were not even on the horizon and all design calculations were done manually and so also the drafting of the complex 3D structures. The Hall of Nations building in Pragati Maidan, New Delhi was the world's first and largest span space frame reinforced concrete structure built in 1972. It was designed by Mr. Mahendra Raj and is a classic example of how hand calculations could be done for designing large span 3D structures. It withstood the rigours of New Delhi's climate for many decades.

View of Hall of Nations at Pragati Maidan

Mr Mahendra Raj and Mr Raj Rewal (Architect) at the exhibition

The exhibits are extremely well presented with lots of details. Vandini and Rohit Raj deserve kudos for making the efforts and arranging the systematic and educative display. My special gratitude to them for projecting Mr. Mahendra Raj as a great "Structural Engineer"; which he truly is. Earlier they had helped in bringing out a book on his works; that too had been received very well and appreciated by all.

Photographs during inaugural function of Exhibition

While, some of the photographs at the exhibition are reproduced here, engineers are strongly recommend to take time out to study the documents and the photographs there, learn from them and appreciate the greatness of Mr. Raj as a Structural Engineer. They can thereafter also enjoy the delicious food at the DLF South Court Mall in Saket.

I humbly salute Engineer Mahendra Raj

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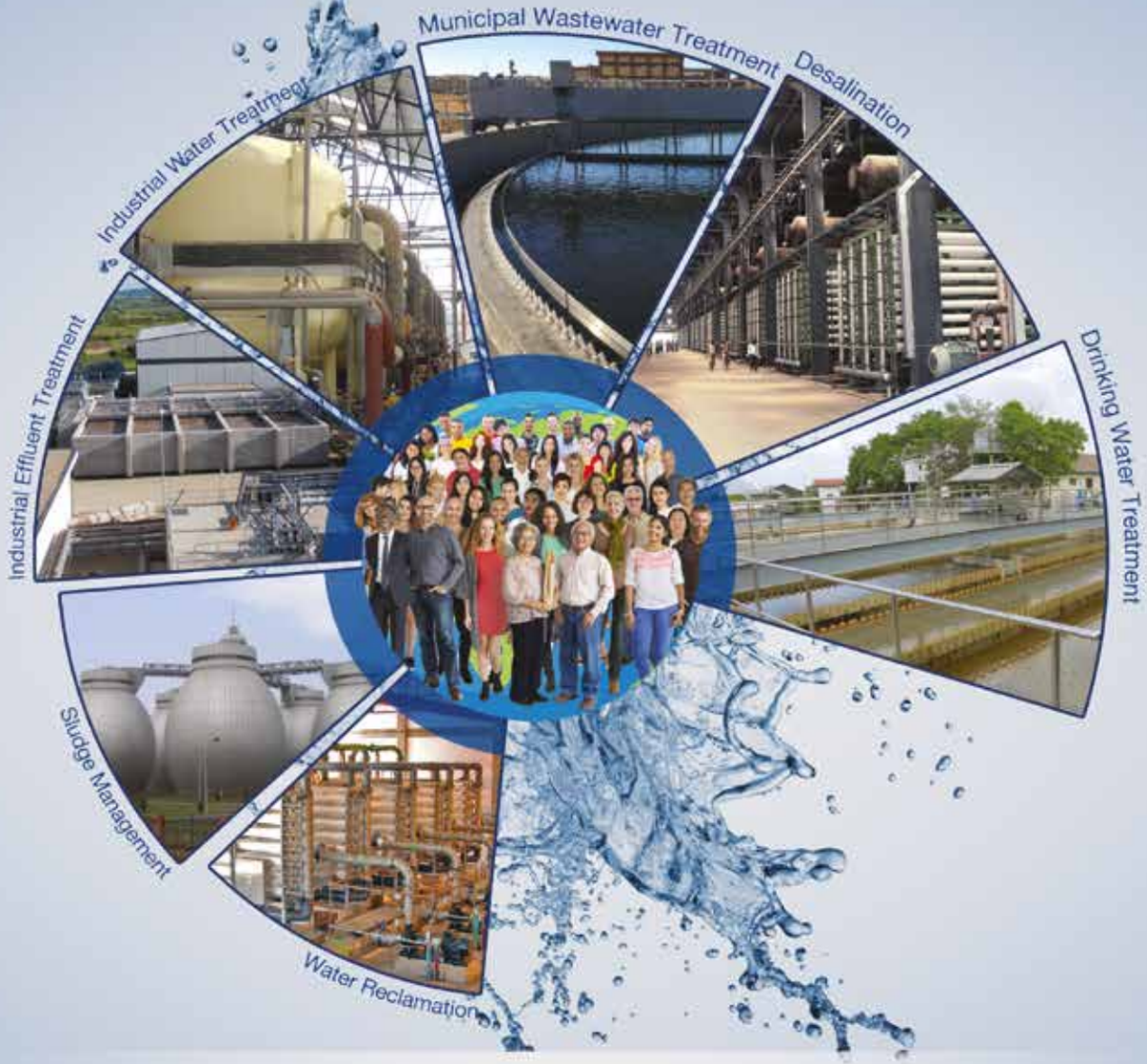

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NEED FOR A POLICY AND PARADIGM SHIFT IN TACKLING AIR POLLUTION IN THE INDO-GANGETIC BELT

Dr Ajay Pradhan
Vice President – CEAI, New Delhi

UNDERSTANDING THE PROBLEM

The National Capital Region of Delhi has been experiencing some of the worse ever pollution from the latter part of October to November every year since last one decade. The City authorities in the NCR have called for public health emergency due to health hazard of toxic smog. Although a variety of measures – such as restricting Diwali fireworks, restriction of traffic and halting construction in the city – have been implemented in an attempt to curb the pollution, blame has largely been apportioned to stubble burning in the neighbouring states of Punjab and Haryana. Despite the ban by the Delhi High Court, the grant of subsidy to farmers to use machine, etc. thousands of farmers continue to burn stubble. Hence, in this paper the author is attempting to put forth causes, effects and long term solutions to the air pollution arising out of stubble burning.

The state of Punjab is known as the food basket of India. Though relatively small, Punjab grows about 20 percent of the wheat produced in India and 10 percent of the rice. During 2019, the total area under paddy cultivation is approximately 3 million hectares which is expected to yield 18 million tonnes. In Haryana alone, 80% of the almost 5 million hectares of land is now under cultivation, producing over 13 million tons of grain per year. This is due to the impact of the Green Revolution in 1960's i.e. the Seeds-Fertilizers-Water Technology.

One of the by-products of such intensive food production is smoke. There are two main cultivation seasons in Punjab and Haryana: one from May to September and the other from November to April. In November, farmers typically harvest rice and sow wheat. After the harvest, they often set fire to the leftover plant debris to clear the fields for the next plantings, a practice known as stubble or paddy burning.

The scale at which stubble burning happens in Punjab and Haryana is visible in the Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite which passed over the region. The stubble fires were widespread. In the image above, the red outlines show the approximate locations of active burning. Fields generally appear brown.

Normally extensive agricultural burning lasts for about three weeks. Although most of the haze appears to originate from the agricultural fires, other factors such as urban and industrial smog would also be contributing factors.

Stubble burning is a relatively new phenomenon. Historically, farmers harvested and ploughed fields manually, tilling plant debris back into the soil. When mechanized harvesting using Combine Harvester became popular in the 1980s, burning became common because the machines leave stalks that are about one-foot tall. Burning the stalks is the quickest and cheapest way to clear them. This is also due to non-availability of migrant labourers from other states as they have found alternate work in the construction industry and other sectors. It is also believed that some of the national welfare schemes launched by the Central Government like MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) and the State Government schemes have discouraged labourers to migrate during the harvesting season.

The stubble fires release several types of particles and gases into the atmosphere, including smog-forming carbon dioxide, carbon monoxide, and nitrogen dioxide. The haze that forms over Punjab rarely stays there. While the fires burn, the smoke generated often blankets much of the Indo-Gangetic Plain, exposing millions of people in the densely populated plain to high levels of air pollution.

The smog is generated 34% from rice and 22% from wheat crops, most of which are burnt on the farms. According to an estimate, 20 million tonnes of rice stubble is produced every year in Punjab alone, 80% of which is burnt.

ENVIRONMENTAL AND HEALTH RISK

A study estimates that the crop residue burning released:

- Carbon Dioxide (CO_2): 149.24 million tonnes
- Carbon Monoxide (CO): over 9 million tonnes
- Sulphur (SOX): 0.25 million tonnes of oxides
- Particulate Matter: 1.28 million tonnes, and
- Black Carbon: 0.07 million tonnes.

These directly contribute to environmental pollution, and are also responsible for the haze in Delhi and melting of the Himalayan glaciers.

The heat from burning paddy straw penetrates 1 centimetre into the soil, elevating the temperature by 33.8 to 42.2 degree Celsius. This kills the bacterial and fungal populations which are critical for a fertile soil.

Burning of the crop residue causes damage to other micro-organisms present in the upper layer of the soil as well as its organic quality. Due to the loss of 'friendly' pests, the wrath of 'enemy' pests has increased and as a result, crops are more prone to disease. The solubility capacity of the upper layers of soil has also been reduced. According to a report, one tonne stubble burning leads to a loss of 5.5-kilogram nitrogen, 2.3 kg phosphorus, 25 kg potassium and more than 1 kg of sulphur - all soil nutrients, besides organic carbon.

A study conducted by Dr. Vitull K Gupta, Professor of Medicine, Bathinda, in 2016, revealed that 84.5% people were suffering from health problem due to increased incidence of smog. The study reported that 76.8% people reported irritation in eyes, 44.8% reported irritation in nose, and 45.5% reported irritation in throat. Cough or increase in cough was reported by 41.6% people and 18.0% reported wheezing. Another study by the Institute for Social and

Economic Change, Bengaluru, estimated that people in rural Punjab spend Rs 7.6 crores every year on treatment for ailments caused by stubble burning.

CAUSES AND EFFECTS OF STUBBLE BURNING IN PUNJAB AND HARYANA

The stubble burning phenomenon in Haryana and Punjab is linked to three unlikely factors:

The (relatively) large size of landholdings of farmers in these states; ii) the (consequent), high level of mechanisation; and, iii) the State of Punjab passed a water conservation law during 2009 that shortens the harvesting window and also shifted the transplantation of rice from May-June to June-July to reduce high Evapotranspiration during peak summer.

Note: None of the three are usually listed among the reasons for stubble burning.

i) Unlike the decreasing landholding size at an all-India level, the operational landholding size in Punjab has increased over the years. Data from the National Agricultural Census 2011 show that average land-holding size in Punjab has gone up from 2.89 hectares (7.1 acres) in 1970-71 to 3.77 ha (9.3 acres) in 2010-11, much higher than the national average of 1.5 hectares (3.7 acres). In Haryana, it is 2.25 hectares (5.5 acres). The next state in terms of magnitude of landholding is Arunachal Pradesh -3.5 hectares (8.6 acres). These relatively large land-holdings mean farmers can afford to use machines, at least for some critical functions.

ii) Crop-residue burning has intensified over the past decade because of multiple reasons, says Manpreet Singh, a Farm Engineering Specialist at the Punjab Agricultural University, Ludhiana. The use of mechanized harvesters, which result in loose straw, is one of the key reasons, he said. Punjab's high farm mechanisation levels have now become counter-productive.

   According to a report by the Environmental Information System (ENVIS) Centre, Punjab, farm mechanisation in the state has reached its "saturation point" and therefore "no more viable, both economically and environmentally".

   As the Combine Harvesters are designed to shave off the grainy part of paddy, leaving loose straw in their wake, farmers find it cheaper to clear the residue by burning. Hundreds of thousands of farmers in Haryana and Punjab, where much of the region's paddy is grown, set their rice fields on fire to clear left-over loose straw after harvesting paddy to make way for wheat. Last year, Punjab reported over 44,000 paddy-straw burning incidents, while 25,000 incidents were recorded in neighbouring Haryana.

iii) A 2009 water-conservation law in the state of Punjab, narrows down the paddy-sowing window to cut down on irrigation rounds and reduce the peak evaporation loss. Consequentially, the window available for harvesting paddy is also limited to 15-20 days. "This means over 2 million farmers all grow similar varieties of paddy and harvest them all at the same time." The area under paddy has also steadily grown to approximately 3 million hectares because it is by far the most profitable crop and an assured Minimum Support Price extended by the Government.

CLIMATE CHANGE AND METEOROLOGY

Another contributory reason for the smog could be major changes in the withdrawal of monsoon from the region and the anti-cyclonic circulations that are formed in that period.

It is reported that the long-term wind patterns over Delhi have changed in the past few years, and that is having major implications on the pollution levels in the city.

"The frequency of winds coming in from the north-west direction has increased in the past few years. Exact quantification of this increase will require more studies which we are now carrying out but a definite pattern is clearly visible", Gufran Beig of the System of Air Quality and Weather Forecasting and Research (SAFAR) at the Indian Institute of Tropical Meteorology (IITM), Pune told 'Down to Earth'.

Delhi during 15 November 2019 – Covered in Smog

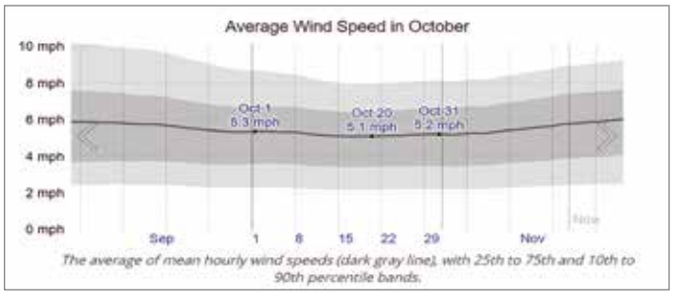
"There could be many reasons for this change of wind patterns but one possible reason could be major changes in the withdrawal of monsoon from the region and the anti-cyclonic circulations that are formed in this period", Beig added.

On November 14, 2019 the air pollution levels in Delhi-NCR were classified as "unhealthy", down from "hazardous" and "severe" in the past weeks. This could be because the rain would have brought the pollutants, especially the particulate matter (both PM10 and PM2.5), down to the surface and cleared the air. If this would not have happened, Delhi was staring at a blanket ban on private vehicles. In this case, weather helped the cause of fighting air pollution in Delhi, but it can also have disastrous effects.

Weather conditions play a crucial role in determining the pollution levels of a city or region. They also form an important component of severe smog events that have been witnessed repeatedly over Delhi in the past few years, especially during winter months. For example, in the first week of November 2017, there was severe smog over Delhi and one of the factors responsible for this was a north-westerly wind that had brought in pollutants from Punjab, Haryana and Pakistan. Similarly, around the time of the Diwali festival in 2016, an anti-cyclonic circulation had reduced the wind speeds in Delhi, making the pollutants settle down near the surface and stick to the water vapour, aggravating the conditions severely. In 2018 too, the air quality had plummeted to hazardous levels even though the Supreme Court had ordered a partial ban on the bursting of crackers in Delhi. The role of wind speeds and directions on air pollution levels in the current year still needs to be studied.

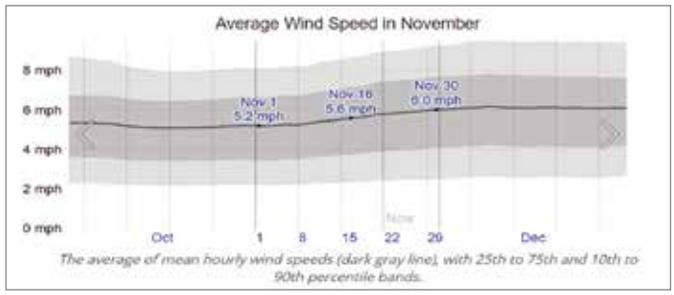
However, it is not only the winter months that have seen such changes in wind patterns. It was also observed earlier this year. The entire northern part of India had been plunged into a dust bowl-like condition in April and May 2019, decreasing the air quality drastically. It was observed that the wind patterns over Delhi and its surrounding regions had changed from the usual westerly winds to winds coming from the eastward direction. The easterly winds had brought in moisture from the Bay of Bengal and this had led to severe dust and thunder storms in the region. In the middle of June this year, an anti-cyclonic circulation from Rajasthan had brought in dust from the desert, significantly increasing (839 microgram/cubic metre) the PM10 pollution in Delhi.

October

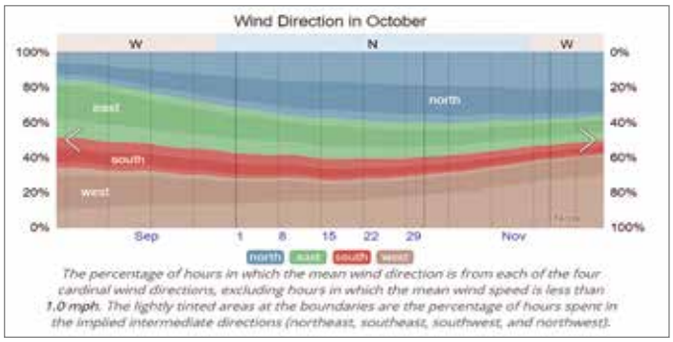


The average hourly wind speed in New Delhi is essentially constant during October, remaining within 0.1 miles per hour of 5.2 miles per hour throughout.

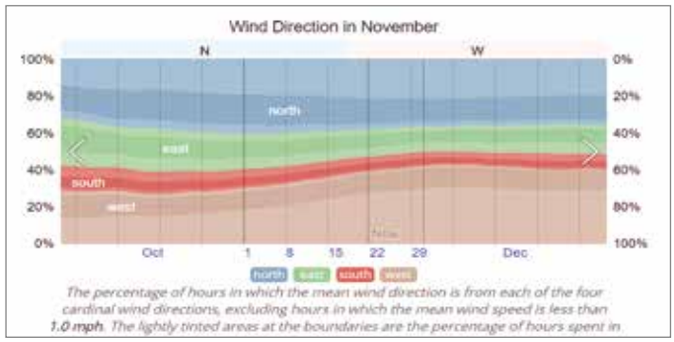
November



The average hourly wind speed in New Delhi is gradually increasing during November, increasing from 5.2 miles per hour to 6.0 miles per hour over the course of the month.



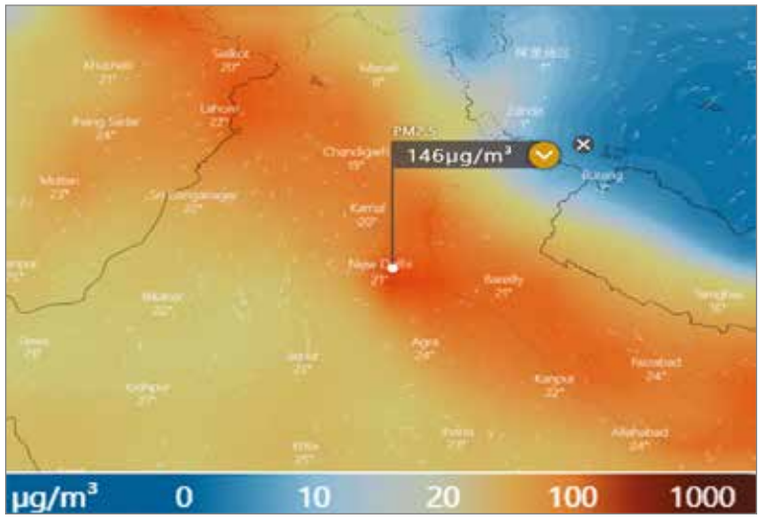
The hourly average wind direction in New Delhi throughout October is predominantly from the north, with a peak proportion of 40% on October 28.



The wind direction in New Delhi during November is predominantly from the north from November 1 to November 18 and from west from November 18 to November 30.

Temperature plays an important role, according to K J Ramesh, former Director General of Meteorology at India Meteorological Department "In summers, because of the heat, aerosol can mix with air up to 5-6 kilometres vertically. But this range comes down to 1-1.5 km because of the stable atmosphere in winter (when the air below gets cold and does not rise up), when the height is less, the smog is thicker, and it won't get dispersed unless there is a strong wind."

Tracking and studying the weather can play a crucial role in not only explaining the occurrence of air pollution but also in predicting severe air pollution and smog events in the future.



New Delhi – Air Quality (PM 2.5 levels on 21st November, 2019)

SOLUTIONS TO THE BURNING PROBLEM

In 2014, the Central Government released the National Policy for Management of Crop Residue. Since then, crop residue management has helped make the soil more fertile, thereby resulting in savings of Rs 2,000/hectare from the farmer's manure cost.

Farmers started managing crop residues effectively by employing agricultural machines like:

- Happy Seeder (used for sowing of crop in standing stubble)
- Rotavator (used for land preparation and incorporation of crop stubble in the soil)
- Zero Till Seed Drill (used for land preparations directly sowing of seeds in the previous crop stubble)
- Baler (used for collection of straw and making bales of the paddy stubble)
- Paddy Straw Chopper (cutting of paddy stubble for easily mixing with the soil)
- Reaper Binder (used for harvesting paddy stubble and making into bundles)

However, these machines are very costly for every farmer to buy. Therefore, the State governments should come forward and provide better subsidy so that farmers can afford these machines even though the Central government is extending a subsidy at 50-80% for crop residue management machinery. To curb the practice, the Central government last year announced funds totalling ₹1151.80 crores (₹ 591.65 crores for 2018-19 and ₹560.15 crores for 2019-20) to subsidise the use of additional farm equipment, such as the Straw Management System (SMS) to states of Punjab, Haryana and the NCR Region.

There are several steps undertaken by the government of Punjab; the major ones being:

a. Punjab government has announced a US$1 million global fund to hunt for new technologies to tackle paddy-straw burning by farmers that triggers north India's toxic winter smog, since, as officials have said, the current measures aren't fully capable of addressing the apocalyptic problem. These smaller machines, which can be attached to mechanised harvesters, shred the residue, eliminating the need to burn them.

b. The Punjab government has banned the burning of crop residue. The State has also made the use of equipment, such as Happy Seeder and Straw Management System, mandatory with mechanized harvesters. In 2017, farmers were fined ₹65 lakhs, in all, for burning crop residue.

c. Jhakhar, Chairman of the Punjab State Farmers' and Farm Workers' Commission, said the Netherland's Wageningen University, one of the world's most advanced centres for agricultural research, and a UK firm have applied for the paddy-straw challenge fund to come up with solutions.

   Even if farmers were willing to adopt subsidised machinery to eliminate the need for straw-burning, the total funds available aren't enough to cover all paddy farmers as stated by Punjab Agricultural University (PAU)

WAY FORWARD

Instead of burning of the stubble, it can be used in different ways like cattle feed, compost manure, roofing in rural areas, biomass energy, mushroom cultivation, packing materials, fuel, paper, bio-ethanol and industrial production, etc.

1. Machine-based technologies can't fully address the issue, disruptive technologies are needed.

2. The problem is that farmers still resort to burning because of lack of awareness and cost issues. Total crackdown isn't possible to stop stubble burning due to socio economic factors and livelihood issues. Besides, there is a strong and powerful farmer lobbies. Therefore, social mobilisation, awareness campaigns and paradigm shift in understanding the greater implications must be resorted to.

3. Shifting back to earlier transplanting and harvesting period with IoT based Alternate Wetting and Drying (AWD) system would help in less consumption of water and thereby reduce ground water extraction and also consumption of energy. This would not only save the government the huge subsidy in free electricity for agriculture but also reduce the carbon footprint of Green House Gas and also stem the fast depleting ground water in the states.

4. The state of Punjab is divided into three major regions Majha, Malwa and Doaba. This division is basically due to the rivers Sutlej (or Satluj) and Beas flowing through the land of Punjab. In the historical times, it was not easy to cross the rivers and hence the areas divided by rivers were considered as separate regions.

   Traditionally most regions of Punjab and Haryana are not suitable for growing paddy because of the soil properties and its climate but Irrigation has made it feasible, even in areas known for their baked climate, to grow rice.

5. Crop Diversification

   Intensive groundwater-based irrigation has deteriorated the quality of soil, making it alkaline in Punjab even as neighbouring Haryana is tackling rising salinity. The intense paddy-wheat cropping - paddy in summer, followed by wheat in winter - has affected productivity and quality of water as well as soil.

   In several pockets in the districts of Mansa, Sangrur, Ludhiana, Bathinda, Hoshiarpur, Jalandhar, Moga, Pathankot and Patiala, the groundwater has gone very deep. "The groundwater that was around 10 metres deep before the Green Revolution has depleted to 40-50 meters in central Punjab and paddy growing districts," as reported by a senior official at Central Ground Water Board.

   Crop diversification will not only reduce the stress on ground water as more and more farmers opt for less water demanding crops compared to paddy, it would also improve the quality of soil. Some well-to-do farmers have already started cultivating other crops either out of realization that parts of Punjab will be desert in less than a decade given the extent of the exploitation of groundwater or growing paddy would became increasingly unprofitable with the input costs on labour, pesticides and diesel for the generator increasing every year.

   Cash crops like vegetables, pulses, coarse cereals, edible oilseeds are also good alternatives. Cotton, maize, pulses are very suitable for Punjab's southern districts. Maize and sugarcane are suitable for areas in and around the Kandi belt. "There is no dearth of viable alternatives and farm enterprise which can easily replace the income being obtained from a crop like paddy,"

6. Cost of Water

   It is high time to move away from paddy and opt for less water-consuming crops like oil seeds and pulses, S S Johal, Chancellor and Agriculture Economist, Central University of Punjab said. "Water exploitation is fast

turning Punjab into a desert and it is not at all in the interest of the country as Punjab is the largest provider of food grains for national food security."

Johal sees the availability of free water to farmers as the main hurdle in promoting diversification from water-guzzling paddy. The cost of water is not factored in while fixing the minimum support price of paddy, he pointed out. The expenditure towards providing free water should be diverted to installing efficient irrigation systems, like drip or sprinklers, is what is suggested by him.

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REVISIT TENDERING SYSTEM FOR CONTRACTS: FICCI

New Delhi: Industry body Ficci on Tuesday said it has urged the government to revisit the tendering system for construction work contracts, claiming that the current least-cost selection method or L1 may not be the most appropriate and suitable method to award a contract.

"...it is well founded that the current contract tendering system by government and public undertakings based on least-cost selection method has shortcomings given the number of infrastructure and other projects facing concerns of delay, quality and disputes, ultimately leading to time consuming arbitration and higher costs," K K Kapila, co-chairperson, National Committee on Infrastructure, Ficci, said in a statement. Experience in India has shown that officials in procuring departments and agencies, in order to maintain utmost probity and transparency, prefer to adopt the least cost principle for the award of contracts. This in turn has resulted in bidders seeking to win contracts by putting in extremely low bids that are eventually found unworkable, leading to huge delays, cost overruns and disputes often ending in the termination of contracts, Kapila said.

It is necessary, therefore, to seriously examine our present procurement procedures to ensure that we achieve our objective of quality, timely completion of works contracts, within the stipulated costs, Kapila added. *(PTI)*

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URGENT ACTIONS TO SAVE RIVER YAMUNA

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It was an eye opening and very useful visit to observe the pollution in River Yamuna on Saturday, 4th May, 2019, organized by the American Center. Based on the observations made, suggestions are given for the public at large, NGOs, RWAs and Government Bodies for actions which need to be taken urgently.

RIVER YAMUNA – CURRENT SCENARIO

1. In the last two decades more than Rs.6,500 crores has been spent to clean the River Yamuna. However the Central Pollution Control Board (CPCB) has stated that the polluted stretch of Yamuna has increased from 500 km to 600 km.

   To support aquatic life, water should have 4.0 mg/l Dissolved Oxygen. The values of the parameter in the River Yamuna vary from 0.0 mg/l at Wazirabad Barrage in Delhi to 3.7 mg/l at Agra.

   Water pollution is measured by measuring its Biochemical Oxygen Demand (BOD) levels and the permissible range is 3 mg/l or less. For the most polluted stretch of the Yamuna it ranges from 14 to 28 mg/l. The BOD is increasing because there are numerous untreated sewage drains which dump polluted water into the River Yamuna.

Photo 01: *Author with Mr. Vimlendo Jha, Environmentalist on the trip to review pollution in River Yamuna*

Wherever the group went it was evident that Swachh Bharat Abhiyan was still to be adopted and practiced. The message regarding cleanliness needed to be still disseminated; garbage was strewn all along the banks amidst the green patches of trees and shrubs. There were squatters and slums, dwelling places for humans and animals. Delhi, with its population of one crore ninety lakhs straddles over 22 kilometers of Yamuna and depends on it for 70% of its water supply. While Delhi constitutes less than 2% of the river's total length, it contributes to about 80% of the Yamuna's total pollution load and Agra contributes about 11%.

During the very short stretch, for the Yamuna is 1,376 kilometers long, through Delhi, effluents and sewage from local industries and residential colonies have been allowed to flow into the river, which has resulted in this stretch of the river being clinically dead by all water quality indicators. As the team walked along with the Guide, the latter's enlightening commentary on the state of River Yamuna only served to portray how URGENTLY ACTION is needed to SAVE the River Yamuna. The visit started at Khajuri Khas/ Sonia Vihar 5 km upstream

of Delhi, where the Guide informed the river has a thriving eco-system and serves as a source of livelihood for fishermen and farmers. Most of Delhi's drinking water comes from that area. Although the river looks clean at that location, it is highly polluted due to the presence of fertilizers and pesticides coming in with agricultural run-offs. Next the team went to Wazirabad Barrage, the point where the River Yamuna enters Delhi. The barrage was constructed for flood control and irrigation purposes, but it now also serves as a political boundary between Delhi and Haryana. The gates of this barrage are usually closed for 8-9 months in a year, allowing a very low quantity of fresh water into the river in the Delhi stretch.

Thereafter the team moved to the Najafgarh Drain, which the old maps of Delhi and Rajasthan describe as 'Sahibi River' while in reality out of the 20 drains of Delhi, this is the biggest and blackest one and dumps 1500 million liters of waste water into the River Yamuna every day. The team then moved to Kudsia Ghat, opposite Inter-State Bus Terminus (ISBT). While boat ride was enjoyable at the ghat, more waste was seen polluting the river. It was primarily waste generated by religious activities and wastes from the adjoining Nigambodh Cremation ground—the biggest one in Delhi.

The Yamuna Action Plan (YAP) is for cleaning the river. Since 1993, Japan International Cooperation Agency, Government of Japan (JICA) has been assisting the Government of India to clean the River Yamuna in phases; 39 sewage treatment plants in 29 towns of Uttar Pradesh, Haryana and Delhi were built in Phase I of the plan. Around Rs1,500 crore has been spent under Yamuna Action Plans I and II but the plight of Yamuna River is still far from satisfactory as the basic requirement to curb the daily pollutants into the River has still to be enforced.

Photo 02: *Nigambodh Ghat - bodies are cremated on river bank and half burnt bodies consigned to River Yamuna.*

2. The burning of dead bodies on the banks of River Yamuna including at Nigambodh Ghat and then letting some of the half burned bodies float away in the river needs to be stopped immediately and a heavy fine imposed for any such act. There is a crematorium provided for use nearby, the use of which must be enforced so that such blatant polluting of River Yamuna is stopped.

3. The 'Sahibi River' which used to join the River Yamuna is now known as the Najafgarh Nala which discharges black colored, foul smelling and highly polluted water in to the River Yamuna. It is imperative that this polluted water be first properly treated before letting it flow into the river. The ETP set up for treating effluent from the Nala is not meeting required standards hence foul and polluted water is still being let into River.

Photo 03: *Najafgarh drain - used to be 'Sahibi River', is now polluting River Yamuna.*

4. It was noticed that posh cars drive up on to the Shadara Bridge, park on the side and throw garbage into the River Yamuna. This needs to be stopped URGENTLY. At least one policeman needs to be deputed on the bridge to ensure that such dumping of garbage is stopped and the concerned municipal authority asked to put CCTV cameras to record the registration number of the vehicles which violate. Signage also needs to be prominently put on the approaches to the bridge that anyone throwing anything in to the river would be fined and the same needs to be enforced strictly and systematically.

Photo 04: *Shadhara Bridge where vehicles stop and dump garbage in River Yamuna.*

5. To control floating debris, it is suggested that Trashnet debris control systems be installed at every two kilometer on the 22 km stretch of River Yamuna passing through Delhi. The Guide informed that in the US, the Trashnet Debris Control Systems are used to effectively manage floatables. Details of the Trashnet Debris Control Systems are given below. Such systems could be installed to properly utilize a fraction of the unspent money allocated for the Yamuna Cleanup Action Plan.

Corrective actions need to be taken urgently by Member Secretary, DPCC, Chief Minister, Delhi Shri Arvind Kerjiwal and Hon'ble Minister of MOEF&CC, Shri Prakash Javadekar to ensure the implementation of the above 5 action points appropriately to save River Yamuna.

Environment Protection

Waterway Protection

STATE OF YAMUNA – A RIVER REQUIRING URGENT CLEANING IN THE DELHI STRETCH

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Yamuna is one of the sacred rivers of India and the largest tributary of Ganga River. It originates from the Yamunotri glacier in Uttarakhand and passes through Himachal Pradesh, Tajewala - Haryana, Wazirabad- Delhi, Okhla – Delhi, Okhla barrage to the confluence point of Chambal River and merges into River Ganga at Prayagraj. The total length of the Yamuna up to its point of confluence with the Ganga at Prayagraj is 1376 km; its catchment area is spread over 3.67 lakh sq kms.

A large stretch of River Yamuna passes through extremely densely populated areas where vast quantity of sewage is being discharged directly into the river with the Delhi stretch being the most polluted section of the River. It has no fresh water augmenting it after the Wazirabad barrage in Delhi. About 3911 MLD of treated/ untreated wastewater is discharged by 22 major drains in the 22 km long Delhi segment. It is only after the confluence of River Chambal near Etawah, UP, 560 km downstream of Okhla Barrage, that the water quality of River Yamuna improves.

Yamuna at Kalindi Kunj – Bidding goodbye to Delhi from Okhla Barrage

Najafgarh Drain at Balsawa

Najafgarh Drain near BSF Camp, Chawla

LIQUID WASTE

CPCB (Central Pollution Control Board) analyzed the water quality data under the National Water Quality Monitoring Programme (for the year 2016 and 2017) statistically. The monitoring locations exceeding the water quality criteria were identified as polluted. The polluted stretches of Yamuna River coming under Priority I (Monitoring locations exceeding BOD 30 mg/l and all monitoring locations exceeding BOD concentration 6 mg/l on all occasions) are:

Sl. No.	Polluted Stretches	BOD Range in mg/l
1	Delhi - Wazirabad to Asgarpur	9 - 80
2	Haryana - Panipat to Sonepat	4 - 55
3	Uttar Pradesh - Asgarpur to Etawah, Shahpur to Prayagraj (Balua Ghat)	2 - 55

Nursing Home Drain

The 22 Drains discharging into River Yamuna are the Shahdara Drain, Najafgarh Drain, Delhi Gate (Power House) Drain, Sen Nursing Home Drain, Drain No.14, Barapulla Drain, Maharani Bagh Drain, Abu Fazal Drain, Jaitpur Drain, Tuglakabad Drain, Abandoned Agra Canal at Okhla Vihar, Abandoned Agra Canal at Kalindi Kunj, Magzine Road Drain, Sarita Vihar Drain, Molarband Drain, Sweeper Colony Drain, Khyber Pass Drain, Metcalf House Drain, ISBT + Mori Gate Drain, Tonga Stand Drain, Kailash Nagar Drain, and Civil Mill Drain.

Liquid Pollution Abatement Efforts

Cleaning of Rivers is an ongoing process and Government of India, through the Ministry of Jal Shakti and its implementing arm the National Mission for Clean Ganga, is supplementing the efforts of the State Governments for checking the rising level of pollution of River Yamuna by providing financial assistance to the States of Haryana, Delhi and Uttar Pradesh in a phased manner since 1993 under the Yamuna Action Plan (YAP). Under the YAP Phase – I & II, an expenditure of Rs. 1514.70 crores has been incurred for creation of sewage treatment capacity of 942 MLD and rehabilitation of 328 MLD STP in the States of Haryana, Delhi and Uttar Pradesh for conservation of River Yamuna. The major works under JICA (Japan International Cooperation Agency) assisted YAP relate to sewerage system/ interception and diversion of drains, Sewage Treatment Plants (STPs), low cost sanitation/ community toilet complexes, electric/ improved wood crematoria, etc.

Details of YAP Projects:

Presently in Delhi, under the Namami Gange Programme (NGP), a total of 14 projects have been taken up at a cost of Rs. 2421 crores by NMCG to conserve the River Yamuna. Major projects are for the sewerage infrastructure. All are at various stages of implementation and expected to be completed by year 2022.

A total of 8 sewerage infrastructure projects amounting to Rs 1435 crores in Delhi for creation of 564 MLD STP capacity at Okhla and rehabilitation and upgradation of 386 MLD STP capacity and rehabilitation of Trunk Sewer and Rising Main of 35 Km length in Kondli & Rithala zones under JICA assisted YAP-III project. All 8 projects are at various stages of implementation. In addition to the 8 projects, two more projects of Public Relation & Public Outreach and Consultancy (PMC) have also been sanctioned.

In addition to these, three projects 318 MLD WWTP at Coronation Pillar, Construction of 7 prioritized STPs (94 MLD) in command area of Najafgarh Drain and 9 decentralized STPs (22.5 MLD) in Chattarpur have been sanctioned for a cost Rs. 925 crores.

In Himachal Pradesh, NMCG has approved the project "Sewerage Scheme of Paonta Town in Paonta Sahib, District Sirmour, Himachal Pradesh" at a cost of Rs. 11.57 crore.

In Haryana, a total of 2 projects "STP & Sewerage works" in Sonipat and Panipat towns sanctioned at total cost of Rs. 217.87 crore have been completed under Namami Gange Program by NMCG to conserve the River Yamuna.

In Uttar Pradesh under Namami Gange Programme, 8 projects have been taken up viz. Baghpat (14 MLD STP), Vrindavan (Mathura) rehabilitation of 4 MLD, Mathura (30 MLD new STP & 37 MLD rehabilitation of existing STP), Agra (175 MLD), and Etawah (21 MLD new STP & 24 MLD rehabilitation of existing STP), at a cost of Rs. 1960.6 crores to conserve River Yamuna. A 6.25 MLD CETP has also been taken up at Mathura to treat the effluent from the textile industries.

Municipal Solid Waste (MSW)

In addition to disposal of untreated sewage and industrial effluent, dumping of MSW and Construction & Demolition (C&D) waste on riverbanks has further hampered the self-cleansing capacity of River Yamuna.

Municipal Solid Waste contributes to Yamuna's Pollution in broadly two ways:

- Direct contamination when solid waste enters into River Yamuna directly or through tributaries/ drains.
- **Contamination by Leachate:** When water comes into contact with organic fraction, a black coloured toxic liquid with pungent odour called Leachate is formed. Leachate often contains heavy metals and has high levels of BOD.

Solid Waste Disposal into river during religious ceremonies

Tromel for Biomining at Ghazipur dumpsite

Drain flowing adjacent to Ghazipur dumpsite

Delhi generates over 9,500 tonnes per day (TPD) of garbage. About 8,000 TPD of waste is collected and transported to three uncontrolled unlined dump sites at Bhalswa, Okhla and Ghazipur, whereas the Municipal Solid Waste Management Rules, 2016 (MSW Rules) mandates that only inert fraction of MSW should be disposed into Scientifically constructed Sanitary Landfills after processing. In absence of proper impervious lining, leachate generated from these dumps seeps into the ground which not only contaminates the ground water but also pollutes the nearby drains which directly or indirectly meet River Yamuna.

These three dumpsites have collectively accumulated 2.9 crore metric tonnes of garbage, and are spread over 152 acres of land. The Ghazipur dumpsite, the biggest of the three is spread over 70 acres. Bhalswa holds about 90 lakh tonnes and Okhla 60 lakh tonnes. Commissioned in 1984, the Ghazipur landfill exhausted its capacity in 2002 along with the Bhalswa landfill which was commissioned in 1994. Similarly, the Okhla landfill was commissioned in 1996 and exhausted its lifespan in 2010.

Delhi has 3 Waste to Energy plant of capacities 16MW, 12MW, and 14MW at Okhla, Bawana, and Ghazipur respectively in addition to a few big and small (decentralized compost plants). The installed waste processing capacity is adequate to cater for entire Delhi however the bigger concern in terms of deterioration of Yamuna's water quality is the legacy waste lying in these 3 dumping grounds which are massive sources of leachate.

These 3 dumpsites have already exceeded their capacity and are already overloaded, but in absence of an alternative site, more waste is being dumped on these sites only. The National Green Tribunal (NGT), on July 17, 2019 has asked the three Municipal Corporations of Delhi to abandon their plans to cap the landfill by greening them, and instead go for bio-mining and bio-remediation to recover the precious land.

MSW MANAGEMENT EFFORTS IN YAMUNA IN THE DELHI STRETCH

As directed by the NGT, the East Delhi Municipal Corporation has engaged a company to bio-mine and bio-remediate the garbage present at the Ghazipur dumpsite by first segregating the different components of the waste (organic fines, bricks, stones, plastics, metals and cloth rags) and send them for disposal in an eco-friendly manner and then add enzymes to the organic fraction to speed up its decomposition. The landfill has about 1.4 crore metric tonnes of garbage with 2,200 metric tonnes waste being dumped there daily. Presently 1,500 tonnes per day (TPD) of garbage is being bio-mined.

Other 2 civic bodies have taken up similar initiatives. The North Delhi Municipal Corporation (NDMC) has deployed nine trommel machines at the Bhalswa landfill. Each of these machines process about 300 tonnes of waste per day. The Bhalaswa dumpsite receives about 2,000 tonnes of waste per day.

For capturing floating garbage from Yamuna, NMCG has deployed 2 Trash Skimmers to clean the 22 km stretch of River Yamuna in Delhi. Each Trash Skimmer is accompanied by 10 workers to manually clean the shallow areas inaccessible by Trash Skimmer or during Monsoon season where Trash Skimmer is not operated due to safety reasons.

CONCLUSION

There is a need to maintain E- Flows or minimum ecological flows in the river, floodplain and wetland management and rejuvenation of water bodies. Recycling/ reusing of treated sewage has to be encouraged to reduce water abstraction from the river. Efficient irrigation methods like sprinklers or drip method should be used; organic farming, adoption of conservation agriculture, crop diversification, etc. have to be promoted, effective check on industrial pollution by ensuring in-situ treatment of effluents is required. There is shortage of landfill sites in Delhi; hence most wastes are dumped in the river. It is necessary to identify more landfill sites in Delhi. Afforestation along the river is also an essential component of river rejuvenation.

It is expected that the actions initiated and being implemented would help to control the pollution of the River Yamuna, however what is also necessary to be done is to educate and train the people regarding preventing pollution by inculcating knowledge of hygiene through social media and other means plus also each person's responsibility to their children, other family members, neighbours and the society at large.

POLLUTION CAUSED BY CONSTRUCTION SITES

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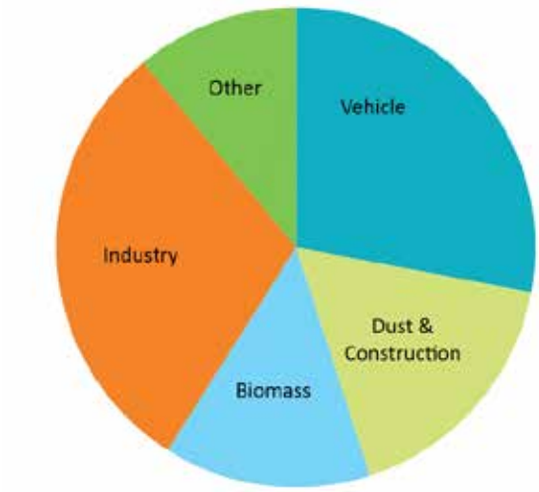
Infrastructure is the back-bone of economic development and is thus essential for development. However, all construction sites generate high levels of pollution which can get carried for long distances over a long period of time. As per the Delhi Pollution Control Committee (DPCC), 30 percent of air pollution is caused due to dust which emanates from construction sites. It is therefore necessary to identify the sources and contain the pollution.



Source: *NCAP Report*

Source of pollution at Construction Sites

Construction activities such as land clearing, operation of diesel engines, demolition, burning, and working with toxic materials contribute to air pollution.

- **Construction dust:** Construction and demolition operations contribute to windblown dust problems - sometimes called fugitive dust - onto nearby roadways which can remain in the air for days or even weeks.
- **Engine exhaust:** A big source of PM 2.5 on construction sites comes from the **exhausts of diesel engines,** of diesel generators, vehicles and heavy equipment.
- **Noxious vapours:** from oils, glues, thinners, paints, treated woods, plastics, cleaners and other hazardous chemicals that are widely used on construction sites, also contribute to air pollution.
- **C&D Waste:** The waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair and demolition of any structure. The Construction industry in India generates about 10-12 million tonnes of waste annually.

Rules and clearances for Construction projects

The Ministry of Environment and Forest has made it mandatory to obtain environmental clearances for construction projects having covered built-up area greater than 20,000 sq.m.

The Government of India has set guidelines and made it mandatory for construction site owners to implement dust preventive measures in order to minimize the impact on the environment. A few of them are:

- Construction material at the site and on the vehicles that carry them should be properly covered.
- Keeping the ground at construction sites moist to let the dust settle and inhibit it from spreading.
- Setting barriers around construction site and covering mounds of sand with dust barrier sheets.
- The construction companies are being asked to submit reports on the current status of construction and the steps being taken by them to comply with the Ministry of Environment and Forests Guidelines, 2010, on Prevention of Dust and Garbage Accumulation on Construction Sites
- Littering or obstruction to public drains, water bodies, traffic and direct dumping of construction and demolition (C&D) waste in landfill sites should not be done.
- According to the C&D Waste Management Rules, 2016, the system should contain proper collection of segregated C&D waste from the generator, proper transportation of waste, storage of waste followed by proper processing of waste into recycled or reusable products that have market value and where minimal rejects are produced which get disposed in designated landfills.

Good pollution control practices currently followed by leading construction companies at construction sites:

Sustainable site planning

- Except the development area of a construction site, other areas to remain unaffected.
- Planning of Optimized vehicular path during construction for minimum disturbance and exhaust emission
- Measures are taken to protect top soil for future use as designed (refer Exhibit 1 and 2)
- To protect soil erosion, construct swale for runoff discharge and pits for sedimentation before discharge (Refer Over All Site Logistic plan; Exhibit 8)

Exhibit 01: *Removal of top soil*

Exhibit 02: *Preservation of Top Soil within Site premises*

REDUCED AIR POLLUTION DURING CONSTRUCTION:

- All inward and outward material transportation (having possibility of dust emission) to be kept in covered vehicle (Exhibit 3)
- On all non-paved vehicle movement paths the dust is to be kept suppressed by sprinkling of water (Exhibit 5 & 6)
- All demolition and dust emitting works area to be kept moist (Exhibit 5 & 6).
- Nose mask to be provided to workmen for working in dust related material handling.
- Site Perimeter wind breaker to be erected up to 6m height.(Exhibit 7)
- All material, which may cause air pollution to be kept covered (Exhibit 4)
- Building perimeter scaffolding to be kept covered by a green cloth

Exhibit 03: *Dumpers carrying excavated material are covered*

Exhibit 04: *Trucks/ Trailers are fully covered while carrying construction material*

Exhibit 05: *Water being sprinkled on an access road to suppress dust*

Exhibit 06: *Water being sprinkled on an access road to suppress dust*

Water Management

For Efficient water use during construction, following practices are adopted:

- Use of Batch mix concrete
- Moist curing/ Curing membrane
- Use of recycled water
- Re use of collected water
- Collection of runoff, sedimentation and thus facilitating natural recharge of ground aquifers by percolation (Exhibit 8)

Exhibit 07: *Site perimeter wind breaker*

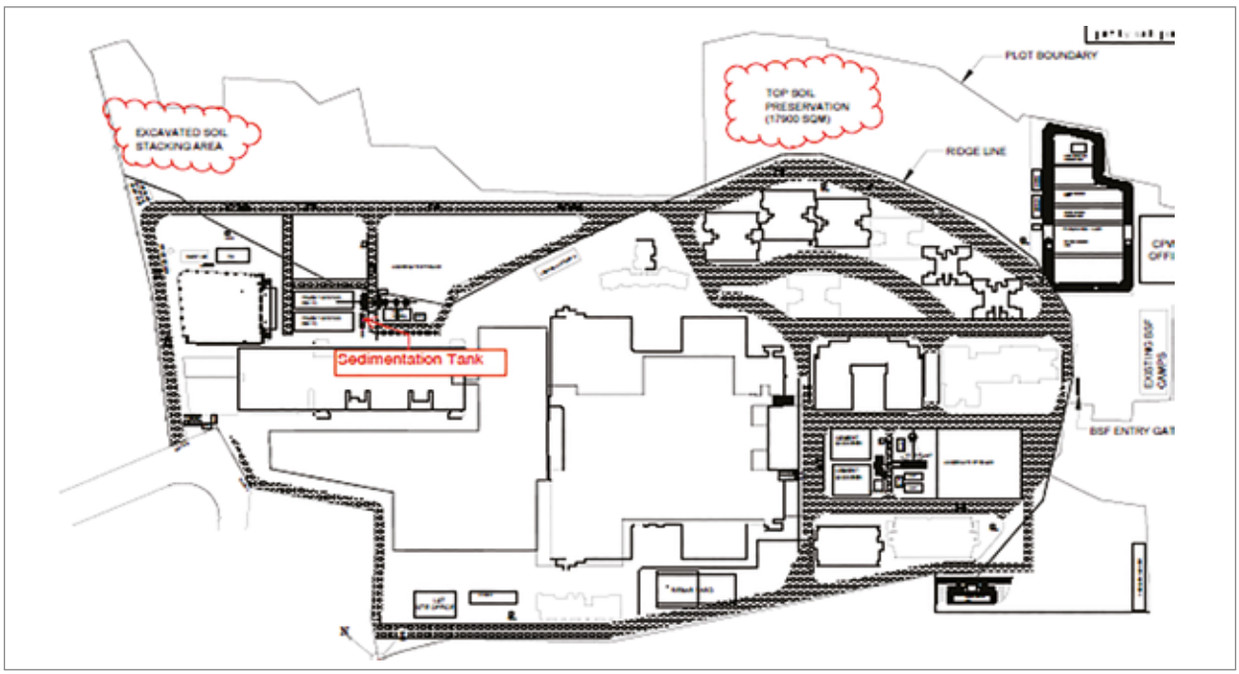
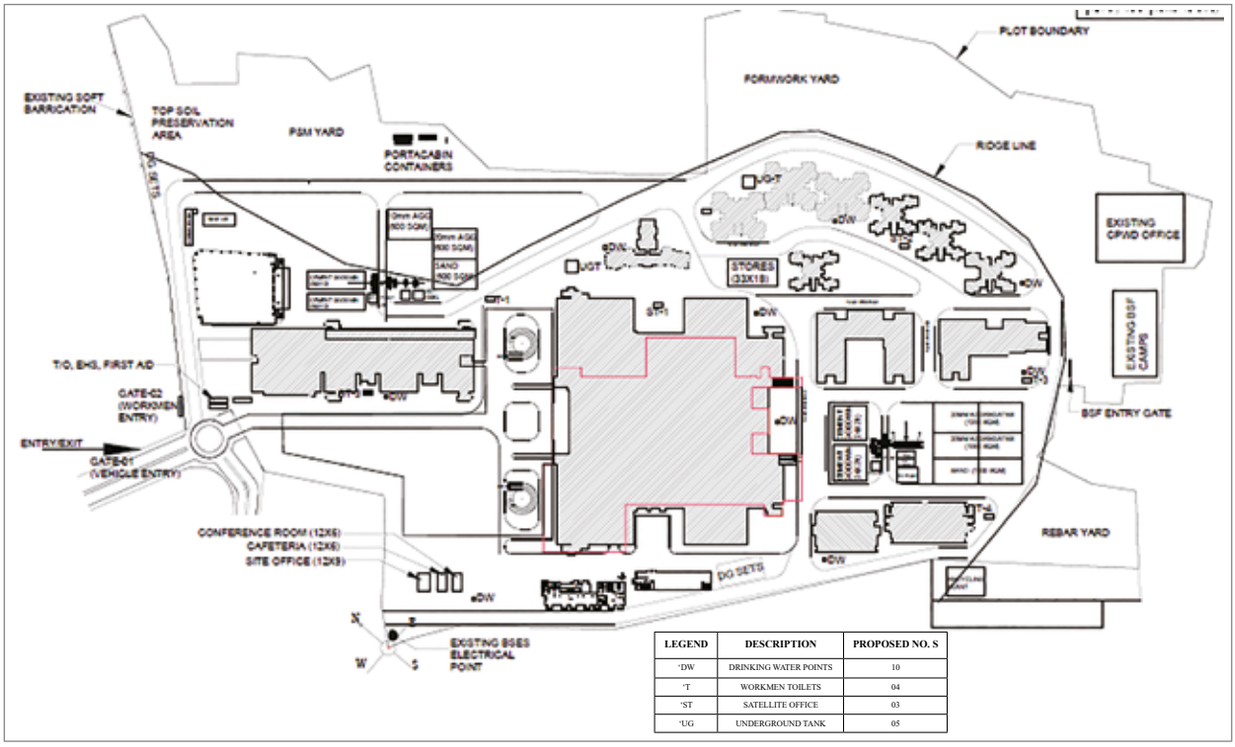


Exhibit 08: *Sample Site Logistic Plan at Construction Site (marking Excavated earth stack area, Top Soil preservation area, Sedimentation Tank among others)*



LEGEND	DESCRIPTION	PROPOSED NO. S
'DW	DRINKING WATER POINTS	10
'T	WORKMEN TOILETS	04
'ST	SATELLITE OFFICE	03
'UG	UNDERGROUND TANK	05

** No And Location May Change as Per Site Requirements*

Exhibit 09: *Sample Site Logistic Plan at Construction Site (marking First Aid, Drinking Water, and Toilets facilities among others)*

Exhibit 10: *PPE & RMC*

Exhibit 11: *Workers Facilities*

LOOKING AHEAD:

The Government, Municipal Corporations, Local Bodies and Authorities must ensure that the construction industry strictly adheres to environmental regulations. Citizens could assist by reporting on projects which are not adhering to the relevant guidelines.

The Green Building Movement by the Indian Green Building Council (IGBC) formed by the Confederation of Indian Industry (CII) has rating systems:

- US based LEED certification managed by CII focuses on 5 factors: (i) Energy savings, (ii) Water efficiency, (iii) CO_2 emissions reduction, (iv) Improved indoor environmental quality, and (v) Stewardship of resources and sensitivity to their impacts.
- National Rating System - GRIHA initially conceived and developed by TERI (The Energy & Resource Institute) also has 5 criteria categorized into (i) Site Planning during building planning and construction stage, (ii) Water Conservation, (iii) Energy Efficiency, (iv) Waste Management, and (v) Environment for good health and wellbeing.

Incorporating the carbon footprint, pollution and waste created during the construction process into such certification systems would both help educate as well as incentivize construction projects to adopt more environment friendly construction practices.

DELHI GETS FIRST SMOG TOWER

Source: *The Time of India; 4 Jan 2020*

The smog tower has been installed by the Traders Association Lajpat Nagar . It will aim at treating 2,50,000 to 6,00000 cubic meter air per day and release fresh air in return.

The newly installed air purifier at Lajpat Nagar central market, in New Delhi, Thursday, January 2, 2020. The smog tower will purify the air within a circumference area of almost 500 meters to 750 meters.

Read full news at : https://www.hindustantimes.com/delhi-news/delhi-gets-1st-smog-tower-today-5-things-about-the-air-purifier-at-lajpat-nagar/story-jjx9ki6YVqmbvi71pJKSZL.html

ENVIRONMENTAL ENGINEERING IN BUILT-UP AREAS

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OVERVIEW

An earlier article, ***"Environmental Possibilism,"*** (VIEWPOINT, March 2018), the author identified that, "Pollution of the Environment is one of the biggest hazards ever experienced, which human beings are facing today due to the ***Environmental Possibilism*** theory happening in every country and that affects human-cultural ecology and contributes to the global climate change." However, that addressed the ecological aspect of what could be from the oil and gas perspective, the airborne pollution from natural, commercial, and industrial sources. The economic growth of some countries resulted in what can now be termed as irresponsible development since it resulted in environmental pollution - as a result of increased production of waste and rapid urbanization including construction industries that contribute to particulate emissions and pollutions in the environmental ecology and affect human health. One of the concepts of Environmental Possibilism - the pollution from the construction built-up areas is dealt with in this paper together with the cause and effect matrix with a case study based on the construction industry experiences.

ENVIRONMENTAL INSIGHT

Out of all the industries and business practices in the world, construction is one of the most extensive and intensive for a country's socio-cultural development, economic aspects, and market values for the activities like those happening in all developing areas of the world.

Construction activities are thus one of the major sources of pollution contributing to **air, water** and **noise pollutions** plus **dust, waste and light pollutions** and the **emissions of hazardous gases and also the waste** that go unnoticed in a construction environment. However, they all affect the health of the construction workers in a silent manner. In addition where heavy construction equipment is used, more energy is consumed to build buildings and infrastructure development each day compared to traditional modes and norms which albeit take longer to construct. Cement is a standard and primary material of construction; however, the cement manufacturing processes itself causes pollution since limestone is heated to more than 2600° F (1427° C). Producing 1-ton of cement causes roughly a ton of CO_2 emission due to the burning of fossil fuels. Cement manufacturers have been tagged by the US EPA *(United States Environmental Protection Agency, n.d.)* as one of the third largest sources contributing to greenhouse gas. The other major construction material - steel also contributes to greenhouse gases.

The construction industry contributes about 4% of particulate emissions (J. Gray, 2019 to pollution in the environment. It also causes water pollution incidents, noise complaints throughout the activities, and also soil pollution.

In, *"Challenge of Environmental Advocacy in Construction Industry"*, Durreesamin Journal, *December 2018* the author mentions that after the construction stage is over, the building maintenance costs has 40% energy component which is used for lighting, air conditioning, heating, and other building electrical components. It is thus responsible

for 30% of the world's carbon emission. Hence, many stakeholders are concerned with how to minimise the direct impact on the environment. One way of course is to construct eco-friendly buildings. Environmental advocates implore that all government agencies should cooperate with the policy- that is issued and implement them well so that there can be eco-environment for the building facility as per the green building principles.

Built-up Areas Categories of Environmental Pollution

Building and infrastructure constructions which are essential for nation building result in environmental pollution, which affects the landscape ecology as well as human health. The case of the construction industry which plays an important role in economic development is presented in this paper with relevance to the construction development in Qatar which is being addressed and known internationally as one of their pillar industry's economic progress. Qatar's construction industry has brought with it great opportunities not only for the local citizens but also for the expatriates working for the country's development. However, the activities are producing a number of pollutants unknowingly and affecting the quality of life plus destroying most of the ecological environment in spite of the push for sustainable development.

All the categories of environmental pollution that contribute to the built-up areas within the construction environment need to be addressed.

AIR POLLUTION

In *"Engineering Consultancy in the World's Environmental Movement,"* (Viewpoint, December 2018), the author has provided a brief discussion on the topic of "Pollution," and explained that most of the environmental pollution concerns arise due to the effect of site construction, which is the leading cause for air pollution generations.

Air pollution, however, is also caused by volatile organic compounds from the building materials through radiation and influence of decoration materials, and building services materials. The pollutants formed are formaldehyde and noxious vapours or gas from the building paints, thinners, coatings, asphalt, adhesives, oils, glues, treated woods, plastics, cleaners, and other hazardous chemicals being employed in the building construction environment. Air Pollution in the construction sites has a negative impact, affecting everyone at the site and the neighbourhood and can result in severe sickness and injuries. The pollutants being formed and produced from the building materials supplied for the construction affect the body's nervous, blood circulation, respiratory, and the reproductive systems. They are great risks and can cause harm due to the polluted air people always breathe on a construction site.

Apart from the combination of dust pollution in the air as discussed below, deployment of heavy equipment is an additional factor that contributes to air pollution due to the use of diesel fuel. These kind of activities on site are said to be responsible too in the ecological aspect for the emissions of carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons, straight-chain hydrocarbons, aldehydes, ketones, halogenated hydrocarbons, alcohols, and the like.

Dust Pollution

Construction activities result in a high level of dust due to activities such as land clearing, excavation, filling, piling, concreting, cement work application – plastering, etc., use of sand and crushed stone, wood, etc. with the dust and sand flying all over. As seen in Photo-01, dust pollution is the most prevalent on every project site. The dust generated at a construction site is classified as PM10, (particulate matter of size less than 10 microns). The dust is invisible to the naked eye, and is dangerous to human health.

The heavy construction equipment excavators, levellers, cement transporters, concrete mixers, transit mixers, concrete pumps, compressors, all cause air pollution. Likewise, sources from the carpentry area emit sawdust. Other building materials also, while being transported or handled or due to human or some meteorological factors, cause dust pollution - limestone, gypsum, backfill yarn, etc. All these dust have a great impact on human lungs since the dust inhaled goes to the lungs and is irreversibly retained there and at times is fatal.

Photo 01: *Dusty Environment in a construction area*

Waste Pollution

Building waste is an offshoot of construction and needs to be managed as per a proper strategic plan as a part of the Project Construction Management. This is often neglected or compromised resulting in harm to construction personnel. The solid waste also damages the construction environment and human health as it is mainly composed of sediment, masonry and concrete fragments, scattered mortar and concrete, variety of building materials, packaging and garbage, generated waste from reinforced concrete, metal, wood, bamboo, glass, variety of plastics, etc. as shown in Photo-02.

Photo 02: *Air & Waste Pollution in a construction area*

Emissions of hazardous waste

Throughout building construction, the hazardous waste category forms a major part. All the chemical toxic waste materials including packaging as shown in Photo-03 are scattered all over the site. Emissions of hazardous waste occur from building materials such as waste aluminum foil, paintbrushes and cans; scrapped mercury thermometers; oil gloves; concrete laboratory wastes such as sodium hydroxide, potassium hydroxide, potassium dichromate, acids, etc. Then there are site office wastes such as paper, printer/ copier waste cartridges and the fumes emitted, ribbons and other stationery. Add to those the waste generated from hand tools, cleaning tools, machinery maintenance liquid waste, waste batteries, disks, batteries of calculators, light bulbs, fluorescent tubes and many other materials which are scattered all over construction site. Photo-03 shows a construction area - the hazardous and spoiled waste contributes to bad odor within the construction environment.

Photo 03: *Hazardous Wastes in a construction area*

Noise Pollution

Noise is another prevalent form of pollution and is mainly generated from the heavy equipment. Photo-04 shows drainage network and road refurbishment improvement which causes continuous noise pollution. In a building construction site the machinery and transport vehicles deployed are far more and result in greater noise pollution.

In a general building construction site noise pollution occurs at all stages starting from the earthwork, piling (where being done), structure and renovation phases.

Photo 04: *Pollution -Noise, Air & Dust, in a construction area*

Noise is also generated by workers shouting or their walky-talkies systems turned on loud for communicating with others. All the excessive noises create a distraction and annoyance and can lead to high blood pressure and hearing loss resulting in extreme stress and sleep disturbance. Research and study advise that since high noise level impacts life's normal cycle and hence precautions must be taken.

Water Pollution

Water pollution is also prevalent at sites. Wastewater spillage from a sewer pipeline project occurs when it is being extended and the last manhole is already full. The air remains polluted till the work is over and the site cleaned. Photo-05 shows one such condition. Water pollution also occurs while cleaning a well point dewatering system from a building basement and the pipe discharging into the nearest sewer manhole. Other cases can be the sludge generated during construction of pile foundation or spillages of wastewater from the pipeline. Sometimes, there is leakage from the temporary sewer pipelines.

Photo 05: *Stagnant wastewater at a sewer line extension work or well point dewatering system*

Construction Debris

Apart from the forms mentioned above there are other sources - diesel and oil spillages from equipment usage, plus harmful chemicals from paints, solvents, and cleaners whose residues in building sites cause water pollution. The construction debris and dirt also cause soil erosion. Whenever land is cleared for construction it leads to silt- run-off and results in sedimentation of the pollutants into natural waterways restricting sunlight and destroying aquatic life. The surface water run-off can carry other pollutants that could poison aquatic life and also the animals that drink from the stagnant water. The pollutants at the construction sites also silently seep directly into the groundwater, which if it is to be used as potable water source, would be difficult to treat.

of all pollutants, construction waste is the most prevalent and noticeable. Control of materials which are principally used in building is problematic but with an Environmental Strategic Plan their impact could be minimized. Refer Photos-06 and 07.

Photo 06: *Waste Environment in a building construction site*

Photo 07: *Waste Materials at a construction site.*

Light Pollution

Lighting is common and is essential for nightshift work but adds to light pollution, a new source of environmental pollution in modern times in addition to the contaminated waste materials and chemicals, stagnant wastewater, air, dust, and noise found at construction sites. Light pollution is also created by the sparks caused by grinding, welding, etc.

Persons who are exposed to severe light pollution have a tendency of worker's blindness and can lead an uncomfortable life.

Construction Environmental Management Planning Study

Considering all the polluting factors as mentioned earlier, an Environmental Management Plan is a good strategy to mitigate the pollution issues. Table-03 provides a plan based on the author's experiences at construction sites. The environmental policy must be drafted and adhered to by all individuals concerned. For that all personnel regardless of rank or position must be made aware of the policy and their responsibility for abiding by it. The responsibilities of the contractors should include the following:

- Commitment to continual improvement and prevention of pollutions,
- Commitment to comply with relevant legislation and regulations, and
- A framework for setting up and reviewing the environmental objectives and targets.

The policy should be maintained, implemented, and communicated to all employees working on whatever or wherever at the construction site. It must be made available to interested parties to enhance their construction activities sustainably for the common good.

A case study is presented in Table-03 for the Environmental Risk Evaluation For Construction Activities. It also deals with how to mitigate pollution from different sources. First an initial Environmental Risk Evaluation needs to be carried out and each risk rated by giving a score between 1 and 9 based on its impact – refer Table-01.

F*I Score		Impact (I)		
		High	Medium	Low
Frequency (F)	High	9	6	3
	Medium	6	4	2
	Low	3	2	1

Table 01: *Frequency-Impact Score Sheet*

Scores of 4 and above represent risks that must be managed and/or mitigated. Those should be carefully studied as to how to prevent their occurrence. In addition, they must be recorded in a register for monitoring purposes during the contract duration. The contractor must review and modify the environmental risks and update the register for improvement in the manner of performing the day to day activities.

Strengthening the Control Measures through Project Supervision and Management

Considering all the pollutions in a construction area as discussed above, the Frequency-Impact Score valuation can help improve the construction activities through the Environmental Management Planning control measures and careful site supervision of the conditions that would help manage the construction activities as per the following strategies:

- The management needs to enhance awareness about the environment issues by incorporating them in the construction ideology and ensure its implementation and adherence by all concerned working on the site so as to assure health for all by maintaining a safe environment.
- Deploy the ISO14000 Environmental Management System to establish the essential requirements in implementing the Construction Environmental Management System standard and align the construction procedure documents with it. The documents must be easy to access by all and monitored to ensure that they provide environmental protection work instructions for all trades and all type of works and personnel.
- In order to make implementation more effective at a site, the Construction Organization and Management Policy must be strengthened accordingly. The Project Manager should lead the Construction Project Environmental Protection Unit. The Work Breakdown Structure (WBS) should be designed so that the required individual's responsibilities are defined, and an Assessment System used to monitor and record.

Strengthening the Technological Effect for Prevention of Noise Pollution at a Site

For noise abatement, effective control measures should be put in place for noise protection by installing security curtains within the construction area. At the same time, improve the process of man-made activities by eliminating unnecessary factors that create loud sounds so that noise would be controlled or even minimised to be within the regulatory norms.

The construction phase that produces high noise levels from the construction plant and equipment should be paid particular attention and the areas where they are used should be segregated by properly designed sound protection system so as to meet the regulatory norms.

Alternatively, low-noise muffler may be used if it can sustain sound reduction and be environmentally friendly. For the use of construction vehicles in the facilities, the access point should be planned away from the sensitive areas so that they do not contribute to the noise and create disturbances within the construction site.

Use of ready-mixed concrete and concrete pumps would help in reducing not only noise pollution but also dust, water, etc. It would also eliminate possible equipment repairs and the maintenance within the construction facilities, and avoid any mechanical failures occurring on-site that could generate abnormal noise and create pollution. Moreover, daily noise monitoring at the construction site would help keep it under control without compromising and other activities. The Supreme Council for Environmental and Natural Reserves (SCENR-Qatar) has provided regulations concerning noise as given in Table 02.

Contractors in Qatar must comply with the requirements for noise level within a construction area.

Table 02: Noise Standards in Qatar

Zones	Maximum Noise Level at Property Line	
	Day time (dBA)	Night time (dBA)*
Residential and Institutional (>50% of properties are accommodation - includes schools, hospitals and mosques)	**55**	**45**
Commercial (>50% of properties are shops, offices, garages and trading premises)	**65**	**55**
Industrial (>50% of the properties are for manufacturing facilities)	**75**	**75**

Source: *SCENR, 2003); *the night time standards would be applicable for the period from 10 p.m. to 4 a.m.*

Strengthening the Technological Effect for Prevention of Dust/ Air Pollutions at a Site

Dust cannot be hidden and hence needs to be controlled using appropriate methods such as:

- Hand watering, hardening roads, sweeping within the site,
- Minimise mixing of concrete at the construction site and instead use of ready-mixed concrete,
- Prohibiting garbage from being thrown or dumped on floors with the site. It must be segregated and deposited in designated garbage bins; e-waste must be segregated,
- Using recyclable semi-finished raw materials to reduce dust on-site, and
- Provision of centralized dust sifting, mixing and set enclosure clubbed with a centralized or mobile dust extraction and collection unit.

Strengthening the Technological Effect for Prevention of Wastewater Pollution at a Site

The wastewater from settling ponds and the sewage water from a construction site should discharge into the designated sewage pipe network. The wastewater may include waste grease, paint, oil and other chemical materials which would pollute the environment and thus must be prevented from leaking out anywhere else than the designated drain system or disposal area. The solid waste collection should similarly be implemented strictly on sites where all construction garbage must be collected into a dedicated garbage tanks, segregated and removed from there periodically. All-metal scraps, electric welding scraps, glass, plastics and waste packaging materials must be collected and disposed of properly.

"Environmental Risk Evaluation For Construction Activities"

After a careful study an "Environmental Risk Evaluation For Construction Activities" is presented in Table 03. It lists the requirements for mitigating pollution within the construction environment, and also serves as a guideline.

Implementation of properly executed and managed mitigative measures would allow for most of the identified environmental impacts to be either eliminated or at least minimized within the ecology and landscape of the construction site.

Conclusion

The issues of sustainability and the integration of environmental considerations into design and construction implementation are required to be incorporated in the environmental management planning stage to ensure the integrity of the construction environment as well as a clean environment for future generations by eliminating or minimising pollutions.

To deal with the complexity of the construction process, experience in the design, planning, and construction can craft a good policy for securing safety of the environment an essential requirement of construction sites and to mitigate pollutions from various sources. The Construction Project Manager **MUST** plan to mitigate the pollution risks carefully through close monitoring of the work being performed in the construction sites and also target zero accidents from start to finish.

For improving the quality of life for the citizens, the quality of the environment that they are exposed to must be improved. To achieve that, there must be awareness of the environment. Working in a construction environment exposes one to all aspects of pollution which could cause harm to an individual's health and hence needs to be addressed. Along with the pollution, other factors such as accidents arise. Insurance and compensation cannot be the cure; safe methods of working must be implemented. In the long run they pay rich dividends by way of satisfied clients and a happy workforce.

Table 03: Environmental Risk Evaluation For Construction Activities

No	Activity	When Applicable	Aspect	Frequency	Impact	F*I	Mitigation Measures
Emission to Air							
1.	Vehicle operation	Construction & Operation	Emissions	H	M	6	Planned maintenance of vehicle emissions. Inspection by the Authority
2.	Odor generation	Operation	Emission	H	M	6	By process management whereby the odorous air must be vented through odor adsorption and control units.
Releases to Water							
3.	Fuel Storage	Construction & Operation	Spill	H	M	9	Fuels must be stored in a bunded area with rainwater outlet control.
4.	Lubricants Storage	Construction & Operation	Spill	H	M	6	The lubricants must be stored in a bunded area with rainwater outlet control.
5.	Stockpile management	Construction	Storm water runoff	L	H	3	The rainwater run-off must be to a settling tank and then through an appropriate device to control the flow into a stormwater drain.
Waste Management							
6.	Vehicle operation	Construction & Operation	Maintenance	M	M	4	Waste disposal procedures for disposal of waste must be addressed in detail for different materials.
7.	Vehicle operation	Construction	Spill during refuelling	M	H	6	The conducted activities must be in a bunded area with rainwater outlet control.
Contamination of Land							
8.	Stockpile	Construction	Damage to habitats	L	H	3	Minimise the footprint by heaping rather than spreading.
9.	Stockpile management	Construction	Windblown waste	M	M	6	If this is a major impact, then erect sheeting or cover with tarpaulins. However, if this is a minor impact, then collect the blown material periodically.

No	Activity	When Applicable	Aspect	Frequency	Impact	F*I	Mitigation Measures
10.	Chemicals Storage	Construction & Operation	Spill	L	H	3	The usage of chemicals must be keep to an absolute minimum. The liquid chemicals must be stored in bunded area with rainwater outlet control. Solid chemicals must be stored inside closed stores.
Other Local Environmental or Community Issues							
11.	Commuting	Construction & Operation	Traffic impact	H	M	6	Dictate access route to be followed. All staff to abide by traffic regulations. Use licensed transport companies.
12.	Plant Operation	Construction & Operation	Noise	H	M	6	Follow regulations with the normal working hours, planned maintenance, and acoustic housings.
13.	Storage of removed soil	Construction	Erosion	L	L	1	This must be appropriately sacked.
14.	Site Activity	Construction	Noise	H	M	6	Fence line measurements, and attention to design.
15.	Site Activity	Construction	Dust	H	M	6	For dust suppression on roads the wheels of the trucks leaving site must be washed and dried.
16.	Site Activity	Construction & Operation	Odour	H	H	9	Correct the plant operation and maintenance procedures, and exercise the complaints route.
17.	Vandals	Construction & Operation	Damage to site or machinery	L	M	2	Have proper site anti-climb fencing with access control into the construction area.
18.	Lighting	Construction & Operation	Nocturnal distress	H	L	3	The lights should face into the site and face down.
19.	Consents	Construction & Operation	Failure of Consent	L	H	3	This must be by diligent operation of the management plan with regular maintenance, monitoring and sampling.

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Delhi worse than hell, people are living in gas chamber: SC

Centre Given 10 Days To Decide On Smog Towers

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New Delhi: Noting that 45% of Delhi's garbage remained unattended and piled up on roads even as the national capital had virtually been converted into a gas chamber, the Supreme Court said on Monday that the city was no longer liveable and had become worse than "narak" (hell) with people dying of various ailments due to pollution.

The apex court expressed anguish that governments had failed to act to deal with pollution and the situation was worsening despite it passing a series of orders over the years. It accused the Centre and Delhi government of politicising the issue instead of cooperating to come to the rescue of the capital's residents.

When Delhi chief secretary noted that 45% of garbage was not being lifted by civic agencies, an annoyed bench burst out, asking why the government should not kill people at one go by using explosives instead of letting them die slowly in a gas chamber. The SC asked Centre to decide within 10 days on setting up smog towers across the city to purify the air.

The court said smog towers, which had been set up China, were proving to be very successful in dealing with pollution. "There is no question of testing it before making it operational. It is just lack of will power on the part of government," the bench said.

The court lamented that no government wanted to take measures that were anti-populist. "You are not sitting together but are blaming each other. The issue of pollution is being politicised and it is happening under the nose of the court. We would not tolerate it.... We cannot allow people to die," a bench of Justices Arun Mishra and Deepak Gupta told the two governments.

The SC slammed UP, Punjab and Haryana for failing to implement its order to stop stubble burning which aggravates pollution levels. The court said it was high time to make state governments and officers responsible for not providing clean air and water.

'BETTER TO KILL PEOPLE AT ONE GO WITH EXPLOSIVES'

> Is this not worse than internal war? Why are people in this gas chamber (Delhi)? ...you better finish them with explosives... it would be better to go rather than suffer from diseases like cancer

> As on today, stubble burning is still adding 8% of pollution in the region. Why should we not impose fine on your state (Punjab) which will be recovered from officials right from top to bottom?

> (Smog) towers are very successful in dealing with pollution. There is no question of testing it before making it operational. You sit together and prepare a plan on how many and where these towers should be set up

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Air Pollution Abatement

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ABSTRACT

This paper is an attempt to examine various long term and short term measures to prevent and control air pollution in the Delhi NCR. The data have been analyzed from various secondary sources. Among various factors, the major cause of air pollution is the stubble burning in the neighboring states of Haryana and Uttar Pradesh, which saw DPCC placing New Delhi in the Severe to Poor Air Quality zones in November 2019. This paper includes a case study covering this aspect. The densely populated and rapidly growing Delhi mega city is often shrouded in a veil of smog resulting from construction and demolition activities, open dumping of waste, garbage, unpaved roads/ pits, road dust, generated by human settlement and unabated pollution from industries. The possible short term and long term air pollution mitigation measures are suggested in this paper.

The 2018 version of the World Health Organization (WHO) ambient (outdoor) air quality database which surveyed more than 4000 cities reveals that Delhi had the dirtiest air. Also, as per the World Air Quality Report 2018 released by IQ Air Visual and Greenpeace on March 5, 2019, seven of the top 10 most polluted cities in the world are in India. This year, between 29 October and 7 November 2019, the dire predictions of all the surveys played out, as most of North India, including Delhi, came under an impenetrable blanket of smog. Public health emergency was declared, as the overall Air Quality Index (AQI) in the capital crossed the severe-plus mark (above 500), with some neighborhoods even recording an AQI of over 1,000. The situation is grave and calls for consistent, round the year efforts on war footing.

Stubble burning in Punjab and Haryana a major contributor to air pollution in Delhi

In India, there exists a detailed administrative and legal set up for the prevention and control of the air pollution, namely -

- The Environment (Protection) Act, 1986
- Air (Prevention and Control of Pollution) Act, 1981 (Air Act)
- Air (Prevention and Control of Pollution) Rules, 1981 (Air Rules)
- Ministry of Environment Forest & Climate Change (MoEFCC)
- National Green Tribunal (NGT)
- Central Pollution Control Board (CPCB)
- Environment Pollution Control Authority (EPCA)
- State Pollution Control Board (SPCB)
- Delhi Pollution Control Committee (DPCC) is empowered to perform the functions to control pollution in capital.

In addition, other initiatives have been taken by the Government for abatement and control of Air Pollution in the Delhi NCR viz.

- The Central Government has taken a number of regulatory measures for prevention, control and abatement of air pollution in the country. A Comprehensive Air Plan (CAP) for Delhi NCR has been developed identifying the timelines with implementing agencies for delineated actions.
- The Government's National Air Quality Monitoring Programme (NAMP), provides for a network of monitoring stations across the country to constantly monitor key pollutants round the year. Besides this, CPCB's Continuous Ambient Air Quality Monitoring (CAAQM) and SAFAR's (System of Air Quality and Weather Forecasting and Research) are also in place. The National Air Quality Index (AQI) launched in New Delhi on September 17, 2014 also strengthens air quality information dissemination system for larger public awareness.
- The Central Government had notified a Graded Response Action Plan (GRAP) for Delhi and NCR for different levels of pollution.
- The Ministry of Environment, Forest and Climate Change launched the National Clean Air Programme (NCAP) in January 2019 to tackle the problem of air pollution in a comprehensive manner with targets to achieve 20 to 30 % reduction in PM 10 and PM 2.5 concentrations by 2024, keeping 2017 as the base year.

In spite of various plans, guidelines and a firm legal and administrative setup as mentioned above, every year the fight against air pollution in Delhi-NCR is lost as winter closes in. It has to be kept in mind that long term solutions will need time to deliver results. Given the current scenario in Delhi NCR, the need of the hour is to have a mix of both short and long term solutions.

Possible short term and long term solutions relating to Administrative and legal set-up

(i) In order to be serious about improving air quality, adequate funds are required, capable institutions and skilled manpower with keen awareness and focused sense of responsibilities. The CPCB is still struggling with inadequate manpower and budget to cover a large population. There is an urgent need to *create a separate budget line for air pollution management at the levels of Centre, State, District and City.*

(ii) There is an urgent need to assess Graded Response Action Plan (GRAP) for its effectiveness. For instance, when the AQI is ranging in the region of moderate to poor, GRAP suggests 10 actions. Nearly seven of these activities

have regulations already in place. But the words "strictly enforce" or "ensure regulations", "increase vigilance" suggest that these are not really meant to be followed in normal conditions. If not, GRAP could be re-graded by shifting actions two or three steps prior. Capable staff for monitoring and management could be created by an environmental cadre that is trained and is in know of what to do under what situation and how to address environmental problems in a holistic manner; they ought to be trained to appreciate the situation, particularly developing conditions and take timely necessary actions.

(iii) The existing regulations demand strict stringent enforcement and vigilance throughout the year. If not implemented, action should be taken against the Authorities and officials responsible for lack of active monitoring and enforcement.

(iv) As per the Supreme Court Order dated 25-11-2019, it was inter alia observed that the Municipal Corporations having annual arrangements to clean the garbage and waste, could only cater to 55% of waste disposal management. It clearly shows lack of adequate infrastructure to manage even such a basic and hygienically sensitive issue. The Municipal Corporations should gear up and chalk out a comprehensive plan, including adequate manpower and infrastructure in Delhi and NCR region, for 100% garbage management.

(v) Since air pollution transcends jurisdictional boundary, a model should be put in place for Delhi NCR region, where both the Central and State governments can work together. A task force is one such option. It could be formed with representation from senior State government officials of Delhi, Haryana, Punjab, Uttar Pradesh and Rajasthan. The task force should be empowered to take consensus-based decision for implementation across the Air Quality Control District.

1. Aggravation of Air pollution due to stubble burning – A Case Study

INTRODUCTION

The air quality of Delhi NCR worsens every year in the months of November and December, as farmers in the neighbouring States of Punjab and Haryana burn crop stubble to clear their fields. According to a study[1], during the autumn and winter months, approximately 500 million tonnes of crop residues are burnt in the Indo-Gangetic plains. This ultimately results in the combination of pollution and fog, leading to heavy smog formation in Delhi, especially during winters. The contribution of biomass burning emissions goes up to 40%.

The farmers have been solely held responsible for stubble burning and to dissuade them from this practice, policies need to be put in place. For instance, the governments could buy stubble at a fair rate, use it to make cattle fodder/ energy, and then pass on the rewards to the farmers, aggregators and others involved. Provisions of biomass pellets may also be explored for families who are dependent on biomass stoves. Further, massive efforts should also be undertaken by the Governments to incentivize technologies for agriculture which would allow them to re-plough the straw into the ground.

Source Apportionment

There are many other factors which contribute to pollution in Delhi NCR, such as construction and demolition, open dumping of garbage waste, road dust due to unpaved roads/ pits, garbage burning, traffic congestion, industrial activities and use of generators. As per the Energy and Resources Institute (TERI) Apportionment Study for Delhi, 28% of the PM 2.5 concentrations are contributed by the transport sector (public, private and commercial), 30% by industries and power plants, and 15% by biomass burning throughout the year - both from agricultural fields and rural kitchens. Another 11% comes from other sources such as diesel generator sets, refuse burning, restaurants and crematoria, and about 17% from sources of dust like roads, construction, natural causes, etc, besides 10% from international boundaries.

The Post-harvest season witnesses higher biomass emissions (40%) into the atmosphere, when crop wastes are burnt for about two weeks between October and November. As per System of Air Quality and Weather Forecasting and Research (SAFAR) of Indian Institute of Tropical Meteorology, Pune, the estimated impact of stubble burning in PM 2.5 levels of Delhi ranged between 2% (07.11.2019) to 46% (31.10.2019).

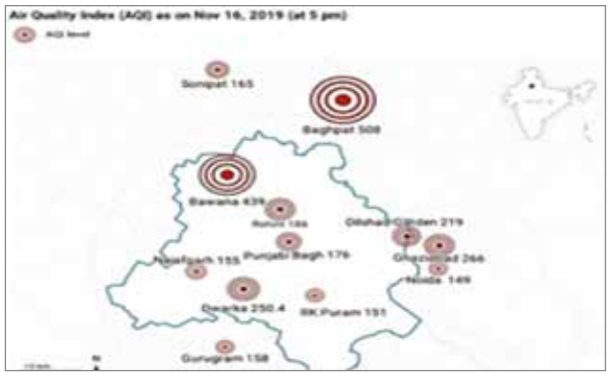
According to an estimate, 20 million tonnes of rice stubble is produced every year in Punjab alone, 80 per cent of which is burnt. Instead of burning the stubble, it can be used as cattle feed, compost manure, for roofing in rural areas, biomass energy, mushroom cultivation, packing materials, fuel, paper, bio-ethanol and industrial production, etc.

Stubble burning in Punjab and Haryana a major contributor to air pollution in Delhi

Stubble burning aids to Delhi's Pollution

The primary cause of air pollution is the burning of crops by farmers from the neighbouring states of Punjab, Haryana and Uttar Pradesh. Farmers set fire to crop residue at the end of the Kharif season before commencing with planting of crops for the Rabi season.

The North-West wind directs the smoke towards Delhi, counted as one of the most polluted cities in the world and worsens the already polluted atmospheric air. The smog in Delhi traps the pollutants and dust particles and makes it difficult to breathe which is quite evident from the data of the Air Quality Index as shown graphically.

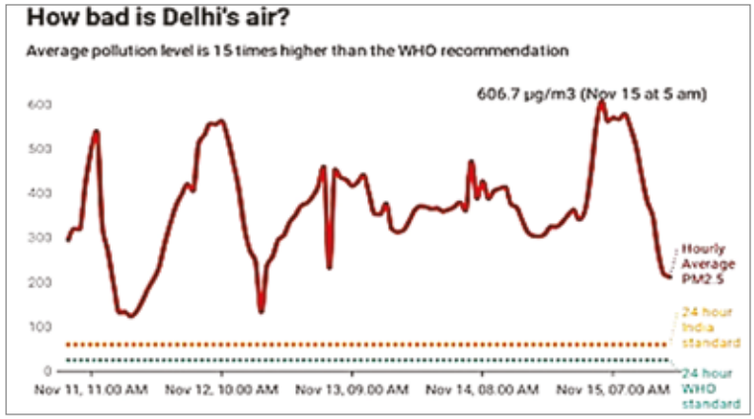


Source: *Central Pollution Control Board*

On Friday, November 15, 2019 the slow and northwest-directed wind worsened the pollution level of Delhi-NCR to "severe" category with the dangerous particulate matter hitting the maximum level with an hourly average of PM2.5.

Reports suggest that 12 to 60 % of particulate emissions are a result of crop residue burning.

Delhi and its surrounding areas have high pollution levels in winters due to drop in the atmospheric temperature and inversion, which is responsible for the smog. The stubble burning in the post-harvest season further aggravates this situation.



Source: *CPCB, Urban Emissions, Nov.2019*

[1]Sharma A.R., Kharol S.K., Badrinath K.V.S., and Singh D. (2010), Impact of agriculture crop residue burning on atmospheric aerosol loading – a study over Punjab state, India, Annales Geophysicae, 28, 367 – 379

Did law to delay crop sowing result in paddy straw burning cases?

Reports suggest that the number of stubble burning cases in Punjab this year had risen by 25 per cent. This also implies that the claims made by the Punjab Government about stopping farmers from burning farm waste are far from the truth. There are apprehensions that a law passed by the Punjab Government in 2009 asking farmers to delay paddy sowing swelled the number of paddy burning cases.

The Punjab Preservation of Subsoil Water Act of 2009 imposed a delay on farmers to plant paddy nursery with an objective to improve the water table. The State Government, by enacting this law also wanted to divert the farmers towards cash crops like Cotton, Maize and Basmati rice, which require less water and are environment friendly.

The well-known agriculture expert Devinder Sharma blames over-mechanisation of Punjab agriculture for the paddy straw burning problem. He opines that, Most of the crop harvesting in Punjab is being done by machines. The Punjab Government is now asking farmers to buy six more machines to stop them from burning farm waste which is not justified. Compelling farmers to take loans to buy machines would only burden them further. The best way to discourage them from burning crop residue is to compensate them in some reasonable manner. "*The Director of Agriculture Department of Punjab, Sutantar Kumar Airi says that the Punjab Subsoil Water Preservation Act is not responsible for crop burning instances, which has not only improved the water table but also brought down the area under paddy cultivation by 3.8 lakh hectares. The total area under paddy cultivation in 2018, which was 31.3 lakh hectares, has been brought down to 27.92 lakh hectares in 2019. Farmers have been asked to switch to Basmati rice farming, which is not only lucrative but its straws can be consumed by the cattle and not required to be burnt"* says Sutantar Kumar Airi.

Why farmers in Punjab and Haryana continue to burn rice stubble?

On December 10, 2015, the National Green Tribunal (NGT) had banned crop residue burning in the States of Rajasthan, Uttar Pradesh, Haryana and Punjab. The burning of crop residue is a crime under Section 188 of the IPC and under the Air and Pollution Control Act of 1981. The State governments have also imposed a penalty of Rs. 2,500 per acre to dissuade farmers from burning stubble. Why then are the farmers still burning the paddy stubble? This section dwells on why these farmers opt to burn the stubble instead of managing it scientifically with a window of about a month between harvesting rice and planting wheat.

Farmer manually cutting Rice

Combined Harvester Machine

Earlier, farmers used to manually cut the rice and the rice stalk would be cut very close to the ground. The agriculture machination has ushered in a machine called combined harvester to cut the rice crop which leaves about 45 inches or a foot-and-a-half-long paddy stalk in the field. This is the stubble that the farmers burn before the next plantation.

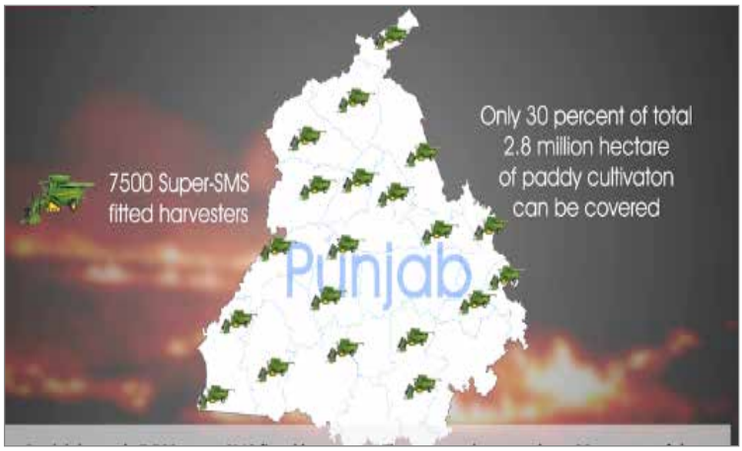
To avoid burning, machines like super-straw management system or super-SMS can be attached to the combined harvester. As the combined harvester collects the paddy, the super SMS would cut the straw and spread it evenly around the field.

But there is a catch! If the super-SMS is used along with the combined harvester, the farmer has to use another machine called the ''Happy Seeder''. The Happy Seeder is a tractor-mounted machine which basically cuts and lifts the remaining stubble and drills the wheat seeds into the soil. It then deposits the straw over the sown area as a mulch cover.

Burning of Crop stubble

A Super-Straw Management System attached to Combined Harvester

A farmer needs to spend around Rs. 5,000 to Rs. 6,000 per acre if Super-SMS and Happy Seeder machines are used. This is much more expensive than burning the stubble and paying Rs.2,500 per acre as penalty to the government. Punjab has only 7,500 Super-SMS fitted harvesters. These can only cover about 30 per cent of the total 2.8 million hectare of area under paddy cultivation in the State.



Happy Seeder to be used along with Super- SMS and Combined Harvester

In 2017, 50 per cent subsidy was announced for farmers wanting to buy Happy Seeders. But in the same year, the cost of a Happy Seeder increased from Rs. 90,000 to Rs. 1,70,000. The Super-SMS and Happy Seeder combination can only be used if the farmer grows wheat in the Rabi season. The farmer cannot grow any other crop using this combination. So, for a farmer in Punjab and Haryana, it is not just difficult to procure machinery that cuts the stubble down, it is also economically unviable.

Farmers can also manage crop residues effectively by employing agricultural machines such as:

- Happy Seeder (used for sowing of crop in standing stubble)
- Rotavator (used for land preparation and incorporation of crop stubble in the soil)
- Zero till seed drill (used for land preparations directly sowing of seeds in the previous crop stubble)
- Baler (used for collection of straw and making bales of the paddy stubble)
- Paddy Straw Chopper (cutting of paddy stubble for easily mixing with the soil)
- Reaper Binder (used for harvesting paddy stubble and making into bundles)

On the other hand, the machines are too expensive for farmers to buy, hence the State Governments should come forward and provide arrangements so that farmers can afford to use these machines.

Initiatives by the Government

- In order to prevent stubble burning, a new Central Sector Scheme on 'Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi' for the period from 2018-19 to 2019-20 is being implemented by Ministry of Agriculture and Farmers' Welfare with the total outgo from the Central funds being Rs. 1151.80 crore (Rs. 591.65 crore in 2018-19 and Rs. 560.15 crore in 2019-20).
- The State Governments have supplied machines to individual farmers and Custom Hiring Centres (CHCs) on subsidy for in-situ management of crop residue. During 2019-20, it has been targeted to supply more than 46,578 machines. Status as on 14-10-2019 was reported as follows:

Name of State	Physical Progress							
	Physical Targets (Nos.)		Applications received (Nos.)		Applications sanctioned (Nos.)		Machines delivered (Nos.)	
	Individual	CHCs	Individual	CHCs	Individual	CHCs	Individual	CHCs
Punjab	7,600	6,230	7,829	5,821	7,714	5,628	2,437	4,631
Haryana	15,343	784	51,274	996	16,676	811	5,113	4,662
Uttar Pradesh	4,077	1,817	1,918	1,817	1,918	1,817	1,391	979
Total	27,020	8,831	61,021	8,634	26,308	8,256	8,941	10,272

Source: *Order of the National Green Tribunal regarding crop residue burning, 15-10-2019*

The above statistics show that physical targets are not supported by any expert study to be effective enough to neutralize the impact of air pollution caused by burning of crop residue. In any case, the said targets have not been achieved. As against target of 27,020 individual and 8,831 Custom Hiring Centres, machines delivered are 8,941 and 10,272. Therefore, the overall average of success appears to be around 53% only.

- With the efforts of the Government, overall about 15% and 41% reduction in burning events were observed in 2018 as compared to 2017 and 2016, respectively. During 2019-20 season, the total burning events recorded in the three States are 19.2% less than in 2018 till 18th November. UP had recorded 36.8% reduction, Haryana had recorded 25.1% reduction, and Punjab had recorded 16.8% reduction respectively, in the current season than in 2018.

Anticipated Measures for consideration by Authorities

- It is undisputed that in-situ degradation of paddy residue is useful for soil fertility while burning of crop results in requiring more fertilizer and less yield and damage to the soil. Hence, massive efforts should be undertaken by the Governments to incentivize technologies for agriculture which would allow them to re-plough the straw into the ground.

- It is clear that steps taken are inadequate and do not provide for ground checking and vigilance and extinguishing of illegal fires. There is no effective incentive mechanism. The effective steps should inter alia include -

  - successful communication with the farmers,
  - educate farmers for diversification of crops,
  - effective prevention of fires,
  - supply of suitable equipment at affordable cost to the farmer,
  - change of crop patterns,
  - use of labour by Panchayats under Rural Employment Guarantee Scheme,
  - purchase of crop residue for fuel or composting, and
  - fixing accountability of officers for the failure.

- As mentioned earlier, the government can find novel ways to take care of the paddy stubble and incentivize the process; for instance, the governments could buy the stubble at a fair rate, use it to make cattle fodder, convert paddy straw into fibre, compost manure, biomass energy, mushroom cultivation, packing materials, etc. and then pass on the rewards to the farmers, aggregators and others involved.

OTHER POSSIBLE SHORT TERM AND LONG TERM SOLUTIONS

2. **Overpopulation:** One of the major problems of India is with regard to a high population and similar is the case with the Delhi NCR. This excess population is largely responsible for depleting and degrading natural resources. There should be a senior government official responsible for addressing population-related issues and promotion of "responsible parenthood", extension of system of rewards/ incentives to a single/ two children families, etc.

3. **Use of Cleaner fuels:** The Government must come up with a comprehensive plan to immediately ban pet coke and furnace oil in the entire Delhi NCR. There is need to move towards the best of technologies - both in vehicles and in usage of fuels. A massive switch-over to friendlier fuels such as gas is needed in vehicles, power plants and industry as the region needs a second transition to natural gas and cleaner fuels (LPG, Electricity, Biomass

stoves). Transition to electric vehicles needs prioritization. Besides, we need to ensure reliable supply of power to bring down the use of gen-sets.

- Though Coal remains as a popular choice of fuel in power plants and it is difficult to phase it out immediately due to economic reasons, one can control the air pollutant emissions from power plants and industries through available tail pipe treatment technologies.

4. The Delhi-NCR region has over 3,000 legal brick kilns, which had been largely practising the extremely polluting FCBTK process of manufacturing bricks. All brick kilns must convert to cleaner technology using zigzag process within a specified period; suggested period of one year. Those that do not comply should be closed down.

5. Use of Smog Towers/ Anti-smog guns:

The Government may explore a comprehensive plan indicating the type of towers required which may operate successfully and number of such towers required so as to take care of the pollution being caused in Delhi and the NCR region.

The Government of NCT of Delhi should come up with a plan of acquiring the Anti-smog guns and its effective usage as well.

6. **Augmentation of Public Transport:** Schemes like odd-even are temporary and do not work very well in the long run. A massive augmentation of safe, comfortable and economical public transportation system within the entire city is required to ensure sustained economy. The Bus-based transportation system should be made more efficient by synergising with the private sector to derive benefits of costs and competencies.

7. Secondly, since Independence, India has moved towards an inefficient way of Transportation, both in passenger and freight modes wherein the share of Railways has gone down while movement through roadways has gone up. This trend needs to be reversed. There is need to improve the share of rail-based transport mode by improving infrastructure and rationalization of tariffs. This would not only reduce emissions, but also save on fuel. Inland Waterway transportation systems also need to be increased.

8. **Parking:** Under GRAP, once the region is found to be under Very Poor category, the parking rates must be enhanced by three to four times. This is a short term solution which requires a parking policy to be in place urgently in the Delhi NCR with the enhanced parking rated to be mandated and implemented, through an Advisory Notification to be issued every time the pollution level becomes very poor.

9. **Road and construction dust:** Construction activities are ongoing on a large scale in the NCR region. The Government, through the Pollution Control Boards should file status reports on the penalties imposed; make public - the names of repeat offenders, blacklisted developers, closed down projects for non-compliance with dust management rules and guidelines. Further, penalties should be imposed on per km stretch of road construction that violate dust management measures.

10. **Garbage burning:** Inadequate infrastructure and manpower for lifting garbage/ waste leads to garbage burning which ultimately adds on to the pollution. For waste management, all sectors should be encouraged to practice cradle-to-cradle approach instead of cradle-to-grave approach which would further reduce generation of waste and the Government may consider rewarding people who take these initiatives. The NCR needs extensive and large scale action to change garbage management system to enforce and implement suitable garbage disposal mechanism. This is most vital.

11. **Green corridor development and Plantation:** Trees act as "sinks" to pollution and directly affect the air quality positively. Intensive plantation drive requires to be taken up along roads, residential areas, wasteland, etc. Vertical gardens could be developed in tower blocks, covered from top to bottom in greenery.

12. **Lessons to be learnt from other Countries:** A large number of countries and cities have faced the problem of air pollution in their "development" phase, for instance, London in 1952, Los Angeles in the 1950s, Tokyo in the 1950s and '60s. The authorities in each of these cities realized the health impact and the huge economic cost of air pollution and started putting suitable measures in place. The US took the technology aided route wherein the economy kept growing but the emissions did not. In California alone, there has been a huge increase in the number of vehicles and diesel consumption, and in spite of that the emissions have gone down by 80% as they have been able to delink the city's economic growth patterns from the emissions.

    In Europe, countries opted for the "management" route. Whenever a pocket in the city showing high pollution levels was identified, low emission zones were created. Congestion pricing was introduced, that is - if one added to the pollution, one had to pay a price for it. Further in such high emission zones, only electrical or non-motorized transportation were allowed.

    In the case of Beijing, the government set up Air Quality Control Districts which were not just intended to control the pollution levels in the city, but also to regulate the air quality in a big region around Beijing. It was all done simultaneously. Therefore, if the government wants to contain pollution levels in Delhi, it is advisable to include the NCR and neighbouring cities. Why should the odd-even scheme and other fuel control be only in Delhi? Greater benefits to Delhi and the neighbouring areas could be witnessed if these efforts are undertaken simultaneously in the surrounding districts of the NCR.

CONCLUSION

In order to ensure a sustainable planet for the future generations, emphasis should be on cutting off pollutants at the source rather than looking at quick fix and short term solutions to tide over the situation. Tackling the air pollution menace is not in the number of plans but in the proper implementation and monitoring of the measures adopted. Coordination between Delhi and its surrounding States is critical to forge effective and long lasting solutions. As matured and experienced professionals, it is time to act as catalysts to initiate priority measures listed as under.

- Promote ways and means of cutting down on use of fossil fuels and investing in electrical power and solar power.
- Keeping high-polluting vehicles away from cities and plan and implement their end of life.
- Well conceived and operational public transportation systems - supporting the metro, and bus services. Better maintenance and traffic management of roads to reduce travel time.
- Control air pollutant emissions from power plants by adopting tail pipe treatment technologies. This needs to be taken up immediately and completed on priority, say in six months' time.
- Provide incentive to brick kilns for adopting zigzag technology within fixed tenure of, say one year. Those who do not do so should be closed down.
- Install smog tower at identified hot spots.
- Penalties for construction sites for not following pollution control measures.

- Efficient waste management covering all waste, provide necessary guidance and the budget, impose heavy penalty on burning of garbage. To be adopted on top most priority, say in next 6 to 9 months.

- Proper and effective control on polluting industries and assisting them with technological solutions and ensuring their implementation. To achieve this, financial assistance at low interest rates should be made available. Any industry if found lacking in taking corrective action should be closed down.

- Promoting use of technologies in Agricultural sector so as to dissuade them from adopting burning of agricultural remains. Reward users suitably through incentives, assistance in setting up Compost plants, etc.; basically explore alternate options towards a win-win situation.

- Development of Green Corridor along roads, vertical gardens on tall buildings, etc.

- Implement enhanced parking rate for graded air pollution scenario to discourage use of vehicles during critical condition.

- Adoption of international best practices ranging from congestion pricing to deployment of suitable and effective strategies to continually monitor and contain air pollution. Identifying and replicating Vehicle Free Zones such as Karol Bagh market area.

- Data transparency would enable all elements of the society to participate in achieving environmental objectives of clean air.

- Engaging the public and all stakeholders to strengthen environmental protection measures and help in achieving Cleaner and Greener NCR.

The article attempts to emphasize on the fact that the Government should implement and continue with all the above measures simultaneously and on a continuous, sustained basis. Backed with stringent monitoring, improvement can be clearly perceived in a short period.

Slash emissions now or face climate disaster: UN

Global emissions need to fall by 7.6 per cent each year until 2030 to limit global temperature rises to 1.5C, the UN warned

The world will miss its chance to avert climate disaster without an immediate and all-but-impossible fall in fossil fuel emissions, the UN said on Tuesday in its annual assessment on greenhouse gases.

The United Nations Environment Programme said that global emissions need to fall by 7.6 per cent each year until 2030 to limit global temperature rises to 1.5C.

The harsh reality is that emissions have risen on average 1.5 percent annually over the last decade, hitting a record 55.3 billion tonnes of CO2 or equivalent greenhouse gases in 2018 -- three years after 195 countries signed the Paris treaty on climate change.

The World Meterological Organization said Monday that atmospheric greenhouse gas concentrations hit an all-time record in 2018.

The Paris deal committed nations to limit temperature rises above pre-industrial levels to "well below" 2C, and to a safer 1.5-C if at all possible.

To do so they agreed on the need to reduce emissions and work towards a low-carbon world within decades.

Yet the UN found that even taking into account current Paris pledges, the world is on track for a 3.2C temperature rise, something scientists fear could tear at the fabric of society.

Even if every country made good on its promises, Earth's "carbon budget" for a 1.5-C rise – the amount we can emit to stay below a certain temperature threshold – would be exhausted within a decade. In its own words, the UN assessment is "bleak".

While it insisted the 1.5C goal is still attainable, it acknowledged that this would require an unprecedented, coordinated upheaval of a global economy that is still fuelled overwhelmingly by oil- and gas-fuelled growth.

AFP

TRANSPORT AND POLLUTION

Suvendu Seth
Transport Planning Consultant

ABSTRACT

Pollution is a serious concern all over the world, including India. Studies have shown that transport contributes to a significant portion of pollution. With the expansion of global economy, transport needs have increased and thereby the pollution caused from transport sources have increased. Transport causes pollution in air, water, noise, ecology and landscape. The major components of air pollution are: lead, suspended particulate matter, Ozone, Carbon dioxide, Carbon monoxide, Sulphur dioxide, oxides of Nitrogen and poly-aromatic hydrocarbons. There are major effects on health due to pollution. There are various technologies available for partially mitigating the pollution caused from road, rail, water and air transport sources. These technologies are evolving with research and development. Policies and measures that can be effective in reducing greenhouse gases and pollution from transport sources are: land use transport planning, taxation and pricing, regulatory and operational instruments, fuel economy standards, transport demand management. Various policies and regulatory mechanisms have been tried out all over the world to reduce pollution with differing degrees of success. Case studies from Kolkata and Delhi show that pollution reduction methods can be implemented with proper incentives and enforcement.

1.0 Introduction

Pollution is a serious environmental concern all over the world, including those in India. A large proportion of population is exposed to poor air, land and water quality. It causes health related problems such as respiratory diseases, risk of developing cancer and other serious ailments. It also contributes to economic loss, especially in terms of financial resources that are required for providing medical assistance to the affected people. Most of the Indian cities are experiencing rapid urbanization. Majority of the country's population is expected to live in cities within the next two decades. This will result in a tremendous increase in the number of motor vehicles, rail and air traffic, resulting is further increase in pollution.

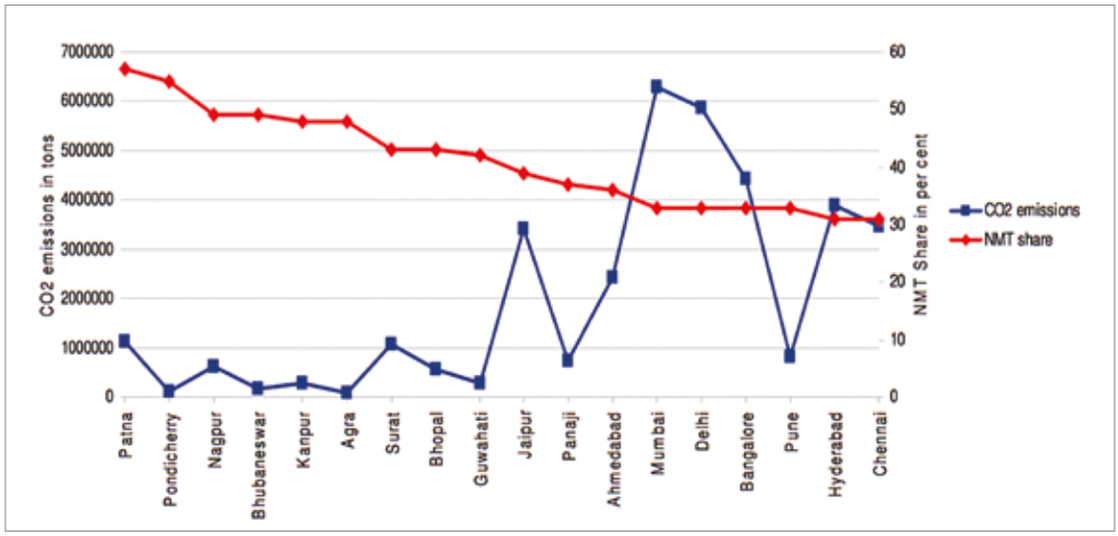
2.0 Transport as a source of pollution

Transport contributes a large percentage to pollution, especially to air pollution. Central Pollution Control Board (CPCB) figures showing contribution of different air pollutants from transport in comparison to industry and domestic use is shown in Table 1.

Pollutant	Transport (in %)	Industry (in %)	Domestic & others (in %)
CO	76-90	37-13	10-16
NO_2	66-74	13-29	1-2
SO_2	5-12	84 -95	Nil-4
PM	3-22	74-16	2-4

Source: *CPCB*

Table 1: *Comparison of contribution of air pollutants from different sources*



Selected walking and cycling dominated cities have significantly low CO_2 levels. Source: CSE

Figure 1: *CO_2 emission and share of NMT in various Indian cities*

Prevalent mode of transport in a city has strong correlation with production of Carbon dioxide (CO_2). Centre for Science and Environment (CSE) compared the modal share of non-motorized transport (NMT) in cities with the CO_2 emissions. Figure 1 shows the variation of CO_2 and NMT share in various cities. It is clearly seen that cities with high percentage of walking and NMT have less CO_2 emission.

Transport is a known source of not only CO_2 but many air pollutants. The "classic" air pollutants defined by the World Health Organization (WHO) and their effect on health are:

Lead from the combustion of leaded petrol is a known toxin. High lead concentration in the bloodstream has serious health implications.

Total suspended particles (TSP) are also referred to as suspended particulate matter (SPM). It is not a single pollutant, but rather a mixture of many subclasses of pollutants that occur in both solid and liquid forms. Each subclass contains many different chemical species.

Ozone (O3) at the ground level is created by chemical reactions between NOx and volatile organic compounds (VOC). This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants and other sources chemically react in the presence of sunlight. It affects the human respiratory system and may lead to premature mortality.

Carbon monoxide (CO) emission mostly occurs from petrol fuel vehicles. It inhibits the capacity of blood to carry oxygen to organs and tissues. At very high levels CO impairs vision and manual dexterity and can cause death.

Sulphur dioxide (SO_2) which is emitted in direct proportion to the amount of sulphur in the fuel, causes changes in lung function in persons with asthma and exacerbates respiratory symptoms in sensitive individuals. Through a series of chemical reactions, SO_2 can be transformed to sulphuric acid, which contributes to acid rain and to the formation of secondary (sulphate-based) particulate matter.

Nitrogen dioxide (NO_2) also causes changes in lung function in asthmatics. Like SO_2, NO_2 can react to form nitric acid and thereby contribute to acid rain and secondary (nitrate-based) particulate formation. In addition, nitric oxide (NO) and NO_2, or NOx as they are commonly called, are precursors of ground-level ozone. Both diesel and petrol fueled vehicles contribute to NOx emissions.

Other air toxin emissions of primary concern in vehicle exhaust include: benzene and poly-aromatic hydrocarbons (PAHs). Both are well known carcinogens. Air toxin emissions such as benzene depend mostly on fuel composition and catalyst performance.

While air pollution is the most visible and studied environmental consequence of transport systems, water pollution and wetlands issues are also of crucial importance in the transport and environment nexus. Fuel, particle, and salt-laden runoff from streets, highways, and storage facilities results in damage to public water supplies, ponds, lakes and surface streams, roadside soil, vegetation and trees. Roadways bisect watersheds. Water quality impacts attributed to erosion, sedimentation and polluted runoff associated with highway construction, operation and maintenance are limited to the adjacent streams. But in the watershed downstream, the impact from the road contributes to other forms of water pollution. Watersheds are therefore both directly and indirectly impacted by transport.

Transport is a major source for noise pollution. Noise from airports and aircraft fight corridors, road vehicular traffic, railways and public transit cause discomfort to public. Noise pollution hurts everybody, but most affected are children, pregnant women, the elderly and people with chronic health problems.

3.0 Transport sectors and their contribution to pollution

The effect of various modes of transport on the environment is shown in Table 2. Some of the effects are direct and immediate and some are indirect and over long time.

Table 2: Effect of transport on the environment

Mode	Air	Land	Water	Waste	Noise	Ecology	Landscape
Road	CO_2 emission CO, HC, NOx, dust, Lead	Construction effect, Terrain modification, excavation	Division of underground veins due to tunnel construction, change in water basins, surface & ground water contamination	Facilities & vehicle disposal, waste oil, battery disposal	Vehicle noise & vibration along routes	Habitat fragmentation, accidents, disruptions due to pollution, street light pollution	Disruption of natural & traditional landscapes, creation of new landscape like bridges
Rail	CO_2 emission, air pollution	Station & permanent way construction	Division of underground veins due to tunnel construction	Facilities & vehicle disposal	Noise & vibration near station and along route	Habitat fragmentation, accidents	Disruption of natural & traditional landscapes, creation of new landscape like bridges
Air	CO_2 emission, air pollution	Airport facilities construction	Development of water regions due to airport construction	Disposal of aircrafts and parts	Noise & shock waves near airports	Habitat destruction due to airport development, collision of airplanes with birds	Loss of natural landscape, creation of new landscape with airplanes
Water	CO_2 emission, air pollution	Port and canal construction	Port construction, drilling & dredging of rivers, canals & coasts	Facilities & ship disposal	Noise around port & jetties	Expansion of invasive species by ballast water, disruption of aquatic life by paint of vessels	Loss of natural coat, river & canal, new landscape with ships

Source: *Organisation for Economic Cooperation for Development, Transport and the Environment, 1988*

5.0 Mitigation technologies

Many technology and strategies are available to reduce the growth of pollution from transport. The most promising strategy to reduce pollution in short to medium term period is to improve vehicle technology. Available improved technologies are: hybrid electric powered trains, fuel cells and electric vehicles. Use of alternative fuels like natural gas, biofuels, electricity and hydrogen in combination with conventional technology can provide large reduction in pollution. Even with all these improved technologies and fuels, it is expected that petroleum will retain the dominant share of transport energy use and the GHG emissions will continue to increase in the foreseeable future. Only with sharp changes in economic growth, major behavioural shifts, and/or major policy intervention would transport GHG emissions decrease substantially.

ROAD TRANSPORT

Pollution associated with vehicles can be reduced by four measures:

1. Reducing the weight of the vehicle
2. Increasing the efficiency of converting the fuel energy
3. Changing to a less carbon intensive fuel
4. Reducing emission of non CO_2-GHG from exhaust

Reducing vehicle weight can be achieved by improved aerodynamic design, lightweight material and improved tyre. Improving efficiency of engine, air conditioning and heating of vehicles can reduce pollution. Alternative fuels available are: ethanol, bio-diesel and methanol. Hydrogen fuel produces no emission. There is ongoing research and development in these fields and more improved vehicles are available, including electric vehicles.

All types of personal vehicles produce GHG and address the mobility needs of very few people. Modal shift to use of public transport and non-motorized transport like walking and cycling can reduce GHG and pollution.

RAIL TRANSPORT

Electricity is the major source of energy for railway. R&D goals for railway transport are: higher speed, improved comfort, cost reductions, better safety and better punctuality. The energy efficient technologies for railways are:

1. Reducing aerodynamic resistance
2. Reducing train weight
3. Regenerative braking
4. Higher efficiency propulsion system

For high speed trains like the Japanese Shinkansen, French TGV and German ICE, aerodynamic resistance dominates vehicle loads. It is important to reduce this resistance to reduce energy consumption and CO_2 emissions. Reduction of train weight is an effective way to reduce energy consumption and CO_2 emission. Aluminium car bodies, lightweight bogies and lighter propulsion equipment are proven weight reduction measures. Regenerative brakes have been used in railways for a few decades, but with limited applications. For current systems, the electric energy generated by braking is used through a catenary for powering other trains, reducing energy consumption and CO_2 emissions. Recent research on rail propulsion has focused on superconducting on-board transformers and permanent magnet synchronous traction motors.

AIR TRANSPORT

Fuel efficiency is a major consideration for aircraft operators. Both aircraft and engine manufacturers pursue technological developments to reduce fuel consumption to a practical minimum. The areas where research work is underway are:

1. Technology development
2. Engine development
3. Aircraft development
4. Alternative fuel

Technology improvement for fuel efficiency is being carried out for aerodynamic improvements, weight reductions and engine fuel efficiency. Engine developments require a balancing of the emissions produced to satisfy the operational need and regulatory need of emissions. For the near term, lightweight composite materials for aircraft structure seem to be most promising. In the long term, alternative concepts like blended wing bodies, high aspect ratio, low sweep configuration may be more suitable. Reduction in both NOx and CO_2 emission could be achieved by advances in airframe and propulsion systems which reduce fuel burn. Kerosene is the primary fuel for civil aviation, but alternative fuels have been examined. A potential non-carbon fuel is hydrogen and there have been several studies on its use in aviation.

WATER TRANSPORT

The International Maritime Organization (IMO) has undertaken R&D to reduce GHG emissions and pollution. The potential of technical measures to reduce CO_2 emissions was estimated at 5–30% in new ships and 4–20% in old ships. These reductions could be achieved by applying current energy-saving technologies vis-à-vis hydrodynamics (hull and propeller) and machinery on new and existing ships. It is estimated that in the short term, the reduction in emission can be from fleet optimization, speed reduction and routing. In the long term, improvement in technology in terms of using alternative fuel instead of diesel fuel, and design of more aerodynamic vessels can reduce GHG. Natural gas is being considered. Another potential is combination of solar panels with sails. Hydrogen propelled and fuel cell ships also have potential.

6.0 Policies and measures

The policies and measures that can be effective in reducing GHG and pollution from transport sources are:

- Land use transport planning
- Taxation and pricing
- Regulatory and operational instruments (like traffic management, control and information)
- Fuel economy standards
- Transport demand management

LAND USE TRANSPORT PLANNING

Use of energy for urban transport is determined by a number of factors, most important being the location of employment and residential areas. In the second half of the twentieth century, most cities had increasing dependence on private cars and decreasing dependence on public transport. Residential and employment areas were dissociated. Developing countries also followed road building and car dependence, though in a less organized way. Studies have pointed out that high urban densities are associated with lower levels of car ownership and car use and higher levels of transit use. There are examples of successfully integrated land use and transport planning, including Stockholm and Portland, Oregon (USA). They mostly couple mixed-use and compact land use development with better public transport access to minimize auto dependence. The literature suggests that in general, single policies or initiatives tend to have a rather modest effect on the motorization process. The key to restraining motorization is to cluster a number of initiatives and policies, including improved transit service, improved facilities for NMT and market and regulatory instruments to restrain car ownership and use.

TAXATION AND PRICING

Transport pricing refers to the collection of measures used to alter market prices by influencing the purchase or use of a vehicle. Typically, measures applied to road transport are: fuel pricing and taxation, vehicle license/registration fees, annual circulation taxes, tolls and road charges and parking charges. Table 3 gives an overview of the taxes and pricing mechanisms tried in some developing and developed countries. Pricing, taxes and charges, apart from raising revenue for the government, are expected to influence travel demand and hence fuel demand and it is on this basis that GHG and pollution reduction can be realized.

Table 3: Taxes and pricing in transport sector in developed and developing countries

Instrument	Developing Countries	Developed Countries
Tax incentive to promote natural gas	Pakistan, Argentina, Colombia, Russia	Italy, Germany, Australia, Ireland, Canada, UK, Belgium
Incentives to promote natural gas vehicles	Malaysia, Egypt	Belgium, UK, USA, Australia, Ireland
Emission trading	Chile	
Congestion pricing including Area Licensing Scheme, vehicle registration fees, annual circulation tax	Chile, Singapore	Norway, Belgium
Vehicle taxes based on emission -tax deduction on cleaner cars like battery operated or alternative fuel vehicle	South Korea	Austria, Britain, Belgium, Germany, Japan, the Netherlands, Sweden
Carbon tax by size of engine	Zimbabwe	
Cross subsidization of cleaner fuels (ethanol blending by petrol tax – through imposition of lower surcharge or excise duty exemption)	India	

Source: *Adapted from Pandey and Bhardwaj, 2000; Gupta, 1999; European Natural Gas Vehicle Association, 2002*

Fuel or CO_2 tax has a limited effect on reduction in pollution. This is because price elasticities tend to be substantially smaller than the income elasticities of demand. In developing countries, where incomes are lower, the demand response to price changes is more elastic. As an alternative to fuel taxes, registration and circulation taxes can be used to incentivise the purchase (directly) and manufacturing (indirectly) of fuel-efficient cars. This could be done through a revenue neutral fee system, where fuel-efficient cars receive a rebate and guzzler cars are faced with an extra fee. There is evidence that incentives given through registration taxes are more effective than incentives given through annual circulation taxes.

The most renowned area licensing and parking charges scheme has been applied in Singapore with effective reduction in total vehicular traffic and hence pollution. General estimates of reduction in use of private vehicles resulting from fuel pricing and taxing are 15–20%.

Box 1: Example of Pricing Policy for Heavy Vehicles

Switzerland: In 2001, the maximum weight limit of trucks was increased from 28 tonne (t) to 35 t. A tax of 1 cent/t-km was imposed on trucks above 35 t. It replaced the previous fixed tax on heavy vehicles. In 2005 the tax was increased to 1.6 cent/t-km for trucks above 35 t but the weight limit was increased to 40 t. Over a period 2001 – 2003, it was estimated that tax contributed to 11.9% decrease in vehicle-km and a 3.5% decrease in t-km. The tax led to an increased carrier's productivity and it is estimated that emission of CO2 and NOx decreased by 6 - 8% over 2001 – 2007 period.

Germany: A new toll system was introduced in 2005 for trucks weighing more than 12 t. It was called LKW-MAUT tax and was levied on super highways based on distance travelled. The rate was between 9 and 14 cents, depending upon the number of axles and emission standards of the truck. Payments could be made by a GPS based system or manual payment at terminals or through internet. The money received was utilized for improving the road network of Germany. The system introduced appears to be successful, though a full assessment of its impact is not available.

The potential GHG savings from pricing, taxes and charges for road transport are shown in Table 4.

Table 4: Potential GHG savings from pricing, taxes and charges from road transport

Tax / pricing measure	Potential GHG savings
Optimal road pricing based on congestion charges in London, UK	20% reduction in CO_2 emissions from 18% reduction in road traffic
Congestion pricing of Namasan Tunnels in Seoul, South Korea	34% reduction in peak passenger traffic volume. Traffic speed improvement from 20 to 30 km/hr.
Area Licensing Scheme in Singapore	Vehicular traffic reduced by 50%, private traffic reduced by75%, travel speed increased from 20 to 33 km/hr.
Urban gasoline tax in Canada	2.6 million tonne in 2020
Congestion charge trial in Stockholm, 2005 - 2006	13% reduction of CO_2

Source: *Adapted from Transport and its infrastructure, Suzana Kahn and Shigeki Kobayashi*

Regulatory and operational instruments

It is estimated that 5–10% reduction in fuel consumption and hence, pollution, can be achieved by strong regulatory mechanism like vehicle inspection and maintenance programmes, adoption of on-board technologies, more widespread driver training and better enforcement and control of vehicle speeds. Vehicle travel demand can be reduced by 10–15% by aggressively combining infrastructure improvements, intelligent transport technologies and systems (e.g., better routing systems and congestion reduction), information systems and better transit systems in addition to road pricing.

In order to implement regulations and for it to be effective, some prior preparation work are needed. Table 5 shows some of the regulatory / operational measures that are usually implemented in various cities and the preparatory work required.

Table 5: Preparations required to implement regulatory/ operational measures

Measures to be implemented	Preparatory work
Speed limit	• Change the law • Install visible speed limit signs
Energy efficient car	• On board efficient system indicators • Driver training • Information on efficient car purchase
Clean car choice	• Public awareness of car fuel consumption • Labelling based on CO_2 performance
Car free days	• Cycling / walking / public transport facilities

Box 2: Effect of regulatory measures on speed reduction

The Swedish Road Administration estimated the effect of regulatory mechanism on speed. Exceeding speed limit on Swedish road network gives an extra CO_2 emission of 0.7 Mt on an annual basis (compared to total emissions of 20 Mt). Using speed camera and intelligent transport system applications, a large portion of over speeding can be controlled. Reduction of speed limit by 10 km/hr could also result in similar amount of CO_2 reduction.

Fuel economy standards

Most developed countries impose fuel economy or CO_2 emission requirements on light vehicles. Studies have shown that there is a strong relationship between fuel savings and pollution reduction with stringent standards. In deciding to institute fuel economy standards, the government should consider the following:

- Fuel quality and availability
- Fuel economy testing methods

- Type and size of vehicles sold
- Road conditions that may affect the robustness of key technologies
- Conditions that may affect the availability of technologies, for example, availability of sophisticated repair facilities

Box 3: Policies to promote bio-fuel

Policies to promote bio-fuels are prominent in emission abatement strategies. Brazil was one of the first countries to implement policies to stimulate bio-fuel consumption. Currently, flexible fuel vehicles are eligible for federal value-added tax reductions ranging from 15 – 28%. In addition, all petrol are required to alcohol content of 20 – 24%.

European Union member states implemented a variety of policies. Most of the member states implemented an excise duty relief. Sweden and Austria implemented CO_2 taxed.

The American Jobs Creation Act of 2004 provided tax incentive for alcohol and bio-diesel fuels. Thirty nine states developed additional policy programmes or mechanisms to support increase in the use of bio-fuels. The type of measures ranged from tax exemptions on resources required for manufacturing and distributing bio-fuels and acquiring government fleet of bio-fuel vehicles to providing tax exemptions for purchase of bio-fuel vehicles.

Blending mandates have been introduced in China, Canada, Columbia, Malaysia and Thailand.

Transport demand management (TDM)

It is a formal designation for programmes to improve performance of roads by reducing traffic volumes. There are many TDM strategies that have varying impacts. Some improve transport diversity (the travel options available to users). Others provide incentives for users to reduce driving, changing the frequency, mode, destination, route or timing of their travel. Some reduce the need for physical travel through mobility substitutes or more efficient land use. Some involve policy reforms to correct current distortions in transport planning practices. TDM is particularly appropriate in developing country cities, because of its low costs, multiple benefits and potential to redirect the motorization process. In many cases, effective TDM during early stages of development can avoid problems that would result if communities become too automobile dependent. This can help support a developing country's economic, social and environmental objectives. Strategies to be adopted vary with each country's demographic, geographic and political conditions. TDM strategies can have cumulative and synergetic impacts, so it is important to evaluate a set of TDM programmes as a package, rather than as an individual programme. Effective strategies usually include a combination of positive incentives to use alternative modes ('carrots' or 'sweeteners') and negative incentives to discourage driving ('sticks' or 'levellers').

In the aviation sector, at the global level there is no support for the introduction of kerosene taxes. Alternative policy instruments that are being considered are: voluntary measures or fuel taxation for domestic flights. A major difficulty in developing a mitigation policy for the climate impacts of aviation is how to cover non-CO_2 climate impacts, such as the emission of NOx and the formation of condensation trails and cirrus clouds. The feasibility of arriving at operational methodologies for addressing the full pollution impact of aviation depends not only on improving scientific understanding of non-CO_2 impacts, but also on the potential for measuring or calculating these impacts on individual flights.

In the shipping sector, the International Maritime Organisation (IMO), a specialized UN agency, has adopted a strategy with regard to policies and measures, focusing mainly on further development of a CO_2 emission indexing scheme for ships and further evaluation of technical, operational and market-based solutions. Currently there are a very few cases where ports introduce economic instruments to create incentives to reduce shipping emissions. Examples include environmentally differentiated fairway dues in Sweden, the Green Award scheme in place in 35 ports around the world, the Green Shipping bonus in Hamburg and environmental differentiation of tonnage tax in Norway. None of these incentives are based on GHG emissions, but generally relate to fuel sulphur content, engine emissions (mainly NOx), ship safety features and management quality. An alternative economic instrument, such as a fuel tax is vulnerable to evasion; ships may avoid the tax by taking fuel on board outside the taxed area. Governments may consider investigating the feasibility and effectiveness of emission charges and emission trading as policy instruments to reduce GHG emissions from international shipping.

7.0 Case Studies on Control of Pollution

Two case studies are presented where measures to reduce pollution were implemented with incentives and enforcement.

Box 4: Case Study 1: Liquid Petroleum Gas (LPG) auto-rickshaws in Kolkata

One of the main sources of air pollution in Kolkata used to be the emission from auto rickshaws. In Kolkata, auto-rickshaws run as stage carriers unlike many other cities where they run as contract carriages. After years of legal and political gridlock, the Calcutta High Court passed a judgment on July 18, 2008, ushering in a new regulatory regime for the city's transport system. All vehicles 15 years or older were banned from the streets and all auto-rickshaws were required to have 4-stroke engines that run only on LPG. The auto-rickshaws converted to LPG. This resulted in a reduction of auto-rickshaw related emission. The benefits of LPG use had a direct bearing on the owner and/or driver, in terms of low maintenance cost, cheaper running and maintenance costs, near- zero pollution, and a life- saver for the environment.

Box 5: Case Study 2: Vehicle replacement in Delhi

In Delhi, some 60,000 commercial three-wheel auto-rickshaws were replaced. This was achieved in two phases. The first phase involved the implementation of a Delhi government programme (which the Supreme Court intervened to expedite) to replace vehicles older than 15 years by new ones complying with the latest emission standards. Between July 1998 and March 2000, nearly 21,000 auto-rickshaws older than 15 years (constituting one-fourth of the auto-rickshaw population) were replaced with those meeting the Indian 1996 emission standards (the prevalent standards for new vehicles at that time). The second phase followed two Supreme Court mandates that called for:

(1) the replacement of all pre-1990 auto-rickshaws and taxis with new vehicles on clean fuels, and

(2) financial incentives for the replacement of all post-1990 auto-rickshaws and taxis with new vehicles on clean fuels.

Incentives combined with strong enforcement were employed. Both phases of the Delhi program were successful because the vehicle owners saw a net benefit. In the first phase, the owners could get rid of very old vehicles and purchase new, superior products at an effectively discounted price. In the second phase, the higher initial cost of the replacement vehicle was offset by the lower fuel cost. Interestingly, in both phases, most owners preferred to scrap old auto-rickshaws even though they were given the option of selling them to buyers outside of Delhi.

CONCLUSION

Pollution is a problem all over the world. Transport contributes to a significant portion of the pollution. Transport causes pollution in air, water, noise, ecology and landscape. The major components of air pollution are: lead, TSP, Ozone, CO_2, CO, SO_2, NOx and PAH. The effects of pollution are on: climate, noise, health, acidification, land use and ozone damage. There are various mitigation technologies available for road, rail, water and air transport. The policies and measures that can be effective in reducing GHG and pollution from transport sources are: land use transport planning, taxation and pricing, regulatory and operational instruments, fuel economy standards, transport demand management. Case studies from Kolkata and Delhi show that pollution reduction methods can be implemented with proper incentives and enforcement.

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ENVIRONMENTAL POLLUTION AND ELECTRIC VEHICLES

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The transport sector is the highest consumer of oil and the second-highest contributor to CO_2 emissions worldwide. "Transportation accounts for about 11 % of India's Carbon emissions and is a major source for air pollution in several cities nationwide. As many as 14 of the world's top 20 most-polluted cities are in India, according to a 2018 World Health Organization (WHO) report."1

Rapid developments in electric mobility are transforming the automotive industry by addressing the growing concerns of environment and energy security in the transport sector. Electric Vehicles (EVs) do not require direct fuel combustion, thereby contributing to transport policy goals such as increased energy security and better environmental compliance leading to reduced greenhouse gas emissions. Worldwide, various countries are making efforts to meet lower CO_2 emission targets. India has an additional incentive of reducing crude oil & gas imports to minimise dependence on oil-rich nations and reduce the nation's current account deficit.

Petrol or Diesel is the fuel that powers the Internal Combustion Engine (ICE) in a conventional vehicle, which produce noise and emit pollutants into the environment. They are inefficient; with less than 25% energy converted from fuel for mobility.

In a Battery Electric Vehicle (BV), the energy is stored in an on-board battery to power an electric motor. The on-board battery gets charged from the grid power supply by plugging into a charging point. The energy efficiency of BV is high, with around 80% of stored energy in the battery getting converted to propulsion. The efficiency of electric motors is high, with further efficiency gains offered by regenerative braking which keeps the battery in charged condition by saving the energy that gets lost during braking.

BVs do not have any exhaust emissions; however, emissions do occur at the power plants which generate the electricity to power the electric vehicles. Environment benefits that accrue would be higher when BVs utilise renewable power sources. The regulatory policies vis-à-vis the environment, drives the extent of penetration of electric vehicles. All major countries have taken a varied range of policy initiatives and regulatory measures, to promote the growth of electric vehicles. Regulatory measures adopted include fuel economy standards and imposing movement restrictions based on tailpipe emissions.

ELECTRIC VEHICLE INITIATIVE

"The Electric Vehicle Initiative (EVI) is a multi-governmental body established to accelerate the deployment of electric vehicles worldwide. Governments currently active in the EVI include Canada, Chile, China, Finland, France, Germany, India, Japan, Mexico, Netherlands, New Zealand, Norway, Sweden, United Kingdom and United States. This group represents the largest and rapidly growing EV markets globally and accounts for the majority of EV sales

in recent years. The EV30@30 campaign launched by EVI set a collective aspirational goal for all EVI members to achieve a 30% market share for electric vehicles (except two and three-wheelers) by 2030. Countries across the globe have developed policies which are aligned with their nation's interests to achieve the set goal. India has started late on the growth path and therefore needs a robust policy framework to race towards the goal of reaching 30% market share for EVs by 2030."[2]

"The EV30@30 target of 30% market share of EVs – Light-Duty Vehicles (LDVs), buses and trucks collectively – is expected to be met at the global level. If accompanied by a reduction of the Carbon intensity of power generation of over 50% by 2030, this goal is in line to meet the targets of emissions as per the Paris Climate Agreement."[2]

ENVIRONMENTAL POLLUTION

When running, BVs do not emit any emissions. However, fossil fuels used to produce the electricity they consume, indirectly contribute to CO^2 and air pollutants. Therefore, while comparing the emissions of conventional vehicles with BVs, Well-To-Wheel (WTW) emissions need to be considered.

CO_2 intensity of BV is governed by the extent of the renewable power mix in the power generation and the extent of Carbon generated in vehicle manufacturing. Multiple factors, such as high efficiency of electric motors and higher renewable share of electricity that they consume, allow BVs to reduce CO_2 emissions.

In many countries, by year 2030, the renewable share of power generation in the total power generation would be substantially higher. The higher percentage of renewables power generation would result in reduced CO_2 emissions per kWh of electricity generated, with the corresponding reduction in WTW emissions of BVs.

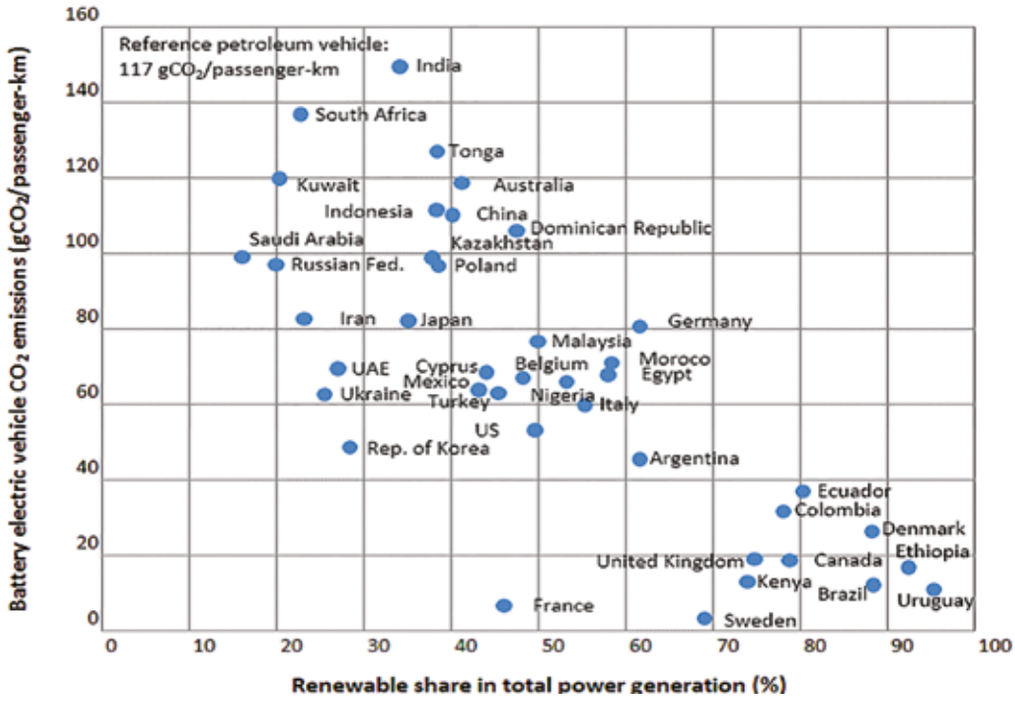

Figure 1: *Relation between Renewable Share in Total Power Generation (including Hydro) and the Battery Electric Vehicle CO_2 Emissions, 2030.*[3]

"Fig 1 depicts the relation between renewable share in the total power generation and the BV CO_2 emission in the year 2030. BV CO_2 emissions, in gCO_2/passenger-km, of countries having a higher share of renewable generation, would be far less in comparison with countries where Coal dominates in the power generation mix. For example, in countries such as India and South Africa, the emissions are exceeding 117gCO_2 per passenger-km, which is the reference level for a petroleum vehicle. Hence, increased share of renewable power in the total power generation would play an important role in improving the environmental benefits of BV."[3]

On WTW basis, battery-electric cars in Europe, emit far less CO_2 when compared to their Internal Combustion Engine (ICE) counterparts, mainly due to a higher share of renewables in the overall power generation. However, when emissions relating to vehicle production are also included, the amount of CO_2 emissions reduction is lower but still lesser than conventional vehicles. In the United States and Japan, where renewable share of power generation is lower, the WTW emission reductions are lower when compared to Europe.

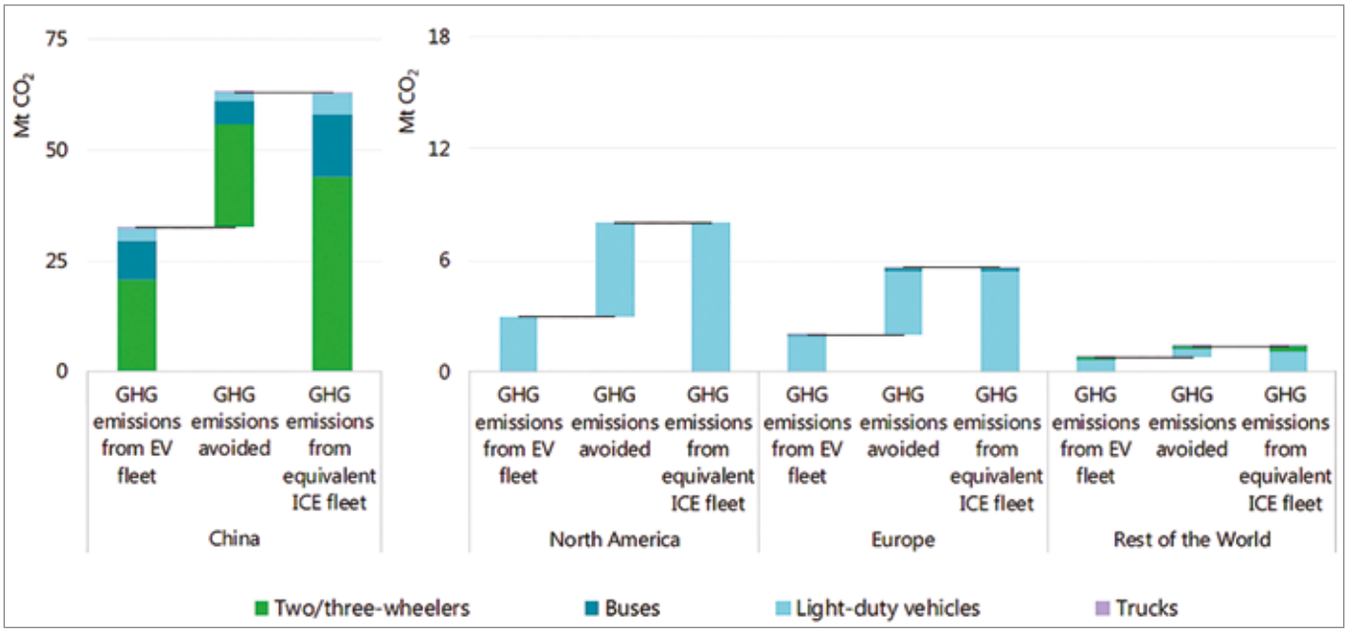

Figure 2: *GHG Emissions Avoided by EV Compared to Equivalent ICE Fleet by Mode and Region, 2018*[2]

In India and China, due to the high Carbon intensive power generation, WTW emissions of BVs are higher when compared with ICE vehicles. Augmenting the renewable share in power generation will have a favourable impact on climate change and BVs would gain advantage over ICE vehicles in terms of WTW emissions. Studies have shown that the electric grid should be decarbonised to the levels of 400 grams/kWh or less for BV to have CO_2 advantage over ICE vehicle. "The present CO_2 emission level in India and China, countries with significant Coal-based power generation, is around 800 to 900 grams/kWh." [4,5]

"In 2018, BVs worldwide emitted around 38 million tons of CO_2 (Mt CO_2) and avoided emissions of 40 Mt CO_2 as shown in Fig 2. China stands out as the most significant contributor to the total emissions; avoided 77% of total due to the very high BV stock in China, rather than through the advantage in terms of WTW CO_2 emissions compared to ICEs, given the high Carbon intensity of power generation." [2] Almost all EVI countries are committed to reducing

Greenhouse Gas emissions (GHG) in line with the Paris Climate Agreement. To ensure that BVs contribute to reduced GHG emissions, countries should foster the growth of BVs, aligned with higher share renewable power generation.

BVs provide fuel efficiencies that are substantially higher than their ICE counterparts due to the power generated through regenerative brake mechanism and the higher efficiency of BV powertrain. "It is estimated that BVs operating worldwide in 2018 saved 21 million tons of oil equivalent (Mtoe), 0.43 million barrels per day (mb/d) of diesel and gasoline. Most of the saving is attributed to two and three-wheelers (60 %), followed by LDVs (23%) and buses (18%)."[2]

BVs do not emit any exhaust emissions and therefore contribute to lower NOx emissions as compared to ICE vehicles. There are concerns about air quality, especially in cities of developing nations such as India and therefore, reduction of air pollutants plays a key role in adopting electric mobility. Moreover, BVs reduce noise pollution in cities.

The share of renewable energy generation is growing in many nations with India being no exception. "India is confident of breaching the initially set renewable power generation target of 175GW by 2022; it has recently revised the target to 227GW."[6]

"India can save 64% of energy demand and 37% of Carbon emissions in 2030 by pursuing electric mobility. This would result in a reduction of 156 Mtoe in diesel and petrol consumption in 2030. Cumulative savings from 2017–2030 would be around 876 Mtoe for petrol and diesel and one Giga tonne for CO_2 emissions." [7]

FUTURE COURSE OF ACTION

The progress that the global electric vehicle industry has seen in recent years is not only extremely promising but also highly necessary in the light of increasing global greenhouse gas emissions. BVs are proliferating globally at a rapid pace due to de-carbonisation policies by various government authorities and due to the improving BV costs and performance.

In India, a slash on GST for EVs/ Vehicle chargers and the launch of Phase II of FAME, a scheme which provides subsidies and incentives for the adoption of EVs, shows government's intention to promote EVs. However, under FAME II scheme the incentives will be applicable for 3-wheeler, 4-wheeler and buses used for public transport and for commercial vehicles, while for 2-wheeler the incentives will be applicable to private vehicles as well.

ICE vehicle efficiency has improved with the enforcement of fuel-economy and emission standards. To ensure that the standards reflect emission and fuel-economy targets not just on "testbed" conditions, but "on-road" conditions, it is necessary to overhaul the regulations and the testing methods. As fuel-economy and emissions standards become more stringent, automobile manufacturers would necessarily have to switch the manufacturing process from ICE vehicles to include EVs.

To allow automobile manufacturers and the component suppliers to adapt to the manufacturing process of new vehicle models, the standards on fuel-economy and emissions need to be established early. To attract investment in a timely manner and to enable ramp-up of production, the standards must be stringent.

Establishing low or zero-emission zones in cities and implementing access restrictions to ICE vehicles can have a significant impact. These measures would supplement other initiatives and would assist in realising cleaner living

environment. Development of guidelines for access restrictions of various categories of vehicles, based on emission performance, to low or zero-emission zones, is an option that could be explored.

Transition to electric mobility depends on restrictions imposed on tailpipe emissions and the incentives and mandates for increased share of renewable power generation. For automobile manufacturers to invest in large scale development of EVs a clear policy direction and its effective communication are essential.

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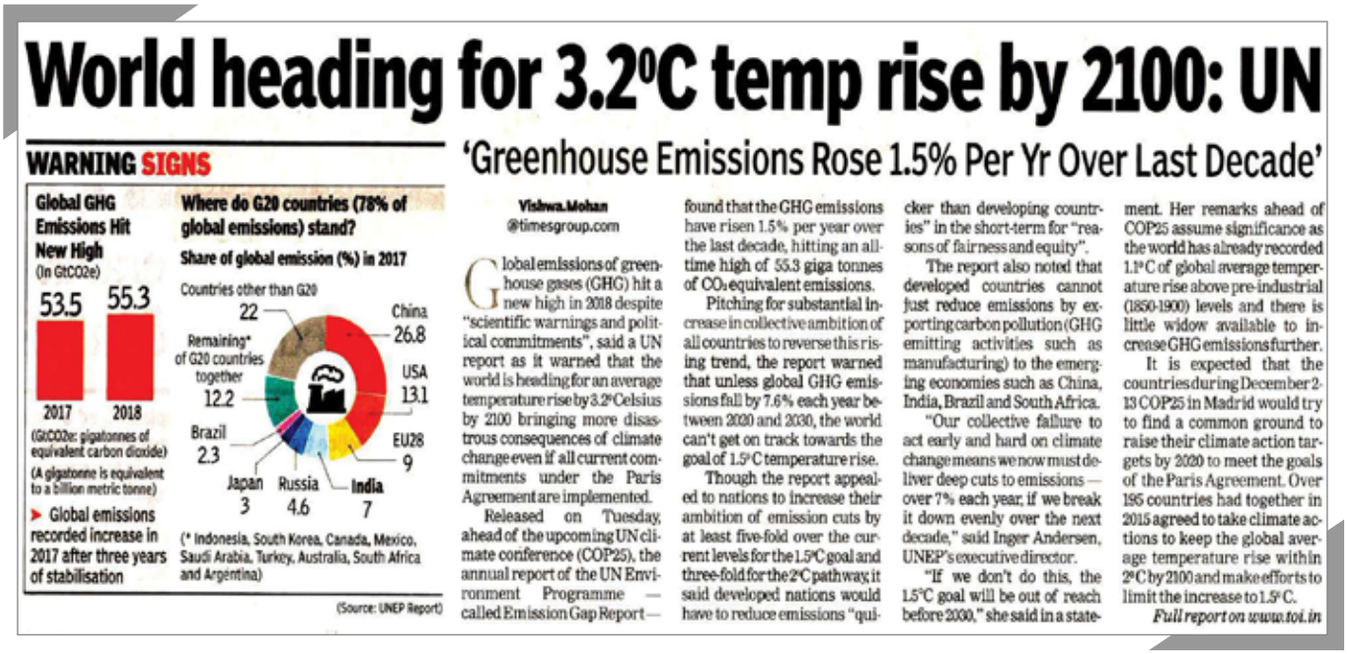

World heading for 3.2°C temp rise by 2100: UN

'Greenhouse Emissions Rose 1.5% Per Yr Over Last Decade'

WARNING SIGNS

Global GHG Emissions Hit New High
(In GtCO2e)

(GtCO2e: gigatonnes of equivalent carbon dioxide)
(A gigatonne is equivalent to a billion metric tonne)

➤ Global emissions recorded increase in 2017 after three years of stabilisation

Where do G20 countries (78% of global emissions) stand?
Share of global emission (%) in 2017

(* Indonesia, South Korea, Canada, Mexico, Saudi Arabia, Turkey, Australia, South Africa and Argentina)

(Source: UNEP Report)

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Global emissions of greenhouse gases (GHG) hit a new high in 2018 despite "scientific warnings and political commitments", said a UN report as it warned that the world is heading for an average temperature rise by 3.2°Celsius by 2100 bringing more disastrous consequences of climate change even if all current commitments under the Paris Agreement are implemented.

Released on Tuesday, ahead of the upcoming UN climate conference (COP25), the annual report of the UN Environment Programme — called Emission Gap Report — found that the GHG emissions have risen 1.5% per year over the last decade, hitting an all-time high of 55.3 giga tonnes of CO_2 equivalent emissions.

Pitching for substantial increase in collective ambition of all countries to reverse this rising trend, the report warned that unless global GHG emissions fall by 7.6% each year between 2020 and 2030, the world can't get on track towards the goal of 1.5°C temperature rise.

Though the report appealed to nations to increase their ambition of emission cuts by at least five-fold over the current levels for the 1.5°C goal and three-fold for the 2°C pathway, it said developed nations would have to reduce emissions "quicker than developing countries" in the short-term for "reasons of fairness and equity".

The report also noted that developed countries cannot just reduce emissions by exporting carbon pollution (GHG emitting activities such as manufacturing) to the emerging economies such as China, India, Brazil and South Africa.

"Our collective failure to act early and hard on climate change means we now must deliver deep cuts to emissions — over 7% each year, if we break it down evenly over the next decade," said Inger Andersen, UNEP's executive director.

"If we don't do this, the 1.5°C goal will be out of reach before 2030," she said in a statement. Her remarks ahead of COP25 assume significance as the world has already recorded 1.1°C of global average temperature rise above pre-industrial (1850-1900) levels and there is little widow available to increase GHG emissions further.

It is expected that the countries during December 2-13 COP25 in Madrid would try to find a common ground to raise their climate action targets by 2020 to meet the goals of the Paris Agreement. Over 195 countries had together in 2015 agreed to take climate actions to keep the global average temperature rise within 2°C by 2100 and make efforts to limit the increase to 1.5°C.

Full report on www.toi.in

PRACTICAL SOLUTIONS TO TRANSPORTATION POLLUTION

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ABSTRACT:

"Man is the most insane species. He worships an invisible God and destroys a visible Nature. Unaware that this Nature he's destroying is this God that he's worshiping." Hubert Reeves – Canadian French Astrophysicist.

Climate change (global warming) is one of the hot topics of the 21st Century due to its impact ranging from extreme temperatures and cyclones to intense rain fall resulting in flooding. Over the last four decades, climate change has been a subject discussed, voices heard, but no concrete action taken. All experts point the finger at one source; that is "pollution", in other words "emissions". The NCR-Delhi area has an added pollution source - the burning of stubble by farmers in the neighboring states, thus loading the already polluted area.

This paper attempts to focus on the causes of major "pollution", particularly in the developing India that is moving rapidly towards the ambition of building a 5 Trillion Dollar economy. To reach that goal it is necessary to understand as to "What would be the real impacts of building such an economy?"; "What are the types of policies that are required to be developed to achieve a balanced approach to environmental and energy needs?" More importantly to understand, how to reduce the effects of pollution that will invariably affect the public health.

To minimize the pollution emissions (CO, CO_2, NO_X, NO, Sulfur Oxides and Particulate Matter) adequate polices should be in place with the capability to enforce them on a consistent basis across all sectors from Transportation to Industries. The principles of both Urban Planning and Transportation Planning are to be used concurrently in developing areas for people to live and provide seamless mobility for providing good quality of life. It is necessary to build efficient and reliable multimodal public transit systems for the daily work trips across the cities and thus to cut the number of personal vehicles used. By implementing some of the potential solutions suggested there is potential to save thousands of gallons of wasted energy (fuel) on the roads and thus reduce pollution.

1.0 Introduction

Transportation is the bloodline of any economy. Majority of the developed countries have well developed transportation infrastructure. Therefore, it is not surprising that a developing country such as India is building more highways and infrastructures to achieve the national objective of 6% to 8% growth per annum. However, the required "polices" to monitor the impacts of the growth, over time, on the health of the public, is not being checked. The news that *"NCR-Delhi is one of the worst polluted City"*, is not a surprise, because adequate policies have not been prepared along with the development to monitor environmental impacts. The reasons for pollution are many including the cold air in winter, burning of the stubbles in neighboring states, the ever increasing number of vehicles, use of fossil fuel, growth in the aviation sector and many other big city factors.

The impact of winter weather on emissions is severe because when the temperatures fall and if wind speeds are slow, the cocktail of weather conditions create a temperature inversion, trapping particulates underneath a layer of warm air, hence there's nowhere for the smog to go. India is home to 22 of the top 30 most polluted cities, according to a study in March 2019 by Greenpeace and AirVisual.

Figure 1 shows the impact of smog in the NCR-Delhi area mostly due to stubble burning, exhaust from cars and the effect of the cold weather. In addition, the "Diwali Effect", that is the burning of firecrackers across all areas of Delhi during the festival period.

Figure 1: *The Smog Effect - New Delhi (November 2019)*

As the median income in the country has been steadily increasing, since the beginning of the 21st Century, particularly for the medium income families, there is more disposable income for other activities, such as travel. Therefore, their needs, expectations and habits have changed rapidly in the past decade as can be seen in Table 1.

Going on "vacations" was number 6 in 2009 but has moved to number 2 place within a decade; clearly indicating the major shift in the attitude of the people in the country and how the financial goals have changed over the years?. Most of the travel has now shifted from buses and rails to cars and air travel in the last two decades.

Table 1: Changing Trends of Financial Goals of Indian Households

HOW FINANCIAL GOALS OF INDIANS HAVE CHANGED IN THE PAST 10 YEARS **Holidays have become an important goal for Indian households, even as funding children's marriage has taken a backseat**										
RANK	1	2	3	4	5	6	7	8	9	10
2009	Children's Education	Buying A House	Retirement	Buying A Car	Children's Marriage	Vacations	Health Needs	Supporting Parents	Upgrading Lifestyle	Paying Off loans
2019	Children's Education	Vacations	Buying A House	Retirement	Buying A Car	Upgrading Lifestyle	Children's Marriage	Starting A Business	Health Needs	Paying Off Loans

Source: *Times of India*

An emerging nation goes through a transformation that is not readily seen and catches the administrators and policy makers by surprise. It is observed that more people are now using various transportation modes, particularly personal cars and there is increased air travel. Irrespective of the annual burning of stubbles, these two major factors contribute significantly to "pollution" all the year round. In the long-term solutions could be developed for the "stubble" burning; but the matter of rising use of cars and airplanes must be addressed.

1.1 Road Sector – Cars (Vehicles)

The planning and design of roads and intersections to provide seamless mobility would assist in reducing emissions. Currently, the way roads and intersections are designed without using the correct principles of urban and transportation planning; the number of stops, acceleration and deceleration are exponential and add to the pollution problem. Therefore, good planning in developing roads and intersections based on good design considering the future growth of traffic in each area1 is necessary.

Road are designed to suit proposed or existing development in an area. Hence it is necessary to answer questions such as: How much growth can be allowed? What type of land uses and land size can be allocated? Proper (standard) design of roads and intersections need to be done to provide adequate capacity for expected traffic with necessary traffic controls. Use must be made of Intelligent Transportation System (ITS) to make the system efficient and simultaneously enforce traffic laws. Such practice would help to reduce pollution due to vehicles on a daily basis.

1.2 Aviation Sector – Air Travel

With the increase in disposable income, the next major transportation sector that is growing exponentially is air travel in India. Simple logic would explain that when an airplane is compared to a car; the emissions are much more for airplanes, regardless of all the arguments related to number of persons carried and the distance travelled by the modes as put forward by the lobbyists on both sides of the aisle.

In case of airplanes, the impact is not directly seen as for the "cars" on the roads. The aviation sector has a "big and powerful lobby" that manages to control any legislations or publicity as related to the air emissions; this is true across the globe. Hence, the scapegoats are the "cars".

Table 2 is self-explanatory. It shows the CO_2 emissions per passenger per kilometer for each mode of travel[2] which gives an idea of the polluting capability of each mode. The figures in Table 2 are based on some assumptions; hence the argument always is that it is difficult to say which is the better or worst mode of transportation as the variables are different in each study[2]. However, the fact remains that the difference in the emissions is high.

Another example is emission from a Boeing 747, which uses an estimated 7840 Kilograms of aviation fuel for a take-off and landing producing tons of CO_2[3,4]. The emissions from one Boeing 747 (there are even bigger aircrafts now) during landing and take-off is estimated to be equivalent to 150,000 cars. Compare that to what an

Table 2: CO_2 Emissions for Different Modes of Transport

Sl. No.	Mode of Travel	CO_2/passenger / Kilometer (in grams)
1	**Small Car**	**42**
2	**Average Car**	**55**
3	Two-Wheeler	72
4	Bus	68
5	Train	14
6	**Airplane**	**285**

Source: *Homepage Energy & Transport*[2]

Figure 2: *Contrails (emissions) left behind on take-off*

average car contributes (Table 2). Consider the number of airplanes landing and taking-off daily in a city like Delhi with three major runways as compared to the number of cars that are on the road in the entire NCR-Delhi area. The combination of both results in very high pollution levels. Add to those, stubble burning and all other regulated and unregulated human activities in the city such as industries, use of fossil fuels, construction and other human activities. To all those add the weather conditions as a silent contributor in the pollution game.

1.3 Loss of Life and Health Issues

It is reported that the total number of estimated deaths in India on the roads, range between 1,250,000 to 1,500,000 per annum. When it comes to airplane crashes it is about a thousand people across the globe. Yet no one has been able to directly attribute the number of deaths due to "pollution" from cars and airplanes as the sources.

Recent studies indicate that one is more likely to die from exposure to pollution than by an accident. Research shows that plane emissions kill about 10,000 people each year[3,4]. Earlier it was assumed that people were harmed by a plane's emissions and its impact on the atmospheric layer, the ozone layer. The emissions of a plane (Figure 2 showing contrails from a plane take-off) at 3,000 feet (about 900 meters) were responsible for most deaths. Like car exhaust, airplane exhaust contains a variety of air pollutants, including large quantities of *Sulfur dioxide and Nitrogen oxides;* these exhaust particulates are smaller than the thickness of the human hair.

Health risks are the major cause of pollution from all the sources. The finer particulates get wedged deep in the lungs and possibly enter the blood stream causing the damage. The most vulnerable are the children and elders of the society. As an example, consider all the flights over most apartment complexes in Dwarka Sectors 21, 22 and 23, in New Delhi every day which are close to the Indira Gandhi International Airport, New Delhi. The planes fly over them at just over 1000 meters.

Therefore, ignoring pollution and environmental impacts is not an option. Cities build economies, hence, the city's authorities should protect the people and collectively plan to build sustainable cities. They must also, save the planet by mitigating the causes of pollution and implement proper strategies. There is a need to look for comprehensive potential solutions and not immediate "patch works" during wintertime especially in NCR-Delhi. Long term planning and solutions must be developed.

2.0 Practical Solutions

For potential practical solutions, there is no need to reinvent the "wheel". Most of the developed and developing countries have made efforts to tackle the problem of minimizing pollution and achieve sustainability. From the current local perspective some practical solutions that could be used are presented in the subsequent paragraphs. The solutions presented relate to both - *energy savings and minimizing pollution.*

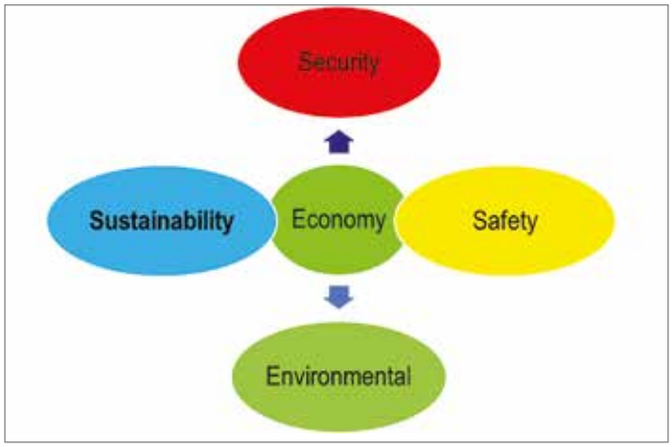

Figure 3: *Objectives of Planning*

2.1 Urban and Transportation Planning

To begin with, "Planning" of cities is very important to minimize the effects of congestion and pollution. There is need to develop Master Plans to allocate land uses, as

each land use generates vehicle trips. In general, urban planning from the transportation perspective can be defined as an action taken to prevent anticipated problems in the future on account of congestion and pollution by projecting the vehicle trips due to different land uses. Planning can be defined as the process of making plans for something to achieve set objectives as in Figure 3; most important is to improve the quality of life of the citizens. Inadequate planning by not integrating vehicle trips, has led to congestion in many areas resulting in extreme pollution and health risk, including those to animals and also affecting the flora and fauna.

2.2. Traffic Impact Studies (TIS)

Traffic Impact Studies (TIS) are required to estimate the trip generation for different land uses allocated in an area and their impact on the existing road network. Un-planned constructions lead to both congestion and pollution as seen today along most of the highways in India, as in the NCR-Delhi areas and other major cities. Most of these developments or constructions are unauthorized and illegal. In India, some traffic analysis is done only while constructing highways and that too at the DPR stage, but no traffic impact analysis is done for both the public and private land use developments. This has allowed many types of land uses ranging from huge malls, large public offices and apartments with several floors (20 or above) to be built without any restrictions, all leading to the current congestion and pollution. All these add to the overall pollution in the area.

Despite all these unregulated growths, yet there is no plan to develop and implement TIS in India for any type of developments, particularly for the large public and private development generating thousands of trips. In the United Arab Emirates (UAE) and other developed countries; nothing can be built without doing a TIS, which verifies the trip generation, parking needs and access management. Most of the transportation facilities are built with the "trip generation fee" accessed by the authorities based on the land use. Until this system is instituted in India, things would not improve and neither would there be sustainable funding to build the next generation of transportation system and improve quality of life (Figure 3).

2.3. Traffic Signal Synchronization

This is another good and proven tool available to minimize pollution and save energy. In a congested metropolitan area such as Delhi, traffic control at road intersections should be signalized along long stretches of roads to be economical. The objectives would be to clear the long queues from idling and emitting emissions, reduce the number of stops to minimize the particulate matter and the travel time for commuters. The other benefits of Traffic Signal Synchronization are reduced accidents, pollution and health risk. The savings in travel time costs and energy savings can be quantified for each project; the benefits would outperform the project budget.

As an example are the results of a Traffic Signals Synchronization project done in Indore, India on the Eastern Ring Road[5]. For this project nine intersections were synchronized after conducting the necessary traffic engineering studies such as the traffic survey, data collection and re-timing of signals.

The total length of the road is 14.6 kilometers with an average of just over 3000 vehicles per hour during peak period on the road section. The results of the study concluded that the travel time would be reduced by 241 seconds and 151 seconds per vehicle traveling north to south and south to north respectively. Due to synchronization 241,000 liters of petrol and 340,000 liters of diesel would be saved; which converts to Rs. 1.2 million/annum and Rs. 30.15 million/annum respectively. The loss to commuters was estimated at Rs. 13.42 million/annum due to vehicle delay (on account of increased travel/ waiting time in that road section). In addition, if the wear and tear, stress on drivers

and passengers and the unavoidable health risks are quantified and added, the losses would be even bigger. *The most important result was the CO_2 emission reduced by 1.5 million kilograms/annum by the Traffic Signal Synchronization.*

Based on the above example of Indore and applying it to all the major road sections across India; the cumulative savings in travel time, energy and reduction in pollution would be a staggering number, if Traffic Signal Synchronization is implemented.

The import of oil at premium price would be cut down if energy savings are considered and if each of the potential solutions are implemented and enforcement is done as per law.

Merely installing a number of cameras all over the City (New Delhi) in the name of using Intelligent Transportation System (ITS) will not solve the "pollution" problem. In some of the Smart City projects, ITMS is used as a tool to put more cameras at the intersections without understanding what really is required and would really work? Proper Urban Planning coupled with Transportation Planning is what is needed before providing the cameras and other sensors.

2.4. Highways and Expressways – Impact on Energy and Pollution

Networks of many highways and expressways have been built since the beginning of 21st century in the country using billions of dollars (most of the money taken as loans from foreign countries). However, the four E's - Engineering, Environment, Enforcement and Education are not implemented once construction is completed. Lack of "enforcement" is particularly astounding.

Considering the thousands of kilometers of highway and the current number of vehicles in the country using them; the "stop and go" along the highways by these vehicles (cars, jeeps, tempo, buses, lorries, tractors, trailers, dumpers, two-wheelers, etc.) due to the "lack of enforcement," and consequent unregulated driving of heavy vehicles along the highways lead to greater pollution and particulate matter.

The heavy vehicles legally should occupy the "left lane" for travel and use other lanes only in case of overtaking vehicles. This, however, is never followed despite numerous signs indicating that it is mandatory. There is no enforcement even if one travels hundreds of kilometers on the highways. The most devastating action that causes more pollution, energy loss and particulate matter is the occupation of the "right lanes" and/or "all the lanes" by the heavy vehicles and causing the "box effect."

The *"box effect"* refers to the inability of the other vehicles on the highway to go past the heavy vehicles that are blocking or running in the lane(s) not designated for them. The effect is that the lighter vehicles are boxed between or stuck behind the heavy vehicles. The "box effect" is illustrated in Figures 4A and 4B; where the cars are unable to go at their designated speed as they must decelerate/ stop and find gaps in the vehicle stream ahead to accelerate to designated speed.

The tendency of heavy vehicles to drive in the "right lane" could be attributed to the fact that the left side of a highway invariably has unauthorized urban development and encroachments which result in human and animal movement plus parked vehicles (usually haphazardly). Push carts and vendors are also present and add to the obstructions. Hence the heavy vehicles prefer to drive on the right side where they do not have to worry about hitting into any human, animal and parked vehicles.


***Exhibit 4A: & 4B**: Illustrating the Boxing Effect by Heavy Vehicles (photos by Author)*

The "boxing" effect on the highways is like having a "stop signal" every 500-1000 meters along the highways. That leads to "stop and go" for lighter vehicles and leads to "micro emissions". These emissions have been quantified; the level of pollution and energy is large due to deceleration and acceleration[7,8]. Experiments of stop, deceleration and acceleration have shown that the tailpipe emission rate is high at lower speed and gradually lowers with increase in speed. Later with further increase in speed the emission rate increases monotonically. The trend is observed for all emissions like CO_x (Carbon Oxides), HC (Hydrocarbon) and NOx (Nitrous Oxides).

From deceleration to acceleration and changing to higher gears reduces power requirement and hence the fuel requirements of engine goes on reducing. This reduced fuel consumptions result in reduced tailpipe emission only after attaining higher speeds. However, at much higher speeds and shifting to higher gears more fuel is used and results in increase in tailpipe emissions[7,8]. The impact of this stop and go along the highways is very huge, leading to emissions, energy loss, stress on drivers and potential accidents. This is an example of the impact of the "non-enforcement" of existing traffic law requirements for the heavy vehicles to drive in the "left lanes" and also not allow any unauthorized and unplanned developments along the highways.

Table 3 shows the average tailpipe emissions for different speed ranges and acceleration levels. It is seen that there is significant variation in tailpipe emission rate for different speed range and acceleration combinations. The lowest emission rate is observed in the speed range of 3-8 meters/second. The effect of acceleration on tailpipe emissions is more significant at speeds above 8 meter/second. All types of emissions with acceleration of 1.6 meters per second per second are much higher[7,8]. The table demonstrates the effect of speed and acceleration on tailpipe emission rates of test vehicles. However, the emissions also depend on the age of the vehicles and maintenance practices used.

Table 3: Average Tailpipe Emission Rate for Different Speed Ranges and Acceleration Levels

Speed Range m/s	CO %	CO %	HC ppm	HC ppm	NOx %	NOx %
	a = 1.0 m/s^2	a = 1.6 m/s^2	a = 1.0 m/s^2	a = 1.6 m/s^2	a = 1.0 m/s^2	a = 1.6 m/s^2
0-3	**0.043**	**0.4**	**2.4**	**3.92**	**15.66**	**27.53**
3-8	**0.006**	**0.008**	**1**	**1.06**	**2.0**	**2.46**
Above 8	**0.29**	**0.865**	**5.29**	**10.49**	**31.08**	**44.77**

Note: m/s = meters/second; a = acceleration in meters/$second^2$; % = Percent

For the country, the savings in travel time, fuel, pollution and reduction in health risk would be tremendous considering the number of vehicles on the highways every day throughout the country, if proper enforcement is instituted, as it should be.

The question that arises is "Why enforcement is not done or if done, done fragmentally?"

The benefits to the entire country by adding up the savings in travel time, energy and minimizing pollution by implementing Traffic Signal Synchronization and enforcing existing laws on the highways/ expressways and other major roads using ITS would be tremendous. The results would be large savings of energy (millions of gallons) and reduction in pollution (millions of Kilograms). The import of oil, paying premium price would be reduced, there would be cleaner skies, better health of citizens, and good flora and fauna.

2.5. Road and Highway Signs

The signs along roads and highways play an important role in informing commuters and directing them to their destinations, helping streamlining the traffic and also enforcement of traffic regulations. Therefore, the signs must be developed/ designed based on an understanding of the characteristics of the commuters; the goal is to create a sign that is easily understood and followed by all users, educated or uneducated, in rural or urban areas.

For example, for the elections, the voting pamphlets and ballot papers provide "images of parties" that are easily correlated to a party and understood by the citizens. Similarly, pictorial/ graphical images signs must be developed for the roads so that they deliver an unambiguous message to the commuters as to what is expected from them while using the transportation infrastructures and facilities.

Currently the signs for the heavy vehicles are placed in the "median" showing that the Heavy Vehicles should travel in the "Left Lanes" with an arrow pointing directly at the "lane" below. Probably this is misunderstood or misread by the truck drivers. These signs must be moved to the "left shoulder" with better design graphics to make them understandable by all, considering that most of the drivers may not be able to read English or even if the signs are in the local language.

There is a need for new graphical design of the heavy vehicle lane signs (IRC could assist in this effort). Numbering of lanes on the highways for easy understanding, pictorially/ graphically showing the vehicle type on the lanes, would make it easy to follow; more gantry signs showing the lane numbers and the assigned lane. Further education by using media and brochures with constant enforcement would go a long way.

Figure 5A and 5B are an attempt to develop new signs, in a pictorial/ graphical manner, to show that heavy vehicles should use the left lane on the highways for 2 lanes and 3 lanes roads in each direction respectively.

Figures 6A and 6B convey the message by pictorial diagrams drawn on the road surface itself to assist in better understanding by the heavy vehicle drivers. This would also assist in regulating traffic through proper channels as vehicles approach toll booths. With the signs placed intermittently, they would remind the drivers about their mandated travel lanes.

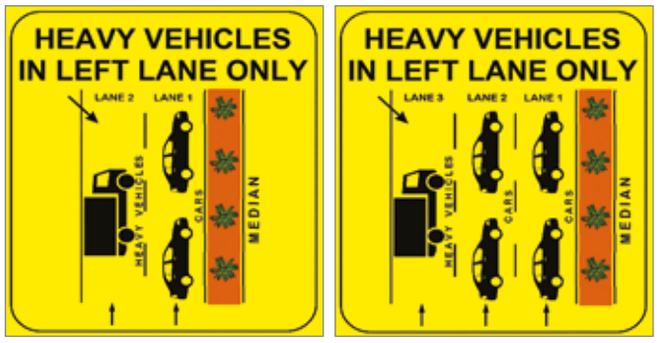

Figure 5A & 5B: *New Heavy Vehicle Signs for Highways (Source: Author)*

The road surface signs should be painted at regular intervals along the highway to inform and remind the drivers to follow the allocated lane. Educating the drivers is very important; the same way new signs should be developed at toll booths to inform the lane in which the different types of vehicles should enter. Currently, at the toll booths there are a lot of illegal movements and unwanted changes by vehicles before reaching the payment booth. The drivers should be informed, a minimum 2 kms before the toll booth as to which lanes they are to be in while approaching the toll booths. The pictorial/ graphical illustration on the road surface could be effectively used to direct the traffic into proper channels for reducing confusion and reduce the average delay of 20 minutes or more at toll booths.

The development of new signs would assist all drivers and improve mobility on the highway with better speeds and safety. The solution should be designed based on the needs of the commuter's knowledge, understanding and education levels. Lack of signs and enforcement has already made driving on highways a hazard, stressful and uncomfortable. The simple sign changes as shown in Figures 5A, 5B, 6A and 6B would assist in the effort to improve highways safety, add local language and educate all drivers through media and brochures with enforcement.

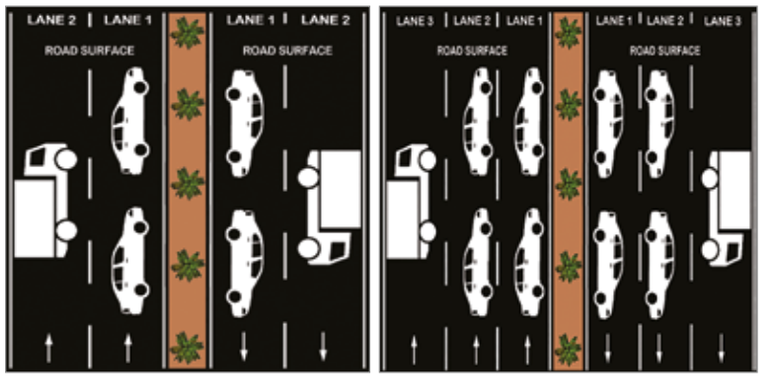

Figure 6A & 6B: *Road Surface of Highway with Pictorial Depiction on Road Surface (Source: Author)*

2.6. Multi-Modal System

The growth in number of vehicles would only increase over the years even though there was some negative growth in the last few months, as per the records of car units sold. The India's Motor Vehicles Sales Growth rate which is updated monthly is available from May 2002 to September 2019 shows an average growth rate of 10.2%. It reached an all-time high of 63.6% in December 2009 and a record low of (-) 26.6% in August 2019. CEIC calculates monthly Motor Vehicles Sales Growth from the monthly Motor Vehicles Sales, by *subtracting* the Two Wheelers and Three Wheelers Sales from the Total Motor Vehicles Sales[6]. A look at Table 2 data shows that the two-wheelers are much more polluters than the cars, hence they should not be ignored the count for total pollution of vehicles.

Just regulating cars on the roads by "odd" and "even" number ending plates for a few days when things are critical does not solve the issue or even tend to minimize the total pollution. Long term sustainable planning and implementation are essential.

The building of the "Metro System" in Delhi in the past few decades has certainly helped to lower the vehicle trips coming to the NCR-Delhi area which has thus reduced the total trip generation. The reduced number of trips has contributed to reducing the pollution level and energy use to some extent. Nonetheless, the rate at which new vehicles are being purchased and new job seekers are entering the urban areas, there is no end in sight to decreasing the total pollution by vehicles.

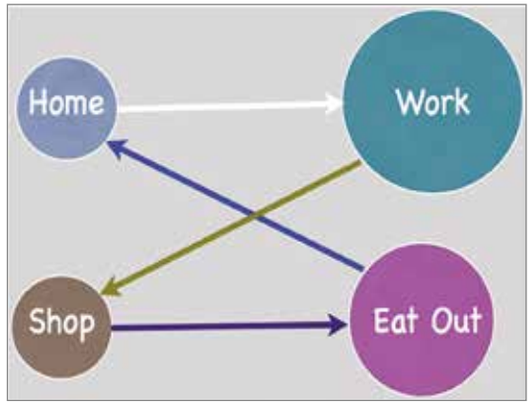

Figure 7: *Trip Generation – Work Trips Weekdays (Typical)*

On weekdays most of the vehicles on the road are work related; that is home to work, plus some work between home and work as shown in Figure 7. To these would add all the business to business trips of vehicles for making supplies and documents to various establishments around the city. There is a need to provide "A Complete Transportation System" as shown in Figure 8 based on trip purpose and distances to be covered by the type of mode. Most of these trips would be within 10 - 30 kilometers range.

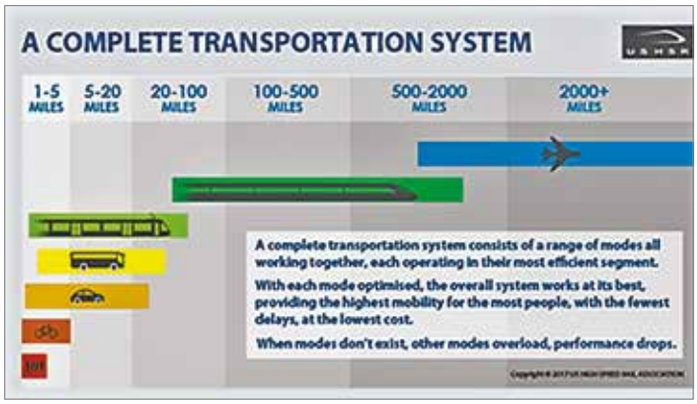

Figure 8: *Building A Complete Transportation System*

Figure 8 shows the multi-modal system that should be developed based on the anticipated distances covered to serve the citizens everyday activities (Figure 7). The objective should be "How to connect the different modes of transport to be "efficient and reliable" for use by the commuters on a daily basis?" The citizens should have the choice to use the multi-modal system seamlessly to conduct their daily trips.

Figure 9 illustrates the other non-polluting modes such as bicycles and walking that need to be encouraged to reduce pollution. (Denmark has the highest number of bicycle work trips in the world) Feasible solutions should be investigated for providing the "last mile connection" for citizens to use the public transit as an option instead of using their private cars for travel. In addition, attention should be paid to providing adequate parking and lighting for safety.

Figure 9: *Bicycle Lanes – Multimodal*

In encouraging multi-modal the Government should acquire and deploy electrical and CNG buses for public transport, including hybrid vehicles. Specific tax incentives should be provided to citizens to purchase electrical and hybrid vehicles.

The Government also ought to regularly use the media to educate the citizens through advertisements clips on lane discipline, energy savings, reducing pollution and safety aspects on a daily basis. Talk about these matters only when there is a critical need such as the Delhi smog belies the issue.

2.7. Crop/ Stubble Burning and Other Factors

There is a strong relation between the severity of pollution in NCR-Delhi area and the burning of stubbles in the neighboring states. Figure 10 shows the contribution to pollution in November 2019. Between November 1 and 5, 2019 increase in stubble burning resulted in higher pollution levels. As a policy, stubble removal machines ought to have been deployed by providing the machines on hire to smaller farmers.

The administrative authorities of the neighbouring states as well as NCR-Delhi should also control the way construction sites are maintained to avoid excess dust released into the atmosphere. The hours of operation of the construction site, the delivery methods used for bringing fill material, cement, sand aggregates, etc. to the site, and disposal of debris, wastage, garbage, etc. from the site need to be regulated.

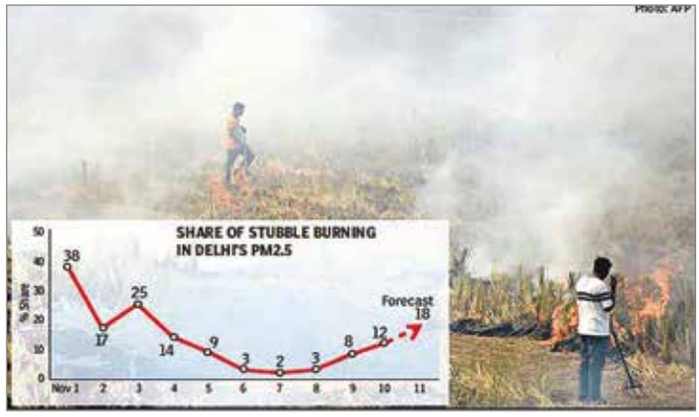

Figure 10: *Stubble Burning Contribution Trend during November 2019 (Source: Times of India)*

Planning must be holistically done by the authorities and permission for new buildings should be fully scrutinised. The unauthorized and haphazard manner of building and structures in already built up areas along the highways must be stopped and existing unauthorized ones removed. If these steps are not taken, within a few years, no pollution measures would be able to assist in easing the problems faced by the public and the health risks would also increase and consequently health costs.

3.0 Impact of Aviation on the Environment

Major emissions of all types impact the environment - vehicles on the ground, use of fossil fuel, aircrafts & helicopters in the air and the boats & ships in the water. However, to estimate the proportion of their contribution to ill health and consequent death of people is still in research stages. As mentioned earlier, airlines with their lobbying have managed to escape emission regulations to-date. Current studies indicate that it can be proven that the airplane cruise emissions impact human health, particularly due to the sulphur emissions, which is a major killer. Can the sulphur emission effect be reduced? The answer is "yes" albeit at a little additional cost[9]. But the question remains who will pay for it?

The Indian air space in the past two decades has expanded exponentially; today there are over 6,000 local flights within the country with projections to exceed 10,000 per day by 2030. In the news recently a private airlines has ordered 300 airplanes to be added to their fleet, similar growth is expected by other airlines operating in India. In India alone, there are an estimated 1,650 deaths per year from airplane emissions. In the future when a greater number of flights will start and finish within India is a matter of grave concern and must be faced.

The question that needs to be addressed is "Will there be taxation on air travel to clean up plus would it include emission trading scheme polices to control the growth of aviation travel and its impacts?"

4.0 Funding for Reducing Emissions

The Central and State Governments must allocate adequate funds to prevent pollution at its source. The toll collected from highways is inter alia supposed to be utilized for their maintenance but how much is really deployed for this purpose is an open question. Monitoring is a must by the authorities as well as citizen groups so that good quality service is provided on all toll roads and highways. The major areas of service that need to be attended are the road surface, excess queuing at toll booths and reducing the effect of heavy vehicles moving in wrong lanes and causing stop and go effect for lighter vehicles on the highway (para 2.4).

5.0 Summary and Conclusions

The NCR-Delhi area has been called "the Choking City." New Delhi has been ranked the most polluted city in the world, since the air quality has been exceptionally severe -- rising to levels more than 20 times what the World Health Organization (WHO) considers "safe"[10].

Planning of transportation needs to be more holistic, encompassing and addressing all issues that could arise at the concept stage itself. External factors such as stubble burning and use of the fossil fuel must be looked into and resolved immediately. *Enforcement of traffic and land laws are major factors that can help to reduce pollution in all spheres, including the implementation of the practical solutions presented in this paper.*

The main conclusions of this study are:

1. The impact of the future growth and developments in the country should be studied at the concept planning stage itself and later periodically revisited so as to develop policies towards a prosperous and healthy country.
2. Planning and re-design of the new and existing developed areas (land uses) should be re-evaluated using Master Plans for an orderly growth.
3. Planning to control or mitigate pollution from extraneous occurrences such as flooding, stubble burning should be done post haste and introduce necessary legislation and regulation where necessary.
4. Roads and intersections should be re-designed to provide multi-modal transportation to encourage bicycling, public transit and walking while simultaneously reducing use of private vehicles.
5. Incentives, such as tax credit, should be provided to buy electric and hybrid. There is potential to save very large quantum of fuels for vehicles in the country.
6. Increase in air travel impacts energy requirement as well as pollution and hence should be studied from a planning perspective.
7. The Government should develop policies to check the emission effects of all transportation modes including aviation and marine.
8. Enforcement is necessary to achieve the objectives using fee collected for road services.
9. The toll revenues should be used for providing better service, planning and enforcement. Use ITS and technology to reduce pilferage of toll revenues to be used for better purposes.
10. By implementing practical solutions such as Traffic Impact Studies, Traffic Signal Synchronization, teaching drivers on regular basis to follow traffic laws and using media to educate the public at large on driving habits, safety, energy and pollution would result in saving thousands of gallons of fuel and also reduce pollution.
11. Pictorial/ graphical signage for the highways and roadways should be developed after field studies to improve the effect, understanding and usefulness of the signs based on the region & languages used.
12. Funds needed to implement energy and pollution minimizing programs should be identified and distributed to reduce the importation of oil at premium price.

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Guj Harappans were first 'climate refugees', finds study

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Ahmedabad: The latest excavations at the Karim Shahi and Vigakot sites in Gujarat, dating back to 2,100 BCE and 5th century CE, right on the Kutch-Pakistan international border, have shed light on how climate change in the post-Harappan period in the Kutch region affected ancient human settlements.

A team of scientists from IIT-Kharagpur, Deccan College, PRL Ahmedabad, University of Calcutta, and Kachchh University, said the sites may help narrate the story of one of the first climate refugees following decline in rainfall, drying up of rivers, and changing weather patterns, which probably led to migration of settlements.

The team published findings of their excavations at Karim Shahi and Vigakot over past three years – estimating the age of the settlements in the range of 3,100-2,300 years before present time (BP) and 1,500-1,900 BP respectively.

"Natural climate change drove out people from their original places. The UN today calls them 'climate refugees'. We think that the excavations points towards a huge migration that may have begun towards the end of mature Harappan era up till the medieval period," Anindya Sarkar, professor at the Department of Geology and Geophysics, IIT-Kharagpur, said.

SHEDDING NEW LIGHT

Gujarat has some of the prominent Harappan sites in India including Dholavira and Lothal, which are nearly 350km from Karim Shahi and Vigakot, which represent the zenith of the Harappan culture. But few sites have depicted cultural continuation after the late Harappan period (1,300 BCE) in the region. Sarkar is among the 13 authors of the research paper on new evidence of early Iron Age to Medieval settlements from the southern fringe of Thar desert and implications to climate-culture co-evolution.

The paper argues that reduction in south Asian monsoon is long held responsible for demise of the Harappan settlements or relocation of settlement thereafter.

"... aridification occurred in two steps, one after 4,000 years and the other after 1,700 years BP," the paper says. The researchers added that up to the 4th century, old local river system at Vigakot was present before it completely turned into a desert in Medieval period.

"It is tempting to speculate that the early disintegration of the settlements in the western domain was a result of the early withdrawal of Intertropical Convergence Zone, monsoon decline and drying up of rivers," the paper says, adding that the increased concentration of settlements in the eastern domain was possibly parallel to today's "climate refugee".

Sarkar said if one observes Harappan sites like Dholavira, one can find excellent water conservation and management system, pointing towards start of the monsoonal decline.

SULPHUR DIOXIDE (SO2) EMISSIONS FROM COAL FIRED THERMAL POWER PLANTS AND RELATED POLLUTION CONTROL MEASURES IN INDIA

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ABSTRACT:

The Ministry of Environment, Forests & Climate Change (MOEF & CC), Government of India issued a gazzette notification in December 2015 revising the emission norms and specific water consumption for coal fired thermal power plants in India and set a deadline of two years for implementation. The prescribed emission norms for SO_2 entailed retrofitting Flue Gas Desulfurization (FGD) systems. In coal based thermal power plants, the sulphur content in the fuel gets oxidizes to SO_2 gas during the process of combustion hence an FGD system is installed to treat the flue gas and scrub the constituent pollutant gas SO_2, before emitting it into the environment through the stack. After analysing 196.7 Gigawatt (GW) installed capacity of coal-based domestic thermal power plants, the Central Electricity Authority (CEA) identified that 166.6 GW capacity with 441 existing units would require FGD retrofit for meeting the SO_2 emission limits. CEA also formulated a five-year phase-wise implementation schedule, based on discussions with the identified power plants for FGD retrofit in a staged manner, with the revised deadline extending till December 2022. This article provides a high-level comprehensive outlook on matters relating to SO_2 emission across India, and also captures the latest bird's eye perspective of aspects such as:

- SO_2 emission trends and applicable environmental norms,
- Background & context of FGD requirement in India,
- FGD implementation schedule and estimated investments,
- Predominant & popular FGD technology in India, with their typical comparative analysis,
- Technical design aspects, challenges and areas of concern for meeting the new SO_2 emission norms, and
- Present status of FGD implementation and perceived roadblocks ahead.

This article is prepared from a consultant's prespective, based on experience of working on various projects as engineering consultants in this domain and extending services to 20+ customers/owners, 35+ Thermal Power Plants, 95+ units and assisting cumulative of 46+ GW of domestic power plants in meeting the new SO_2 emission limits.

1.0 SO_2 Emission from Coal Fired Thermal Power Plants - Global Scenario

Air Pollutants from coal fired thermal power plants are namely SO_2, NOx SPM, and Mercury. Of these, SO_2 remains a key contributor to deaths worldwide. The SO_2 gas liberated to the atmosphere is a health hazard, exposure to which causes respiratory infections, eye irritation, breathing difficulty, asthma, etc. It is also an environmental hazard since it is the primary cause of acid rain and smog causing a detrimental effect on agricultural, biological and aquatic ecosystems. As per the analysis report of Greenpeace Environment Trust, released in August 2019, India is presently the largest emitter of sulphur dioxide (SO_2) in the world. About 4586 kt/year of SO_2 is emitted by India which contributes to about 15% of the global SO_2 emissions, surpassing China. China has been able to reduce emissions rapidly due to measures taken by the country to switch to cleaner fuels and enforcing stingent emission standards and measures to control SO_2 emissions. The study found the thermal power plants of industrial clusters at Singrauli, Neyveli, Talcher, Jharsuguda, Korba, Kutch, Chennai, Ramagundam, Chandrapur, and Koradi to be the major emission hotspots in the country.

Fig 1. shows the SO_2 emissions captured in NASA Ozone Monitoring Instrument database through Google Maps. *(Ref. Greenpeace Environment Trust Report August 2019)*

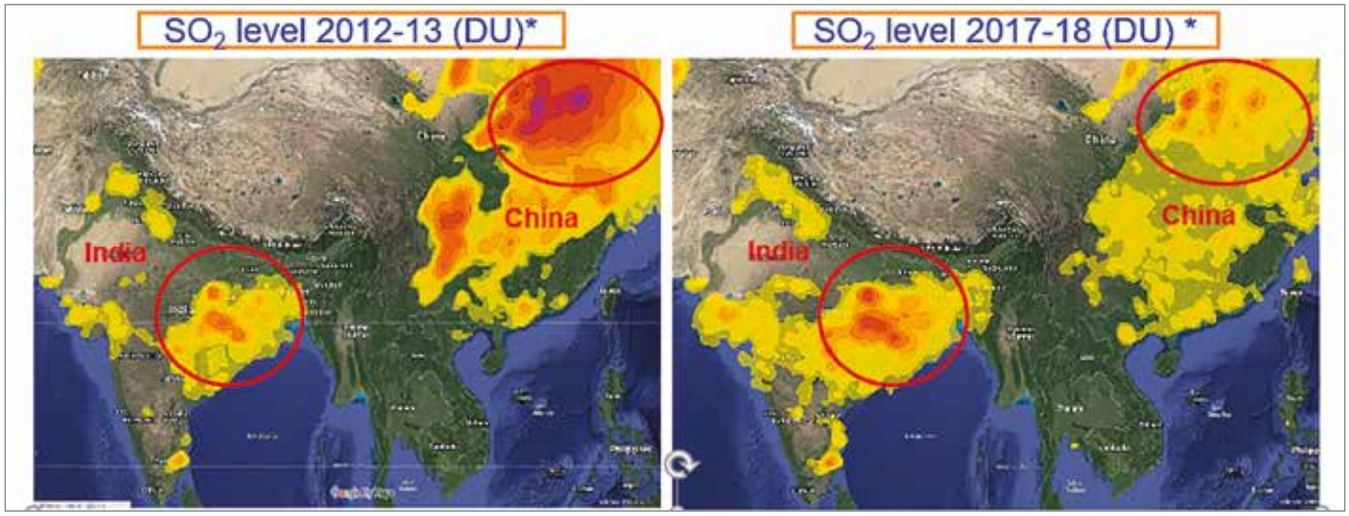
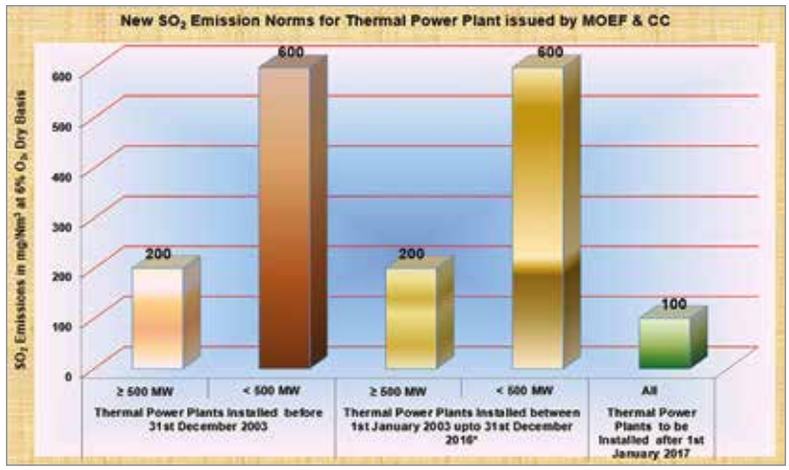


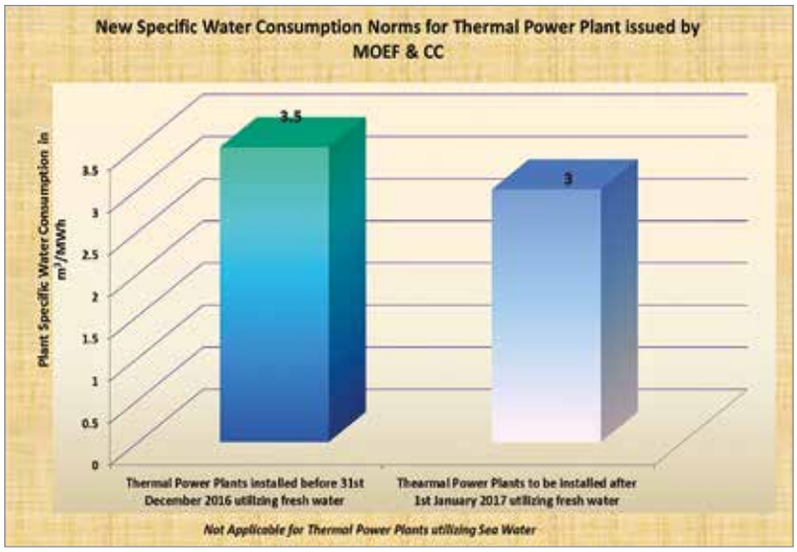
Figure 1: *SO_2 emissions - NASA Ozone Monitoring Instrument database*

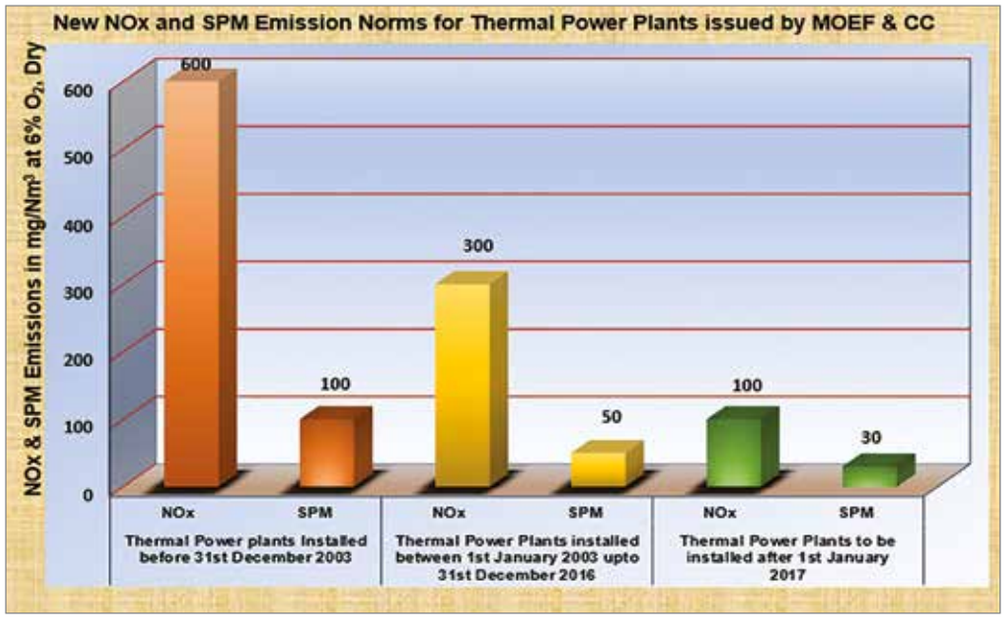
2.0 Emission Norms for Coal Fired Thermal Power Plants in India

Ministry of Environment Forest and Climate Change (MOEF & CC), Government of India, had released new environmental regulations applicable to coal fired thermal power plants in the country on 7th December 2015. The new norms are to be complied by all operating Thermal Power Stations and new Thermal Power Projects within a period of two years from the date of the notification. An amendment was issued on June 29th October 2018 for revised stack height post FGD as well as pegging the emissions measured at 6% O_2 and dry basis of flue gas.

The present notification from MOEF & CC modifies existing norms (prior to December 2016) related to emission of SPM and introduces new norms for emission of SO_2, NOx and mercury from Thermal Power Plants (TPP). It also specifies modified limits for specific water consumption by TPPs and directs that the existing once through based condenser cooling system be converted to recirculation type. Different limits are specified based on capacity of power plant and year of installation. A summary of the new environmental regulations is given in Fig. 2.


New SO_2 Emission Norms for Thermal Power Plant issued by MOEF & CC
SO_2 Emissions in mg/Nm³ at 6% O_2, Dry Basis
600
200
200
600
100
≥ 500 MW
< 500 MW
≥ 500 MW
< 500 MW
All
Thermal Power Plants installed before 31st December 2003
Thermal Power Plants installed between 1st January 2003 upto 31st December 2016*
Thermal Power Plants to be installed after 1st January 2017


New Specific Water Consumption Norms for Thermal Power Plant issued by MOEF & CC
Plant Specific Water Consumption in m³/MWh
3.5
3
Thermal Power Plants installed before 31st December 2016 utilizing fresh water
Thearmal Power Plants to be installed after 1st January 2017 utilizing fresh water
Not Applicable for Thermal Power Plants utilizing Sea Water


New NOx and SPM Emission Norms for Thermal Power Plants issued by MOEF & CC
NOx & SPM Emissions in mg/Nm³ at 6% O_2, Dry
600
100
300
50
100
30
NOx
SPM
Thermal Power plants Installed before 31st December 2003
Thermal Power Plants installed between 1st January 2003 upto 31st December 2016
Thermal Power Plants to be installed after 1st January 2017

Stack Height/Limit in Meters	Power generation capacity: - 100 MW and above $H=6.902(QX0.277)^{0.555}$ or 100 m minimum - Less than 100 MW $H=6.902(QX0.277)^{0.555}$ or 30 m whichever is more"; Q = Emission rate of SO_2 in kg/hr* H = Physical stack height in meter *total of the all Unit's connected to stack **Note:** These standards shall apply to coal / lignite based Thermal Power Plants.".

Figure 2: *New Environmental Norms for Thermal power plants issued by MOEF & CC*

3.0 SO_2 Emission Trends in Coal Fired Thermal Power Plants

Indian coal fired thermal power plants utilize an extensive range and combination of coals varying from different Indian coals, imported coals (such as from South African, Indonesian, Australian, etc) or a blend of Indian & imported coals.

Based on a few selected Indian coal samples from those listed below (based on in-house data), the variation and trend of SO_2 emission levels with the % Sulphur content in Indian coal is presented in Fig. 3 whereas that for Imported Coal is presented in Fig. 4.

Parameters	Unit	Coal sample 1	Coal sample 2	Coal sample 3	Coal sample 4	Coal sample 5	Coal sample 6	Coal sample 7
Sulphur content	%	0.3	0.4	0.5	0.6	0.7	0.8	0.9
GCV	Kcal/Kg	3655	3300	3300	3729	3000	3073	3242
SO_2 emission in dry basis, at 6 % O_2	mg/Nm³	1014	1538	2012	2194	2311	2686	3116

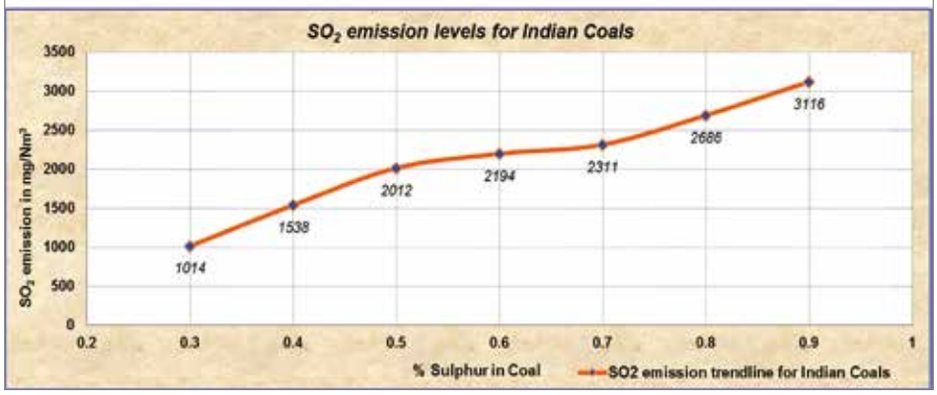


Figure 3: *SO_2 Emission Trend in Indian Coals*

Figure 3: *SO_2 Emission Trend in Indian Coals*

Parameters	Unit	Coal sample 1	Coal sample 2	Coal sample 3	Coal sample 4	Coal sample 5	Coal sample 6	Coal sample 7
Sulphur content	%	0.1	0.5	0.6	0.9	1.2	2	3.29
GCV	Kcal/Kg	4751	5200	4800	5658	5500	5343	6392
SO_2 emission in dry basis, at 6 % O_2	mg/Nm³	265	1326	1752	1908	3350	5500	6930

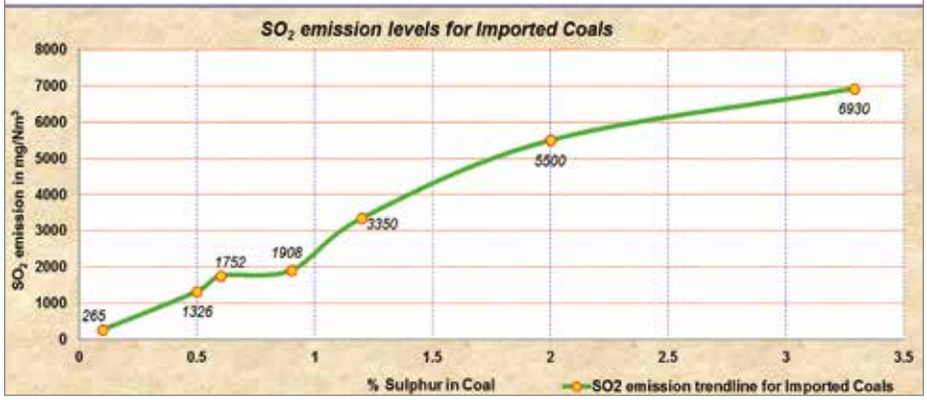
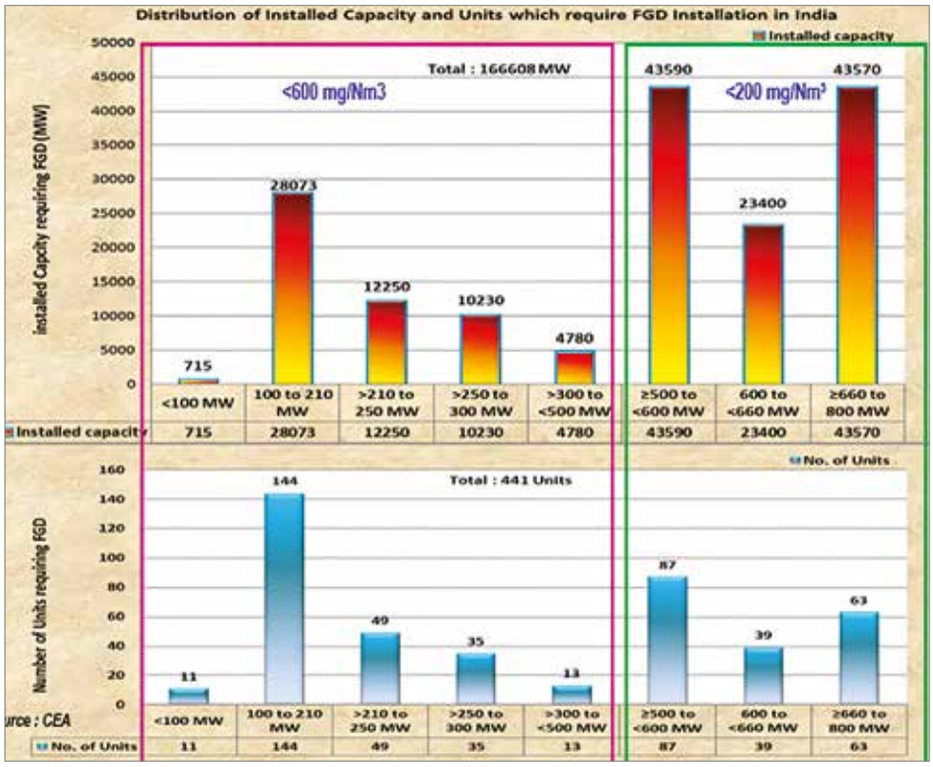


Figure 4: *SO_2 Emission Trend in Imported Coals*

For a typical Indian coal sample, it is noted that the coal with average sulphur content is between 0.4-0.6% and has an emission between 1500-2200 mg/Nm^3 at 6% O_2 Dry basis. Imported coal has higher sulphur content usually more than 0.5% hence it is usually blended with the worst Indian coal to reduce, ash, sulphur content.

4.0 Implementation of FGD in India- Present Status

Subsequent to the issue of the revised norms for emission by MOEF & CC, the Ministry of Power (MOP) appointed CERC and CEA as nodal agencies to identify power plants to which the norms are applicable and set deadline for implementation of the new norms. Post analysing 196.7 Gigawatt (GW) installed capacity of coal-based domestic thermal power plants, the Central Electricity Authority (CEA) identified that 166.6 GW capacity with 441 existing units would require FGD retrofit for meeting the SO_2 emission limits. Fig.5 presents the capacity-wise, unit-wise and sector-wise distribution of the power plants requiring FGD installation/ retrofit.



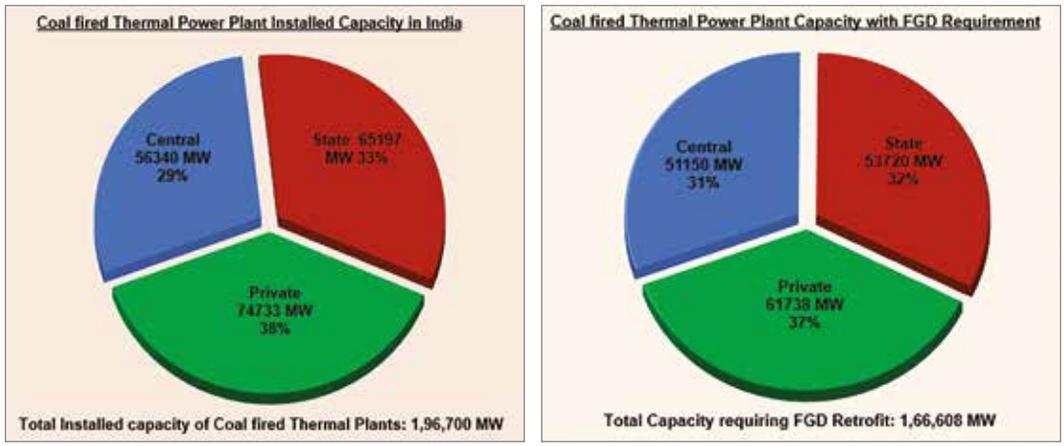


Figure 5: *Distribution of Units, Sectors & Installed Capacity with FGD Requirements*

5.0 FGD Implementation Schedule and Estimated Investment

CEA also formulated a five-year phase-wise implementation schedule, based on discussions with the identified power plants for FGD retrofit in a staged manner, with the revised deadline extending till December 2022. The primary purpose of developing this year-wise FGD implementation plan as shown in Fig 6. was to prevent market saturation due to peak/ concentrated demand, disproportionate Capital Expenditure (CAPEX) escalations and to avoid power crisis resulting from plant/ unit shutdown during FGD retrofit.

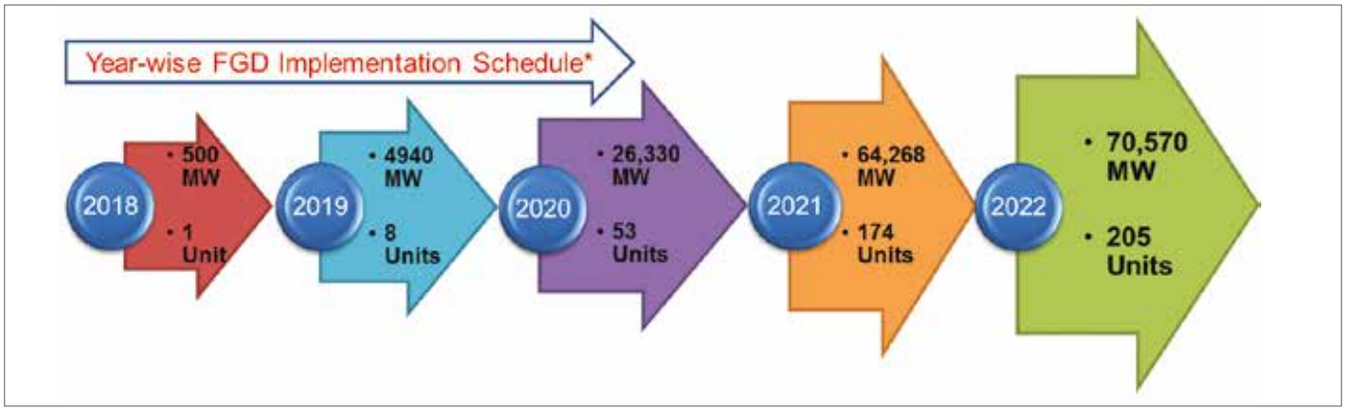


Figure 6: *Year-wise FGD Implementation Schedule*

The CAPEX can vary considerably based on numerous factors such as market demand, availability of vendors, type of technology, installed capacity, number of units, plant specific aspects, fuel fired, layout, design parameters, etc. However, taking into account the present market trend, in-house data and the above indicated factors, a budgetary estimate of Rs. 0.7 Crores/MW has been considered (including taxes, duties, IDC) to provide an overall picture of the investment scenario necessary for meeting the new SO_2 emissions. Fig. 7 shows that about Rs. 1.16 Lakh Crores investment spread over 5-6 years could be required for FGD retrofit, which would be one of the largest financial and funding requirements for Indian coal -based thermal power sector in the contemporary period.

6.0 Predominant & Popular FGD Systems in India, and Typical Comparative Analysis

The broad classification of prevalent FGD systems based on nature of reagent can either be Once-through type (reagent cannot be reutilized in FGD) or Regenerative type (reagent is reutilized in FGD).

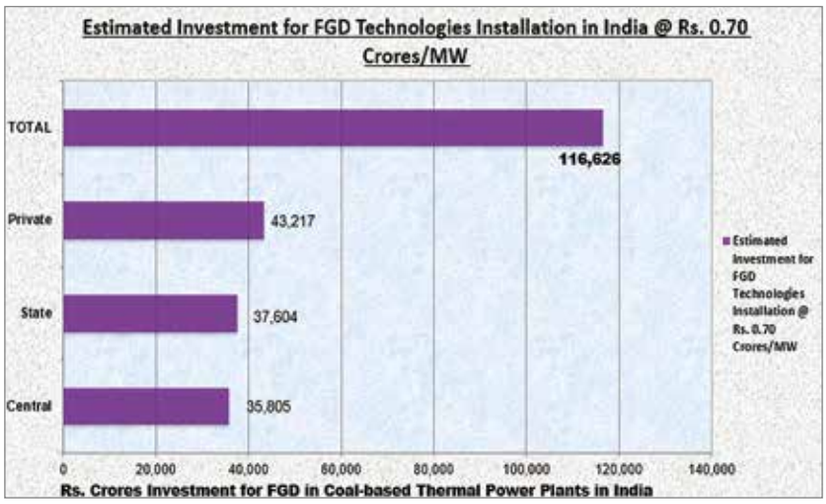


Figure 7: *CAPEX Investment for FGD*

Once-through FGD can be further subdivided into Conventional technologies (like Wet Limestone, Sea Water, Dry/ Semi-Dry, etc. based) and Proprietary/ specialized technologies (like Ammonia, Sodium Bicarbonate-Trona, Multi-pollutant control, Non-thermal plasma, etc.). Conventional technologies usually have larger reference lists/ installations and multiple technology providers available.

Regenerative type technologies also have extensive technology variations (like alkali, activated coke/carbon, patented reagent, etc. based) and reuse of reagent is possible.

Fig 8. provides a typical comparative analysis of some popular FGD technologies currently prevalent in India, which have a higher market footprint.

The typical analysis above is indicative in nature, and may vary/ change, based on plant specific factors and future market trends.

Description	Wet Limestone FGD	Ammonia FGD	Dry/Semi-Dry FGD	Sea Water FGD	DSI FGD
Reagent	Limestone	Anhydrous Ammonia	Lime	Sea water	Sodium Bicarbonate/ Trona
Byproduct	Saleable gypsum or landfill	Saleable Ammonium Sulfate	Landfill only	Treated seawater	Unsalable Ash + Na-Sulfate/ Chloride/ Fluoride
Removal efficiency	>98%	>98%	70-98 %	>98%	<70%
Foot Print Area	Base	Smaller	Smaller	Larger	Smallest
Acid Resistant Lining in Stack	Required	Required	Depends on SO_3 levels	Required	Not required
Pressure Drop in the system (without GGH)	Base	Comparable to slightly lower	More due to additional Fabric Filters	Comparable to slightly lower	More due to additional Fabric Filters
Absorber outlet temp (without GGH)	55-60 °C	55-60 °C	65-85°C	55-60 °C	120-130 °C
Water Requirement	Base	Lower	Lower	Highest (depends on Alkalinity in sea-water)	Not required
Waste /Scrubbing Water Treatment	By waste water treatment plant	Not Required	Not Required	Oxidation & Dilution	Not Required
OPEX	Base	Comparable to slightly Lower	Higher	Lower	Higher
CAPEX	Base	Lower	Lower	specific to intake / outfall nature, scheme, location	Lowest
Auxiliary Power Consumption	Base	Lower	Comparable to slightly lower	specific to plant location, distance, elevation	Lowest

Figure 8: *Typical Comparative Analysis of Predominant and popular FGDs in India*

7.0 Technical Design Aspects, Challenges and Areas of Concern for Meeting the new SO_2 Emission Norms

From Consultant's as well as Owner's perspective, the following aspects need to be analysed for Selection & Design of Optimal FGD Technology:

- Plant Capacity, Existing Layout, Ducting and Space Requirement for Retrofitting,
- Nature and variation of fuel, flue gas composition and plant operating conditions,

- Percentage emission abatement necessary to meet the revised norms,
- Source/ Intake, cost, availability, purity, reactivity & consumption of Reagent,
- Generation, quality, disposal/ outfall, saleability & utilization of By-Product,
- Existing plant water consumption and additional water requirement/ treatment ,
- Requirement of utilities and additional auxiliary power,
- Proven nature of technology, reliable reference lists and remaining plant life,
- Extent of impact/ modification of existing plant and systems, and
- Life Cycle Cost comparison of feasible technologies.

The areas of concern and technical challenges are required to be studied and addressed for FGD system design, installation and operation are:

- Proper emission measurements with corrections for moisture (Dry basis) and O_2 (6%) incorporated,
- Unit/plant shutdown time for existing chimney lining or ducting interconnections,
- Layout constraints, duct modifications issues, existing structure/system relocations, demolitions,
- Wet vs Dry Stack with/without installation of choke, and meeting prescribed exit velocity,
- Significant variation of composition/ type of fuel fired and sulphur content of fuel,
- Additional auxiliary power & utilities consumption and impact on existing systems & net heat rate,
- Enhanced corrosion, localized acid formation and condensation of flue gas, post treatment,
- Appropriate Liner material selection for absorber/ ducts/ tanks/ stack,
- Optimization of existing WBD to cater additional FGD process water requirement and meet norms,
- Chlorine content in coal and process water and impact of chloride levels,
- Waste water treatment and handing of water treatment rejects,
- Selection between Conventional vs Patented FGD Technologies,
- Availability/ Intake/ Reactivity / Quality of Reagent in present and future scenario,
- Disposal / Outfall/ Sale-ability/ Utilization of By-product in present and future scenario, and
- Impact of CAPEX & OPEX on electricity tariff/ cost of power production.

8.0 Present Status of FGD Implementation and Perceived Road Blocks Ahead

The present status of FGD Implementation in-line with the data published in CEA report is presented in Fig. 9.

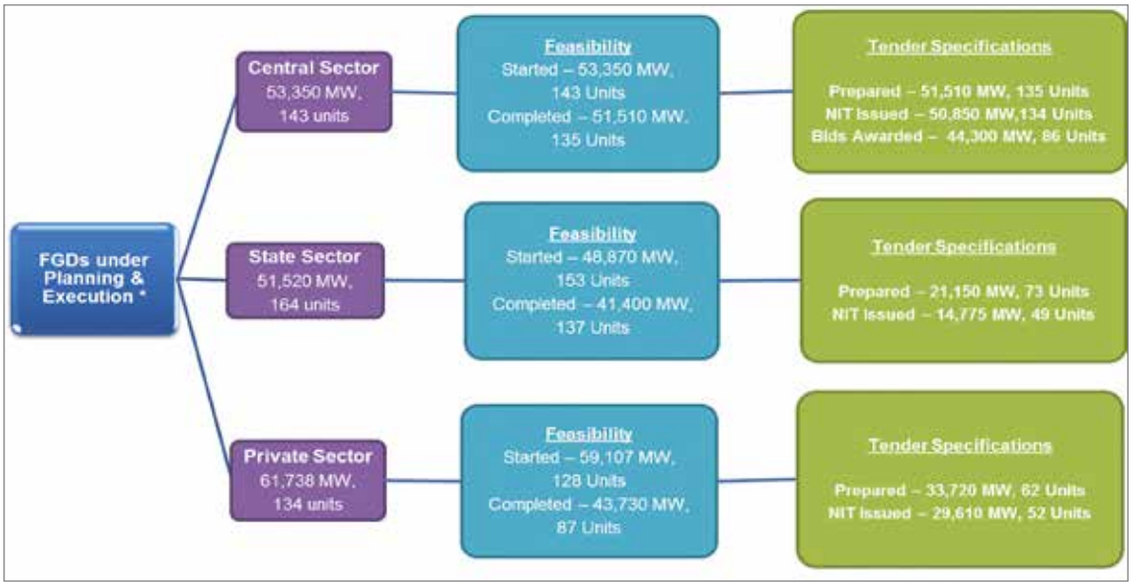
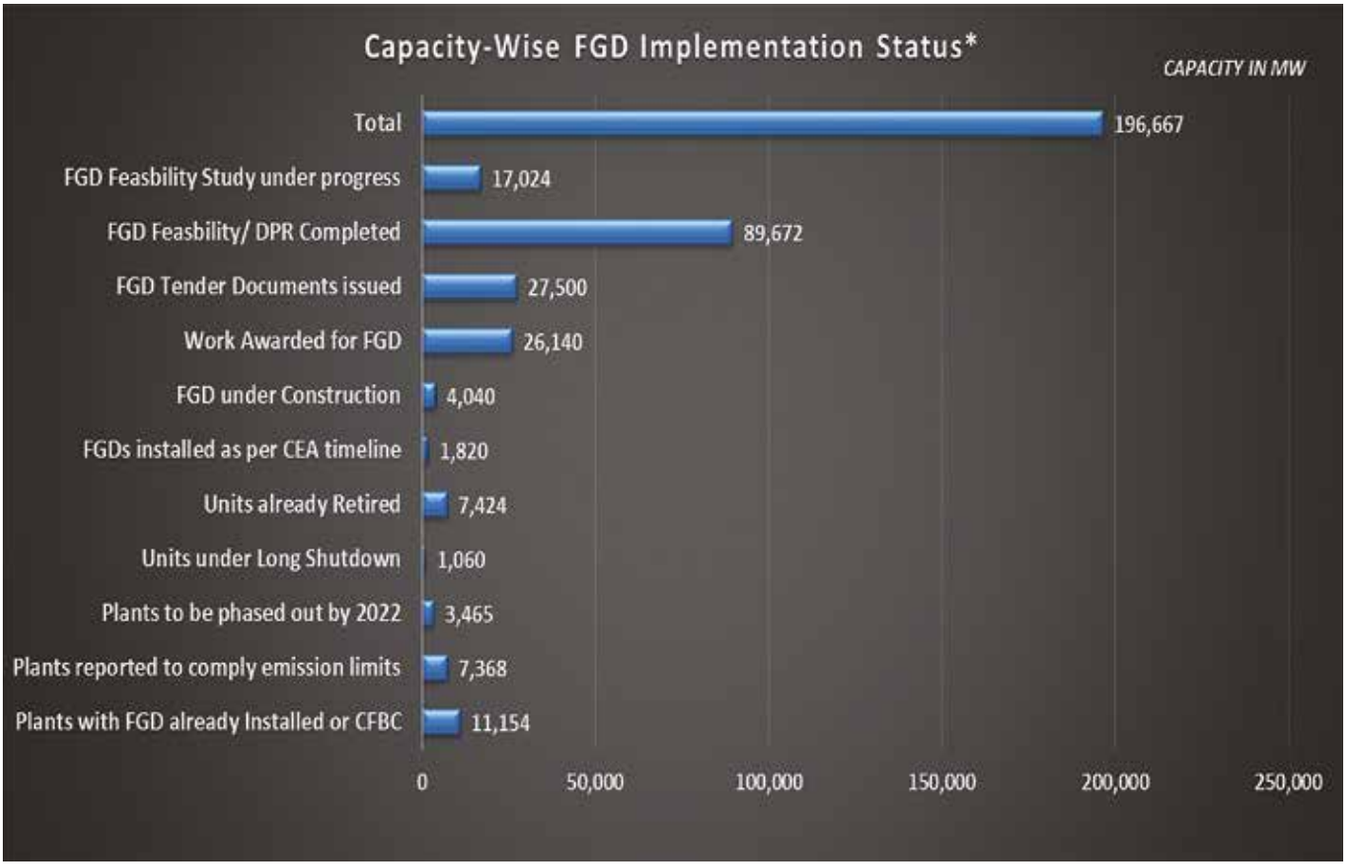


Figure 9: *FGD Implementation Status by CEA*

The capacity-wise and unit-wise implementation status of FGD in India, as provided by MOEF & CC are given in Fig. 10:



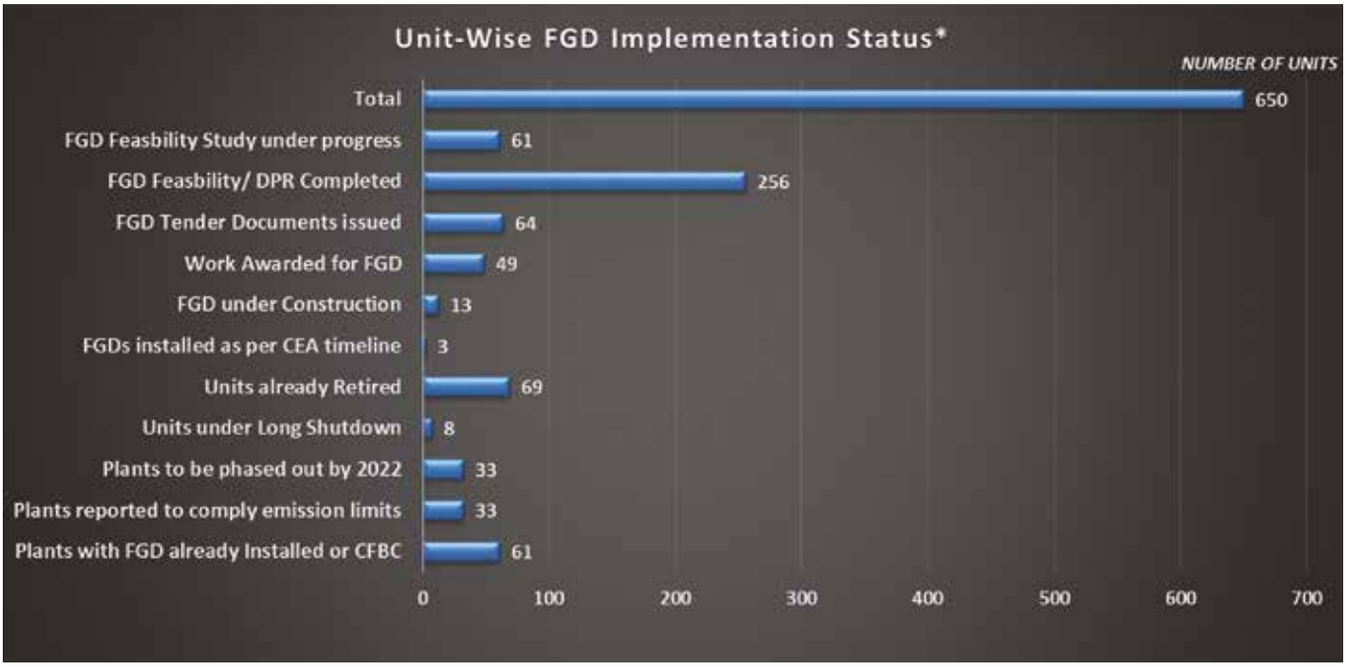


Figure 10: *Unit-wise & Capacity-wise FGD Implementation Status by MOEF & CC*

The key roadblocks & challenges which need to be addressed promptly for seamless FGD retrofit and reduce SO_2 emission from power plants are listed below:

- Less progress in FGD pre-execution work and very few Bids awarded, especially in Private and State Sectors,
- Challenge in meeting the Year-wise FGD implementation schedule with current progress, and completion of all FGD installation across India by 2022,
- Availability of handful technology suppliers/ sub-vendors, and many leading EPC contractors will get saturated with parallel ongoing FGD projects,
- Very limited developments till date in restructuring of tariff of existing plants (Independent Power Producers) under long term and medium-term Power Purchase Agreements (PPA),
- Difficulties in approval & granting of funds for FGD retrofit from Financial Institutions, to existing power plants listed under Non-Performing Assets (NPAs)/ stressed assets,
- Significant revenue loss and power crisis during plant/unit shut down period,
- Long term supply of reagent and unequal price escalations in future, and
- Disposal of significant quantity of by-products in case of non-saleability.

9.0 CONCLUSIONS

Although actual progress of FGD implementation is behind the planned schedule, but most thermal power plants have shown positive developments and are now on their way to retrofit air pollution control technologies for their existing units.

This would help India progress towards achieving the ratified international commitments of Paris Agreement on Climate Change 2015, combat global warming & harmful greenhouse gasses.

It would also improve nation's air quality by producing clean power and result in preventing emission of hazardous gases & associated harmful effects, global warming and climate changes.

From being the largest contributor of SO_2 emissions, India is now taking promising and significant strides towards achieving improved air quality and a sustainable environment.

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Scientists Around the World Declare 'Climate Emergency'

More than 11,000 signatories to a new research paper argue that we need new ways to measure the impacts of a changing climate on human society

An image of the Camp Fire in Northern California on November 8, 2018, from the Landsat 8 satellite. (USGS / NASA / Joshua Stevens)

By **Avery Thompson**

SMITHSONIAN.COM

NOVEMBER 5, 2019

The world's scientists are increasingly worried about our civilization's reluctance to tackle climate change, so in a paper released today, thousands of them are raising the alarm.

In a report published in the journal BioScience, over 11,000 of the world's leading climate scientists have added their names to a declaration calling the planet's current warming trends a "climate emergency." Titled "World Scientists' Warning of a Climate Emergency," the paper takes an urgent tone, detailing a dire situation that will require extreme responses to avert disaster.

Source:*https://www.smithsonianmag.com/science-nature/scientists-around-world-declare-climate-emergency-180973462/?utm_source=smithsoniansciandnat&utm_medium=email&utm_campaign=201911-science&spMailingID=41204346&spUserID=NTA2MTIyODY1MjY1S0&spJobID=1642423460&spReportId=MTY0MjQyMzQ2MAS2*

MITIGATING THE UNKNOWN - RISKS IN POLLUTION ASPECTS (II)

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1.0 INTRODUCTION

Solid waste implies any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant or air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations etc. Improper *solid waste* disposal leads to substantial negative environmental impacts (pollution of air, soil, water, and generation of greenhouse gases from landfills), and health and safety *problems* (such as diseases spread by insects and rodents attracted by *garbage* heaps, and diseases associated with pollution. There is also evidence that nanoparticles are released by these processes even if they have not been added to the materials. For example, demolition and refurbishment of ordinary concrete has been shown to release a very high number of nanoscale particles (although these account for a tiny proportion of the total dust released in terms of mass or volume). There is little information available to show if or how this might be changed by the addition of nanomaterials to the concrete at construction levels[1]. Be it Bangalore, Hyderabad, Mumbai, Delhi, Chennai, Kolkata, Pune or Visakhapatnam- huge mountains of waste gets piled up every day reaching up to 25 to 35m (80 to 100 feet) above the existing ground level. Due to lack of proper space for landfills or dumping grounds, the municipalities let them grow higher and thus needing the approval of Airport Authority of India for the dumps that come in the flight paths near airports. The waste also contains skin of fruits and vegetables, stale food, wood, plastic and paper rejects, glass pieces, ceramics, injection and needles, old medicines, chemicals, things made of rubber, batteries, mortar, concrete, etc. According to the Ministry of Urban Development, Government of India, the quantities of municipal waste produced in the cities every day is '1.6 lakh metric tonnes' i.e. 16 crores kg of waste every day from 424 Municipalities. The Municipalities pick up the waste and dump it at places which are called landfill sites or dumping grounds which are either within city limits or in rural areas adjoining the city and are now spread over 1000 acres in the country. The life of the people and environment are badly affected in the places where this work goes on continuously. On one hand the waste generates toxic gases that are inflammable and on the other hand the decomposition of this waste produces a toxic liquid called 'leachate'. This liquid destroys the ground water and crops in the adjoining areas. Besides taking a huge toll of the areas where this mayhem is happening, it is also gradually returning to the cities through food, water and air.

2.0 BRIEF DESCRIPTION

The toxicity of these solid wastes is a cause of many diseases. Apart from bacillary dysentery, malaria, typhoid fever, cholera, flies, bad odor, skin infections diarrhea and amoebic dysentery, plague, salmonellosis, trichinosis, endemic typhus, cholera, jaundice, hepatitis, gastro enteric diseases, etc. it may also include dengue,chickengunea and gynecological disorders. Nanomaterial use has grown exponentially in recent years for their proven multiple benefits. Engineered nanoparticles (1-100nm) are found in an increasing number of consumer products such as lotions, shampoos, socks, paints, toys, chips, tyres, etc. The study of toxicity of engineered or non-engineered

nanoparticles is a relatively new field, which is still evolving, presents unique challenges as dosing of nanoparticles is different from their micro counterparts due to size related orientations. As regards 'nano' releases to the environment, while nanoparticles are not present as freely dispersed particles in many applications, large fractions may go to landfills, soils and sediments at the end of the life cycle, and smaller fractions to water, and air[2]. Nanopesticides may also be a potential source of significant environmental releases[3,4]. Depending on the product lifetime, large stocks may build up from which nanoparticles can be released over long periods of time[5,6]. Once released to the environment, nanomaterials may undergo many transformations, potentially altering their fate, transport and toxicity[7]. Most nanomaterials do not undergo biological degradation and can therefore persist in the environment as solid waste[8]. The 2030 Agenda for Sustainable Development includes a number of Sustainable Development Goals (SDGs) and targets that are directly or indirectly relevant for chemicals and waste but the 21 targets for the year 2020 now seem distant.

3.0 Land filed with flyash or other contaminants affect flora and fauna

It is reported that the land at Singur, West Bengal was acquired for building an automobile manufacturing plant. The land was filled with fly ash as per a Business Standard report of October, 2016[11] and hence it is not suitable for cultivation after that. Another instance of flyash contamination is reported to be from the coal based thermal power plants in Ennore, Tamil Nadu. They have also reportedly[12,13] affected the flora & fauna in Seppakkam, around 30 kilometers north of Chennai. However, the question remains - Does only flyash contaminate land? The answer is a definite No. There are many other nanoparticles coming from paints, construction & demolition wastes that also leach into the soil under conditions of extreme sunlight, cold and rain, thus rendering the land infertile. Flyash is very similar to nanomaterials[10]. Perhaps the state governments should take help of experts in contaminated soil removal/ remediation where they desire to make the land cultivable. Alternative areas would of course have to be allocated for disposal albeit with precautions to prevent or minimize affecting the soil, water and air in those areas.

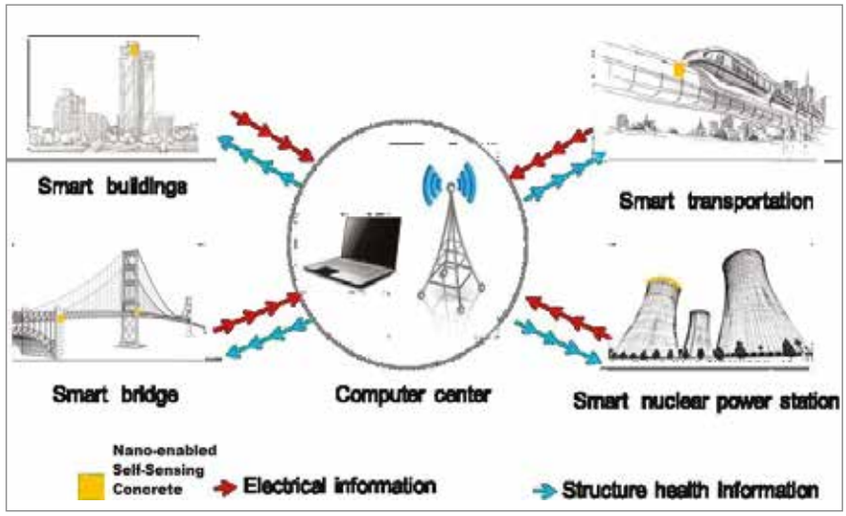

Figure 1: *Smart City of the future*[9]

4.0 CONCLUSION

The desire to promote the economic growth of the nanotechnology industry, ensure the confidentiality of nanoparticle manufacturers' intellectual property, and protect the privacy of consumers is often at odds with the need for data on nanoparticle manufacturing and use. Recent advances in the field of Nanotechnology have led to the development of new multifunctional and smart materials that have tremendous potential in Structural Health Monitoring (SHM) to be used for future smart cities. However, the level of nanotechnological research needs to be undertaken is not being done in India. Once, Dr. A. P. J. Abdul Kalam, former President of India and Bharat Ratna, aptly mentioned that 'Four technologies are going to drive the future world and future India - biotechnology, nano-technology, information technology and environment technology'. Though the IT revolution has occurred, India needs a nanotechnological revolution to address its multi-modal problems of skill development, employability and low GDP growth (slipping

from 7.13% to 4.5% in 2019). As discussed in the first part of the paper entitled "Mitigating the Unknown – Risks in Construction & Demolition (I)" by the Author, India is still in a learning mode as far as nanotechnology is concerned while other countries have surged ahead. The policy think tank, Niti Aayog is more or less silent on nanotechnology.

Nanomaterials within the United Kingdom and Europe are covered by the same regulations as other chemicals and toxic substances, such as COSHH, REACH and CLP, but there are no specific nanorelated requirements except those relating to cosmetics and use in foodstuffs. There are ongoing discussions within the European Commission to refine the definition of nanomaterials and to strengthen requirements under REACH so that better data can be gathered regarding the production and use of nanomaterials which contain nano-objects. France, Belgium and Denmark have each produced their own regulations requiring the registration of nanomaterials, although the exact requirements vary between them. In the United States, specific reporting requirements for existing and new nanomaterials have recently been approved. Both Canada and Australia manage nanomaterials through their existing registration systems, although the Canadian system makes higher demands, including the classification of a nanomaterial as 'new' even if the bulk (non-nano) form has previously been registered. These regulations generally apply only to nanomaterials which contain nanoparticles or other nano-objects.

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Learning Never Stops: At 77, This Retd. Engineer is One of IIT Delhi's Oldest PhDs

After crossing border during Partition at age five, Dr. Dhawan braved financial constraints to secure multiple degrees. His life is truly a testament to the spirit of learning! #Respect #Inspiration

On November 2, 2019, Dr SK Dhawan, a 77-year-old former Chief Engineer with the Central Public Works Department (CPWD), became IIT-Delhi's oldest PhD recipient this year.

However, this honour marks just another step in a life dedicated to the pursuit of knowledge.

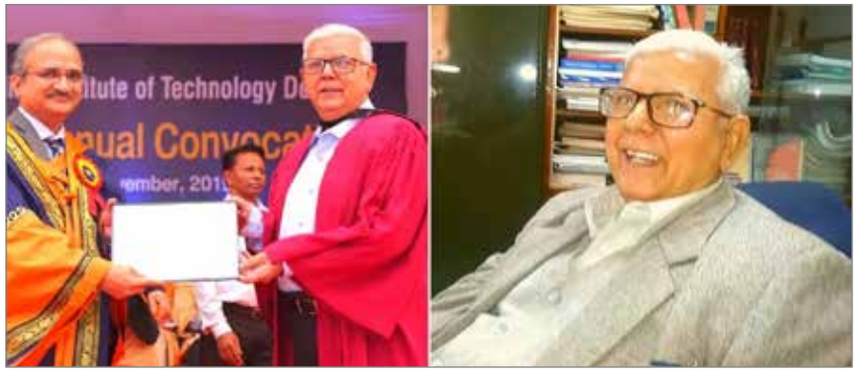
Born on August 15, 1942, in a small village in the Panjab province of present-day Pakistan, his family migrated to India during Partition when he was just a five-year-old boy. The event and its subsequent consequences on his family played a crucial role in shaping his life.

"My father left his property, belongings, and migrated to India along with my mother, myself and two siblings. It was a massive challenge for my parents, both emotionally and financially and due to the latter, it became imperative for me to take up a job right after matriculation. Strangely enough, instead of crushing my desire to study further, the experience only reinforced it. I went onto complete a vocational diploma course from the Industrial Training Institute in Pusa. By the age of 18 in 1961, I began work as a draughtsman in the CPWD. But I wanted to learn more and become an engineer," says Dr Dhawan, speaking to **The Better India.**

While working full time, he also appeared for the Associate Member of The Institution of Engineers (AMIE), cleared it and became a graduate junior engineer at the age of 22. In 1971, he passed the combined Engineering Services Examination conducted by the Union Public Service Commission, and was selected as a Class I Officer with the Government of India. "My work took me all over the country from Maharashtra to the Northeast," he says.

However, he wasn't satisfied yet. In 1979, he joined IIT Delhi to do his Masters in Structural Engineering, while still pursuing a full-time government job at the CPWD.

"I did my M Tech in structural engineering while fulfilling my professional obligations and looking after my family. This required extra work for six to seven hours, staying up late, getting up early in the morning and working seven days a week for my course. While working, I was also attending classes, working on assignments, taking minor tests and major tests for six semesters, including finishing a research project," he mentions.



Left: Dr. S K Dhawan receiving his degree from the Prof. V Ramgopal Rao, Director, IIT Delhi. (Source: IIT-D) Right: Dr. S K Dhawan. (Source: Facebook)

Left: Dr. S K Dhawan receiving his degree from the Prof. V Ramgopal Rao, Director, IIT Delhi. (Source: IIT-D) Right: Dr. S K Dhawan. (Source: Facebook)

Calling the entire experience a small discomfort, he adds, "For the most part, I didn't really feel the experience was burdensome because of my prior experience of doing the same (working and studying at the same time) and the fact that I had studied below streetlights as a child. I was awarded my degree in 1982, and it felt truly wonderful."

He did not stop there. After securing a Commonwealth scholarship, he left for Birmingham University in the United Kingdom to obtain a Master's degree in Management of Urban development sometime in 1988.

He would also go onto earn a Masters degree in Public Administration from the Indian Institute of Public Administration, New Delhi, with distinction, besides an M Phil from Panjab University.

As an engineer with the CPWD, his work ranged from planning, construction and maintenance of colleges under Delhi University, roadways, inland waterway projects, and urban transport, among other areas. He even wrote guidelines for the Ministry of Finance to help the Income Tax Department evaluate immovable properties of individual citizens. He retired from government service as Chief Engineer in 2002 and has lived in Delhi ever since.

"After my retirement, I was an advisor with RITES for two years (2002-04) and after that, an advisor with an MNC, where I prepared detailed reports for the construction of national highways (2004-06). The latter wasn't a good experience because they weren't doing their work properly. Soon, I went on to teach at the School of Planning and Architecture in Delhi for six years, but somewhere along the line, I had a deep desire to study further. In 2013, I registered for the PhD programme at IIT Delhi. It has taken me six years, but the journey has been worth it," he says. A bonus is that he became tech-savvy as well.

Dr. S K Dhawan's PhD thesis from IIT-Delhi titled 'Expected Remaining Life of Existing Reinforced Concrete Building Structures' deals with how long an existing building can stand safe or be retrofitted to improve its longevity. "My research focussed on developing a computational methodology based on in situ tests and experimental investigations. It would help in making decisions related to repairs, rehabilitation, demolishing, retrofit and future extension of existing building structures. It would also help buyers and sellers to make informed decisions dealing with immovable properties," he says.

How did Dr. Dhawan's work experience feed into his PhD thesis?

"During my service in the government, I was associated with planning, design and construction of roads, buildings and bridges. This experience helped me to understand the behaviour of structures under transient loading (winds or earthquakes) in addition to dead loads and imposed loads," he says.

While Dr. Dhawan's decisions have been largely self-motivated, he is also immensely grateful to his family.

"My wife, Sashi, has always encouraged me to pursue my research work. Throughout my pursuit of knowledge, she has always given me moral and emotional support, besides always taking care of me. The same is true for my children," he says. Following his PhD, the plan for Dr. Dhawan is to attend international conferences, write papers, and guide masters and PhD students. "I will continue to share my knowledge. I always feel there is something more I can do. For me, every day is value addition, and that's where my motivation lies. As someone who has worked 12+ hours a day, I just want to maintain my discipline, remain engaged, and most of all, useful," he says.

There is no question Dr. Dhawan's life is a testament to the spirit of learning.

(Edited by Gayatri Mishra)

Source: *https://www.thebetterindia.com/206787/iit-delhi-oldest-phd-student-partition-engineering-india/*

CEAI NEWS

ANNUAL GENERAL MEETING OF CEAI

The 23rd Annual General Meeting of the Members of the Consulting Engineers Association of India was held on 7th December 2019 at the CEAI Centre, New Delhi. The following actions and decisions were taken:

1. Minutes of the 22nd Annual General Meeting held on 14 December 2018 were confirmed.
2. Adopted the Annual Report of the Association for the year ended 31st March 2019.
3. Passed the Audited Accounts of the Association for the year ended 31 March 2019.
4. Appointed Auditors for the Financial Year 2019-2020.
5. Presented future Action Plans in keeping with the Strategic Plan adopted by the Association for systematic rapid development.

Members discussing at the 23rd AGM of CEAI

FIDIC TRAINING PROGRAMMES

Open House Training

CEAI organised an open house Training Course on the module "Practical Use of the FIDIC Conditions of Contract" on 14 - 15 October 2019 at Royal Plaza, New Delhi. Around 30 delegates from various organisations attended the training.

Mr. Bogdan Oprea interacting with the Participants

Participants with Mr. Bogdan Oprea at the Open Training Programme

IN-HOUSE TRAINING PROGRAMMES

a) DFCCIL - 16-17 OCTOBER 2019

FIDIC Training Course on "Practical Use of the FIDIC Conditions of Contract" was organised for the employees of DFCCIL on 16-17 October 2019 at Royal Plaza, New Delhi. Around 48 people attended the training.

b) DFCCIL - 18-19 OCTOBER 2019

FIDIC Training Course on "Management of Claims and Dispute Resolution" was organised for the employees of DFCCIL on 18-19 October 2019 at Royal Plaza, New Delhi. About 42 people attended.

Managing Director, DFCCIL, addressing the participants

DFCC participants during the 2nd training session on 18-19 October 2019.

c) Training Course in Kolkata – 21-22 October 2019

CEAI Northern & North East Region organised a FIDIC Training Program on 21-22 October 2019 which was attended by 60 officials from various Urban Development Authorities and Municipalities under the initiative by Department of Urban Development and Municipal Affairs, Government of West Bengal.

FIDIC Training in Kolkata

The training courses were conducted by Mr. Bogdan Oprea, a FIDIC Accredited Trainer from Romania.

Mr. Bogdan is a Member of the Dispute Resolution Board Foundation, of the Romanian Association of Consulting Engineers and other organizations. His name is also listed on the DRBF President List of Dispute Boards Member, Romanian national list of adjudicators, and he is an accredited mediator.

The series of courses conducted during this month indicated that there is a rise in demand for training on FIDIC contracts, perhaps due to mandatory requirements of use of such contract for externally funded projects.

SEMINAR ON WATER INFRASTRUCTURE FOR URBAN AREAS & INDUSTRIES

Consulting Engineers Association of India is organising a Seminar on 'Water Infrastructure for Urban Areas & Industries' on 13-14 February 2020 at Bhubaneswar in partnership with Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar.

The objective of the conference is to understand the current state of the affairs and need for the development of water infrastructure for Urban Areas and Industrial Sectors. The conference will also deliberate on the shortfall in financing which has led to massive backlog in creating new infrastructure, and belated attempt to rehabilitate crumbling water infrastructure. The conference will dwell upon water management practises, the plans and proposals contemplated by the Government to bolster the water infrastructure.

The discussions will be held on the following sub-themes:

Plenary Session:	State of Water Infrastructure
Focus Session 1:	Water Resource and Supply
Focus Session 2:	Waste Water Management
Focus Session 3:	Water for Mining
Focus Session 4:	Water for Industries
Focus Session 5:	Financing in Water Infrastructure

For more details please contact CEAI Secretariat or visit at https://ceai.org.in/events/seminar-on-water-infrastructure-for-urban-industries/

QUALITY MANAGEMENT SYSTEM – ONLINE SURVEY

CEAI conducted an online survey as a follow up action of recently formulated CEAI **Strategic Plan 2019-2024.** The Strategic Plan Report's recommendatory Action Plans serve as a guide for CEAI's activities.

The CEAI Governing Council has formed the Ethics and Quality Committee under the Chairpersonship of Ms. Sayona Philip, immediate past President of CEAI.

'Quality' has been incorporated for the first time, as CEAI had presumed that its members always make it certain to provide 'quality' engineering services. However, based on feedback received from clients and Multilateral Development banks, CEAI realised that there was room for improvement and that CEAI should do its bit to promote quality of engineering consultancy services.

The Committee framed a Terms of Reference to address quality related concerns and have formulated an Action Plan.

The initial steps proposed are to

- Identify those companies which are ISO-9001 certified and create a data base
- Where companies are not certified, encourage them for

- ✓ adoption of a Quality Policy
- ✓ effective implementation of Quality Management Systems in accordance with the requirements of ISO 9001/ relevant standards.

More than 65 members have participated in the survey and CEAI thanks all of them for their cooperation.

ISSUES OF CONCERN FOR CONSULTANTS

The Consultants while providing consultancy to their clients, both from Government and Public Sector as also from Private Sector, face many issues. In order to improve the working condition of the Consultants, the Association wishes to identify major issues and problems which the Consultants are facing in general. After scrutinising them, solution are proposed to be taken up with the client organisations.

In view of the above, CEAI Institutional Relations Committee has requested members to send their feedback on the problems or issues which they are facing as a Consultant. CEAI have received response from a few members and would like others to respond.

REPORT FROM REGIONAL CENTRES

CEAI WESTERN REGION CENTRE

Workshops on "Tubular Structures and Welding Techniques", Goa

The Association of Consulting Civil Engineers [ACCE(I)] Goa Centre organized Workshops on 22nd and 23rd November 2019 at Goa Engineering College, Farmagudi – Goa on ***"Tubular Structures and Welding Techniques"***. The Workshops were accredited by the Engineering Council of India and their members who attended the seminar, were eligible for 16 points. The workshops were supported by CEAI.

Mr. Jeffrey Nambiar, Hon. Secretary cum Treasurer CEAI-Western Region Centre was a key speaker at the seminar to give lectures on welding for tubular structures.

On 22nd November 2019 Mr. Nambiar gave lectures at the *"Workshop for Welders & Fabricators"*. There were 36 welders plus others who attended the workshop. He focused his lecture mainly on "Shielded Metal Arc Welding Process", to suit the audience and Types of Weld Defects. He emphasized on the importance of good welding procedures, control of consumables, importance of preheat, proper weld geometries, qualifications for different weld positions especially the TKY joints. He also provided handouts of the different weld processes, like "Gas Tungsten Arc Welding", "Submerged Arc Welding", "Gas Metal Arc Welding" and explained the Do's and Don'ts while trouble shooting.

Later practical demonstration and practice sessions were held for all the welders. An expert welder who had been especially taken by Mr. Jeffrey Nambiar from Mumbai guided the participants in batches on butt joints in beams and TKY joints in thin box tubular sections.

All the participants were extremely happy with the workshop because of the theoretical and practical learning that they could get from it. They interacted a lot with Mr. Nambiar.

Mr. Jeffrey Nambiar explaining salient points

Practical workshop for Welders in progress

The Professional Engineers on Day 2

On 23rd November 2019 he gave a lecture to Professional Engineers on *"Welding Techniques & Joints in Tubular Structures"*. In this Mr. Nambiar covered Welding, Types of Joints, Non-Destructive Testing suitable for structures, Weld Symbols and Defects associated with improper Welding procedures. The second day workshop was attended by practically all the Consulting Structural and Civil Engineers in Goa including those from Contractors. There were over 50 persons in the audience. Mr. Nambiar stressed on adopting and following the correct procedures, case by case, so that the welded joints meet the design and performance requirements. He also stressed on the need to ensure that the welder is properly qualified for the job before being allowed to do it. The different defects in welds, if the correct procedure and posture are not followed, or the joint design did not factor in severe shrinkage stresses, were also highlighted. Testing of the welds was also driven home especially of those joints which would become inaccessible later on. In this workshop also the interaction was intensive and the participants enriched their knowledge.

The take away from such supportive networking, among like associations, could build future goodwill, towards initiation of CEAI's strategic plan, for development of a city centre in the state.

CEAI SOUTHERN REGION CENTRE

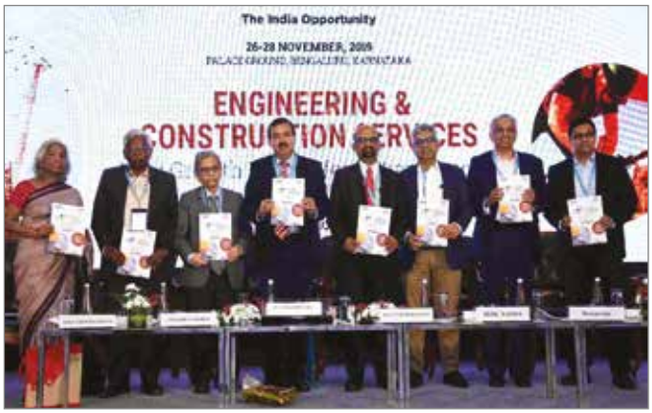
The Fourth Meeting of CEAI – SRC was held on Tuesday, November 27, 2019 at Speakers Lounge during GES 2019 in Bangalore. Following points were discussed.

1. CEAI SRC was actively involved in GES 2019. Dr. Malur moderated and Mr. Samuel participated in a Panel Discussion on Champion Sector session on Engineering and Construction Services. President, CEAI was also a Panellist.
2. Based on the feedback and inputs received from DG SEPC, it was decided to hold a one-day session on Engineering and Construction Services jointly to be organized by SEPC and CEAI in the month of January 2019 at New Delhi. CEAI-SRC would be organizing the event.
3. President, CEAI advised CEAI-SRC that World Bank desires that all projects should be on FIDIC guidelines hence a training program on FIDIC Contracts may also be planned in the month of February 2019 in Bengaluru. He promised support from CEAI Administration for the same and would also send the extract of relevant clause of The World Bank. Mr Samuel would seek an appointment with the Chief Secretary, Government of Karnataka for planning the same.

PANEL DISCUSSION AT GES (GLOBAL EXHIBITION ON SERVICES), BENGALURU, 26-28TH NOVEMBER 2019

SEPC (Services Export Promotion Council) under Ministry of Commerce, Government of India, organised a three day meet with foreign buyers along with a very large exhibition displaying Indian Prowess in the Service sector.

A panel discussion on the theme of Engineering Consultancy services was organised as a part of the event where Mr. Amitabha Ghosal, President CEAI, Dr. Rajashekhar Malur, Chairman CEAI Southern Region Centre and Mr. A. T. Samuel were speakers. Mr. Sudarsan Pandey, Addl. Secretary, Ministry of Commerce during his address informed that the Government of India is now very keen to push the legislation for Engineers. The GoI also now recognises the importance of the Consultancy services as that gives a boost to export of Construction services and Construction materials supply. SEPC highly appreciated the value of CEAI and promised to organise shortly another event on the theme of Consultancy export.



Dignitaries on the stage releasing a brochure on Engineering and Construction Services L to R: Ms. Sangeeta Godbole, DG SEPC; Mr. Anbu Samuels, Director, Stup Consultants; Mr. Amitabha Ghosal, President, CEAI; Mr. Sudhanshu Pandey, Additional Secretary, MoCI, GoI; Dr. Rajashekhar Malur, CTO, Tata Consulting Engineers Limited; Mr. Alok Nanda, CTO, GE South Asia and CEO, GE India Technology Center; Mr. Bharat Gala, Director, Atkins India; Mr. Ganesh Iyer, CTO, Knowledge Lens Pvt. Ltd.

STEEL USAGE IN BUILDING & CONSTRUCTION AND INFRASTRUCTURE SECTOR

Ministry of Steel is planning to organise a workshop/ seminar in the last week of February, 2020 by inviting Japanese experts on usage of steel in Building & Construction and Infrastructure Sector. The purpose of the workshop/ seminar will be to identify the areas in Building & Construction and Infrastructure sector where more steel usage can be achieved with the help of Japanese experts in the field. To identify such areas in India and share with the Japanese side to get their expert views, Ministry of Steel has invited CEAI to attend a meeting held in Udyog Bhawan, New Delhi on 24 December. Mr Rajiv Maini, Director CEAI represented CEAI for this meeting. The representatives from MoHUA, MoRTH, SAIL, RINL, NMDC, MECON, INSDAG, ISA, SRTMI, JSW, Tata Nest-In, Everest, BMTPC, DLF, NBCC, L&T. were also attended the meeting.

MEETING WITH ADDITIONAL SECRETARY, MINISTRY OF COMMERCE

A meeting between Mr Sudhanshu Pandey and senior members of CEAI comprising Mr Sudhir Dhawan, Past President, Ms Sayona Philip, Past President and Dr Ajay Pradhan, Vice President, held on 23 December 2019 at the chamber of Additional Secretary at Udyog Bhawan, New Delhi.

CEAI members discussed with the Additional Secretary regarding the challenges that are being faced by the engineering consultancy industry in India.

FIDIC NEWS

INTERNATIONAL CONFERENCE ON 'RESILIENT INFRASTRUCTURE FOR BETTER TOMORROW

The Nepalese Society of Consulting Architectural and Engineering Firms (SCAEF) organised an International Seminar on '*Resilient Infrastructure for Better Tomorrow'* on 18-20 November 2019 at Kathmandu, Nepal.

Mr. Amitabha Ghoshal, President CEAI making his presentation

Mr. K. K. Kapila, Member CEAI Governing Council delivering Key Note address

SCAEF was invited Mr. K. K. Kapila Member CEAI Governing Council to deliver a Key Note speech and Mr. Amitabha Ghoshal, President CEAI for presenting a paper at the Conference. Both the presentations were appreciated.

CEAI SIGNED MOU WITH FIDIC MEMBER ASSOCIATIONS

With a view to promote and develop the engineering industry in India and abroad, CEAI signed a MoU with three FIDIC Member Associations:

a) Society of Consulting Architectural and Engineering Firms (SCAEF), NEPAL

b) Stowarzyszenie Inzynierów Doradców I Rzeczoznawców (SIDIR), POLAND

c) Romanian Association of Consulting Engineers (ARIC), Romania

The MoUs cover:

- Exchange of information on Consultancy opportunities and technical developments,
- Joint study and research activities,
- Joint seminar and symposium,
- Firm level cooperation, and
- Promotion of other cooperation on mutually beneficial basis in the field of engineering.

President CEAI signing the MoU with SCAEF

OTHER NEWS, VIEWS & NOTES

SPECIAL RECOGNITION TO CEAI MEMBER ORGANISATIONS

Tata Consulting Engineers Ltd, an Indian Design Engineering firm, received special recognition for being ranked 127 in the prestigious Annual ENR 2019 ranking list of Top 225 International Design Firms. This award was given on 15th October 2019 at the "INDIA CONSTRUCTION FESTIVAL 2019" hosted at ITC Maurya, New Delhi.

L&T which is an EPC company has also been recognised in the Design Engineering part.

OBITUARY

It is with profound grief, that we have to inform that Prof. Anand Swarup Arya left for his heavenly abode on 1st September 2019.

Prof. Arya, got his bachelor's and master's degrees from the then University of Roorkee (now Indian Institute of Technology Roorkee). He got his doctorate degree from the University of Illinois at Urbana-Champaign. He was an Eminent Structural Engineer, known for his expertise in the soil and foundation engineering and earthquake disaster management. He was a former Chairman of the Bureau of Indian Standards (BIS) Committee on Earthquake Engineering and a recipient of the United Nations Sasakawa Disaster Prevention Award of 1997. The Government of India awarded him the fourth highest civilian honour of the Padma Shri in 2002.

VIEW POINT

The themes for the next three issues of Viewpoint spread over nine months would be:

(a) **Building Services** (March 2020)

(b) **New Materials & Systems for Buildings** (June 2020)

(c) **Stakeholder Management in Public Infrastructure Projects** (September 2000)

Considering the experience of CEAI members and various stakeholders in the subjects, CEAI would be happy to receive articles on the above themes.

Authors could share their knowledge and experience by providing case studies of the works executed or in execution, firsthand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit the readers and enable better appreciation of the issues encountered and addressed.

The articles for an issue need to reach CEAI at least 6 weeks prior to the end of the month of the Viewpoint issue.

Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin on A4 size. A recent clear and bright passport size photograph of the author(s) is to be sent along with the article.

Tech Quiz

1. **When was the oldest environmental law enacted in India?**
   a. 1981
   b. 1860
   c. 1850
   d. 1853
   e. 1774
2. **Under which Article of the Constitution is the environmental law enacted?**
   a. Article 246
   b. Article 253
   c. Article 300
   d. Article 310
   e. Article 422
3. **Which was the most polluted city in the World on 15 November 2019?**
   a. Mumbai
   b. Kanpur
   c. Beijing
   d. Lahore
   e. Delhi
4. **Which city in India is lately considered to have the best air quality?**
   a. Kota
   b. Bhuj
   c. Kochi
   d. Shillong
   e. Thiruvananthapuram
5. **Which is the most polluted river in the world?**
   a. River Yamuna
   b. Yellow River
   c. Citarum River
   d. Sarno River
   e. River Ganges
6. **Which is the cleanest port in India?**
   a. JNPT
   b. Haldia Port Complex
   c. Visakhapatnam Port
   d. New Mangalore Port
   e. Kandla Port
7. **Which is the cleanest airport in the World**
   a. Haneda
   b. Changi
   c. Hamad
   d. Incheon
   e. Hong Kong
8. **Which is the cleanest Railway Station in India?**
   a. Vijayawada
   b. Jaipur Junction
   c. Haridwar
   d. Jodhpur
   e. Jammu Tawi
9. **Which is the cleanest city in India**
   a. Ambikapur
   b. Mysore
   c. Indore
   d. Ahmedabad
   e. Bhopal
10. Which is the highest lake in India?
   a. Cholamu Lake
   b. Pangong Lake
   c. Changu Lake
   d. Gurudongmar Lake
   e. Chandra Taal

The first person who mails the correct answers to CEAI ***info@ceai.org.in*** will get a congratulatory mail and will be acknowledged by publishing the persons photograph in the next issue.

Contributed by A P Mull

Answers to Tech Quiz June 2019 issue

1(c), 2(d), 3(f), 4(b), 5(b), 6(a), 7(d), 8(e), 9(c), 10(b)

Prof. Mainak Ghosal, Consultant is the winner of the Tech Quiz with full/ maximum marks.

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03. Energy, Telecommunication and Space Infrastructure
04. Roads, Highways, Expressways
05. Urban, Rural and Industrial Development including all Types of Buildings
06. Bridges & Flyovers
07. Railways
08. Offshore, Harbour and Coastal Engineering
09. Metros
10. Water Resources and Agricultural Development
11. Construction Engineering, Project Management and Technology Transfer
12. Rehabilitation of Structures and Heritage Buildings


01


02


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04


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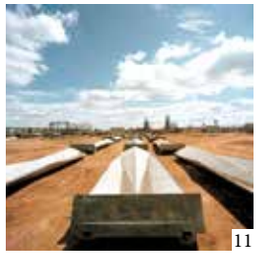
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