How to combat rising temperatures in India?

There has been an observable change in the weather pattern in India as also rest of the world. At least for last ten years, we have not seen droughts in any part of the country; rains are excessive, well spread, and last longer (almost four months); winters are more severe, with more snow in hilly regions; and summers have become hotter.

While it is possible to live with more rains and colder weather, managing high temperatures is troublesome for most people. There are many deaths reported each year, particularly in North India, during May and June when outdoor temperatures touch 45°C. Air conditioning is not affordable to most, and the cost of electricity has been going up.

What could be a solution to combat temperature rise?

Before we attempt to find a solution, we must first find the root cause of global warming.

Rising carbon dioxide (CO_2) levels

Over last several decades CO_2 levels in the atmosphere have been steadily rising. In the beginning of the last century, CO_2 levels were about 300-ppm,

but in recent years it has reached 440-ppm. This has led to a rise in average global temperatures by 0.5-0.7°C.

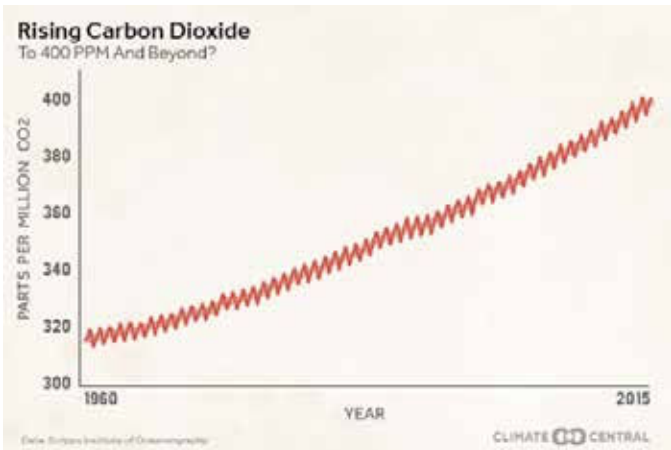
The rising temperatures have several repercussions: For one, it is leading to melting of polar ice, causing sea levels to rise. There are fears that large parts of several coastal cities could soon be submerged.

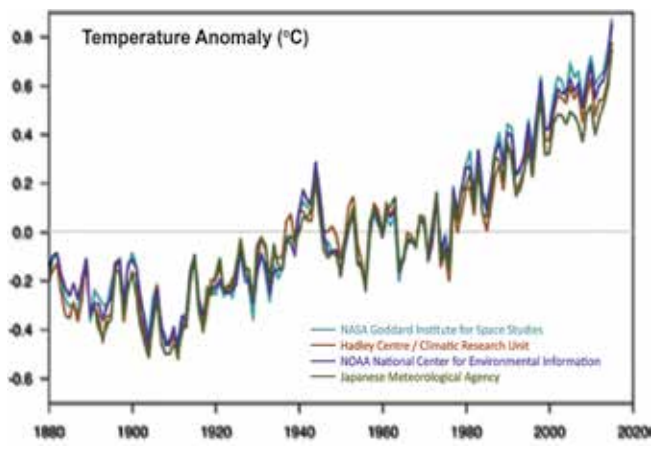
Cities will have to find their own ways to stay dry, and this has been done in the past. In several parts of the world land has been recovered from the sea by construction of solid dams. The Netherlands is a good example, but even here in Mumbai, Nariman Point and Cuffe Parade have been reclaimed from the sea.

What's raising CO_2 levels?

Quite clearly, it is burning of fossil fuels – crude oil & its fractions, coal, lignite and natural gas. CO_2 is also produced by burning of farm residues, forest fires and to a small extent by the cement, steel and alcohol fermentation industries. It is also exhaled by animals and humans.

CO_2 is essential to life. By combining CO_2 with energy (from sunlight) and water (in the atmosphere and on land), plants produce fruits, vegetables, firewood, proteins, sugars – all important for life. In fact, the plant kingdom should benefit with increasing CO_2 concentration, as crop yields could increase if adequate water and nutrients are made available.





How do increasing CO_2 and methane levels increase the temperature of the globe?

The heat liberated by burning oil, coal or natural gas is a reason, but more important is the reflection of heat radiation of the earth back from the stratosphere.

Emissions of methane are also contributing to global warming. In fact, methane is 21 times more reflective of heat than CO_2 at the same concentration.

Lowering CO_2 levels through conversion

Many groups are researching recovery of CO_2 from the atmosphere and other sources and converting it to useful products.

Efforts are also being made to recover CO_2 directly from the atmosphere (Direct Air Capture, DAC), but the low concentration of CO_2 makes this process difficult.

Recovery of CO_2 from industries that produce it in large concentration (up to 20%) such as cement, steel, alcohol industry – is more feasible.

The captured CO_2 can be converted to useful industrial chemicals such as methanol (which can be used as a fuel), and polyols (for polyurethane coatings). But the economics of these processes can only sustain on external fiscal support, as the cost of hydrogen required to convert CO_2 to methanol, the energy required for conversion, and the cost of recovery of CO_2 from atmosphere, all add up, and cannot be supported by the value of methanol so produced. In other words, such a project cannot sustain without subsidies. Furthermore, after all the effort, the chemical conversion may prove net carbon negative. Hence it is important to look at the overall energy balance.

I have been advocating use of solar energy to convert CO_2 to a range of chemicals besides cellulose, lignin, sugar and fats (A 10-15 year plan for India's energy security and carbon neutrality, *Chemical Weekly,* March 19, 2019, pp 206-208).

CO_2 sequestration

Another approach that was considered about 20 years ago was to capture CO_2, fill it in cylinders and dump the cylinders in the sea. The idea was a nonstarter on day one given the energy needs to: produce the required amount of steel; capture and compress the CO_2; the life of cylinders under the sea in a highly corrosive environment; and the risk of sudden release of CO_2 in the event of leakage. No one takes this approach seriously.

However, carbon capture and sequestration (CCS) in underground natural reservoirs, as well as in depleted oil & gas fields, is a reality.

Raising forest cover

The total forest cover of India is 7,15,343-sq.km., of which 14% is dense forest. The easiest way to cool any object is to spread water on its surface. This cannot be seawater; it has to be reasonably clean and low-TDS (Total Dissolved Solids) water. Most wastewater available in cities can be purified and used for this purpose. If the wastewater from these cities are spread on forests, those which are lean can be converted to medium forests, and medium forests can be converted into dense ones. Such a conversion of CO_2 to biomass will bring down CO_2 levels.

This can be tried in some of our deserts, as well as those in other countries (USA, Australia, China and parts of Africa) with the greening starting from the edges.

Treating and spraying water

Large scale investment in water recycle and reuse is required in all major cities of India. It is a matter of concern that even a large city like Mumbai has not invested adequately in water recycle and reuse. The entire coastline of Mumbai looks dark due to discharge of untreated sewage. (I feel bad for the millions of tourists who visit Mumbai in the fond hope of taking a dip in the sea; in my 56 years of stay in the city, I have not dared to do this).

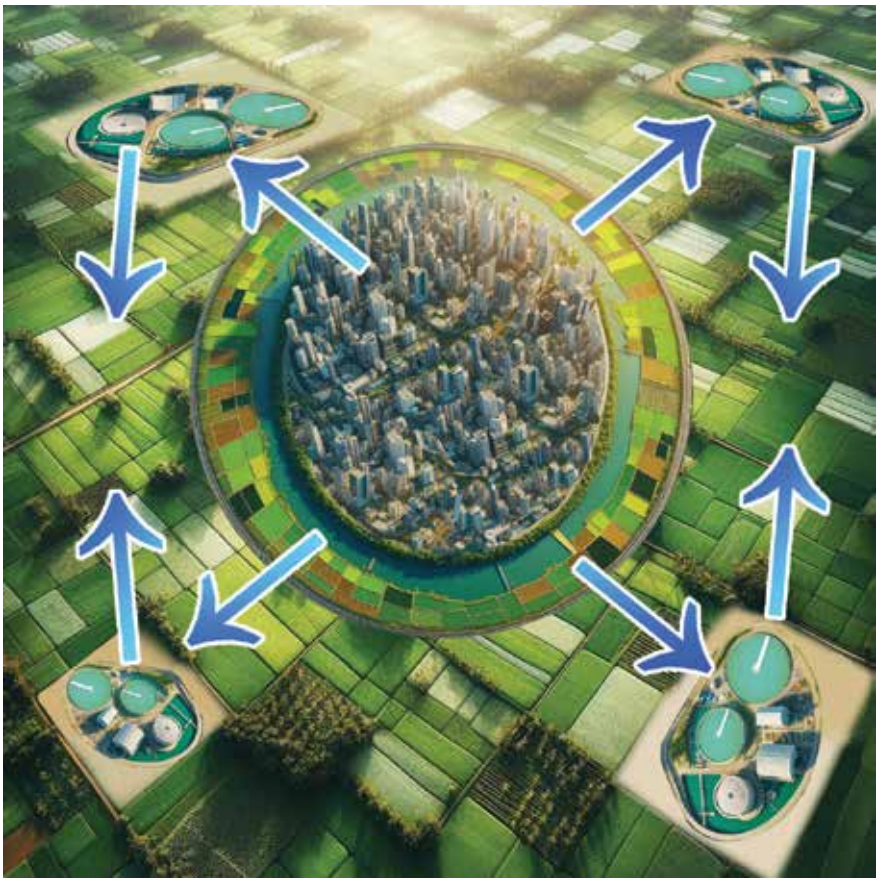
Mumbai gets its water from a distance of 50-60 km. It may as well transport the untreated sewage 50-60 km away, along the sea to reduce pumping costs, treat it there and use it locally for farming. Chennai collects all raw sewage in a nearly 50-m wide stream, treats it close to the seashore and discharges it to the sea. There is scope to consider use of this water as fertigated water in surrounding areas. The high temperatures of Chennai can be tackled by spreading the treated water on streets, trees, gardens and playgrounds.

The entire used water of cities should be divided in three parts: Sewage water, sullage water and storm water. Separate treatment should be provided to each of these streams.

Sewage water is the most valuable of all three. All sewage should be first anaerobically digested to recover methane for town gas as well as transportation. This sewage can be enriched with cow dung and other green wastes (e.g., from vegetable markets). The resultant water should be disinfected with ozone and sent to farms for watering crops.

Phosphorous and potash, present in sewage, are indestructible elements, and essential parts of food. Their accumulation in adults is very little (only growing young people accumulate it). Thus, most fertilizer that India imports can be indefinitely recycled. Similarly, significant quantities of urea can also be recycled from the treated sewage.

The sullage water is much larger in volume. It comprises water used in bathing, kitchens and washings. It also may



contain some nutrients. It is a lot easier to treat, being very dilute. BOD and COD levels of this water are within 100 ppm. After treatment, this water should be spread on large surfaces of the city as a means of dust control.

Rainwater is the cleanest resource. All cities must make efforts to store as much rainwater as possible. (For more ideas on this my contribution in *Chemical Weekly,* January 28, 2025, should be referred.) This can be done by rejuvenation of old ponds, and construction of soak pits all along the roads. Rainwater harvesting should be made compulsory for all residents of single- and multi-storey buildings. This would help improve groundwater levels. Traditional techniques of water conservation such as that practiced by residents of Rajasthan who collect every drop of rainwater and use it for the entire year should be practiced. Each year, this water must be completely used up to make space for the next rains. There are hundreds of stone quarries lying empty. By closing one side, these can be converted into rainwater catchment ponds. Along the Mumbai-Pune highway, on both sides of Parsik Hills, and above the Western Ghats, at least 100 such locations can be found.

Stone excavation for roads, dams, industries and building construction is a continuous activity. All excavation should be done underground so as to create huge water storage facilities.

In short, water should be spread on large surfaces to capture excessive heat. This would also promote vegetation and fix CO_2. India receives a lot of solar radiation. Several million tonnes of CO_2 can be captured by simply spreading water on barren surfaces, allow grasses or small plants to grow. The vegetation can be recovered and used as a fuel, thus recycling the fixed carbon. This process would be net carbon negative. Over a period, the planet will cool and produce a huge amount of biomass, and even lead to net zero production of CO_2.

These ideas should be a part of the Smart City development planned by the government. In their planning stage, provisions should be made to recover all waters separately, and purify & distribute the treated water for different applications. There should be four sewage treatment plants at the outskirts of each city (EWSN), approximately 8-km away (to provide for growth of the city). The treated water should be distributed to farmers (at cost, because it would save them fertilizers and pumping costs).

Key takeaways

1. Water is the best coolant. Spread water on surfaces to cool it. Spreading water on trees and on the ground will also increase photosynthesis and reduce CO_2 levels.
2. Collect rainwater by rejuvenating ponds and constructing soak pits along the roads (we are constructing 35-km of highways every day). To compensate the loss of percolation due to concretized surfaces, harvest rainwater in underground storages, and directly collect it in bore wells. This would also reduce flooding in rivers.
3. Recycle sewage and sullage after treatment back to fields. This water, available through the year, is laden with resources and best of all is free. Save imports of potash and phosphorous for fertilizer use.
4. Treated sullage should be used for washing streets, spread on roads and open lands to prevent dusting, clean and wash trees to help them bear more fruits.
5. Cool the environment by evaporation of wastewater.

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