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RENEWING MOTHER EARTH
Pre Conference Draft Report
Working Group 2

The Kalam Conference Team

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RENEWING MOTHER EARTH

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Contents

List of Figures

Chapter 1

Introduction:Mandate of Working Group 2

The ambitious mandate of this Group is to map a route to negotiate the most difficult problems facing Humanity: food security, water supply and quality, air quality, land sustainability, and reversing Climate Change. The mandate is in fact to see how to return to a state of high reforestation without destroying the modern amenities of life, and without causing food shortages or hindering economic progress. A tall order indeed.

We believe that pollution can be reversed, air, land and water quality improved, and eventually, anthropogenic Climate Change can be stopped and reversed to the extent deemed safe and suitable. Technology, public policy and implementation aspects of these objectives intersect the domains of Working Groups 3 and 4 respectively, and will be further discussed there.

A crucial component of our plan is to reverse urban migration and instead foster a massively distributed, rural-based economy. As discussed in Working Group 1, this fits with the notion of rural self-reliance, starting with energy self-reliance or *Urj Svavalambi*. It opens the space to a very different type of development and progress from what has been seen around the world. We argue why this is desirable, and why it is enabled by a synergy of recent developments, both technological and social.

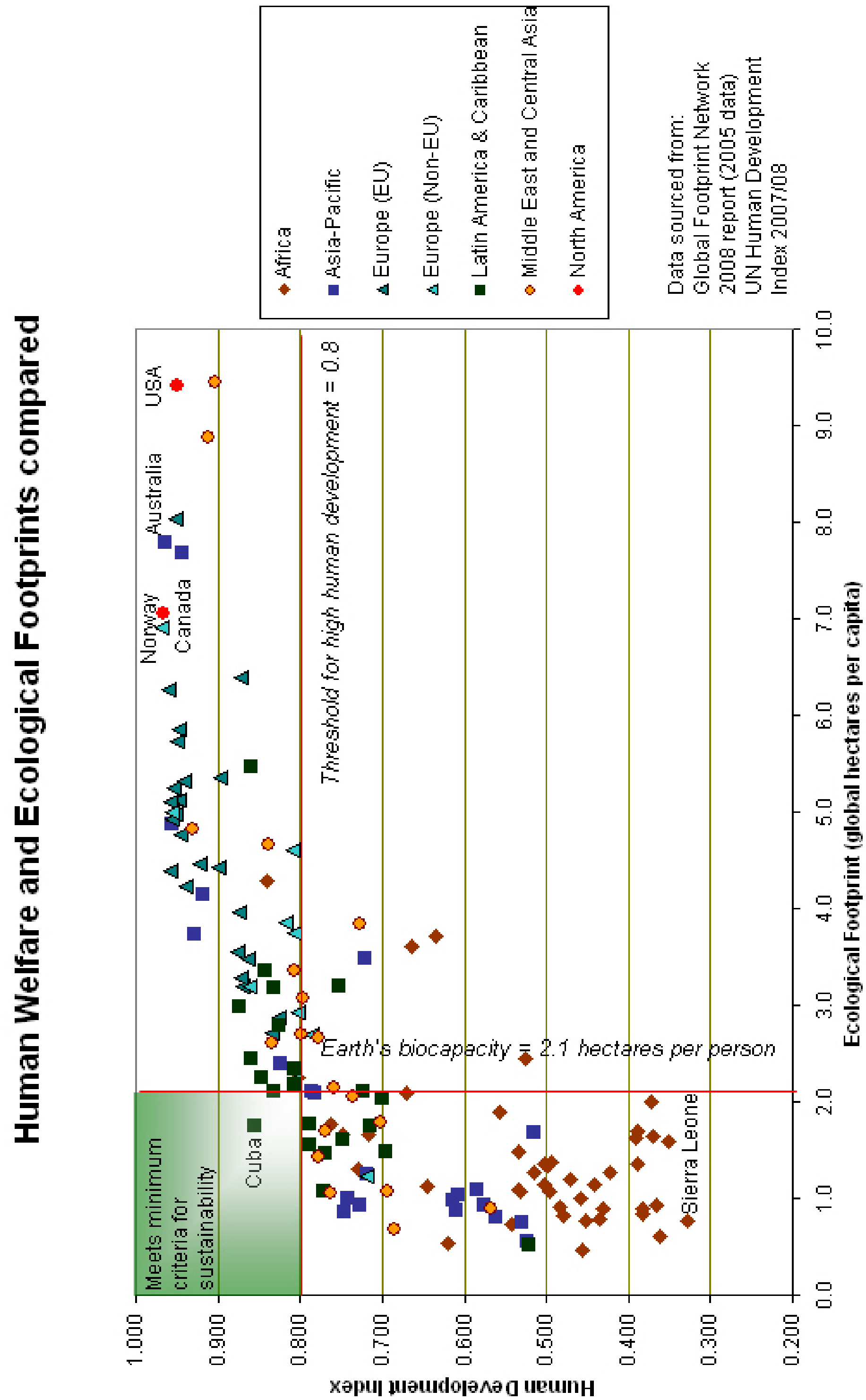

Figure. 1.1: Human welfare and ecological footprint sustainability

1.1 Summary Recommendations

We recommend:

1. A nationwide program of reforestation.
2. To motivate this, we suggest creation of National Nature Credits, similar in concept to Carbon Credits but much broader in scope.
3. Microscale Carbon Credits that are verifiable through the Internet and easily accessible to all residents without need for the complex and expensive certification process of present Carbon Credits.
4. We propose a shift to technology-enabled Vertical Farming, redirecting agriculture from the present large-area model exposed to the elements, to compact vertical farming modules surrounded by large-tree forests.
5. We propose supporting initiatives to clean up the ground, lakes, rivers and coastal waters and beaches.
6. We propose strict enforcement of systems to collect and dispose of waste materials, with some initiatives funded initially through the fines collected from wilful offenders.

1.2 Arguments For and Against Reversing Urban Migration

Since ancient times, humans have chosen to live in communities. These communities were established in desirable locations where many wanted to live. As communities grew larger they also became stronger. In most cases, the answer to *Why do so many people live here?* is simply *Because so many other people live here.* The presence of other people creates opportunities to set up the business of trading with others in proximity. It enables life as a skilled worker at many levels. It provides security in numbers. In times of natural disaster, communities come together to enable survival that would be impossible in isolated places.

As cities grew, they attracted more and more residents. Schools, hospitals, recreational facilities, supermarkets, office buildings, parks, theaters, museums, transportation hubs, all depend on the presence of large numbers of regular users and in most countries, a tax base. Like stars accumulating dust and gases, cities became “hotter’ in economic activity and innovation, and glowed brighter and brigher. One commentator (identified as 'Gerard') describes the attraction of the cities compared to rural areas thus:

> *"Why this romantic notion of village life? This fetish with farming and inefficient small scale industry? Held by people (city dwellers) who don't have to live there? Some of the first cities on this planet were on the Indian subcontinent. Urbanization has been occurring for thousands of years. Only cities provide the concentration of people and resources necessary for civilization to advance. Cities destroy the old feudal order. They destroy the tyranny of the village (tribal) hierarchy, the rough justice of the panchyat. They are great levelers of society.*
>
> *Urbanization occurs all over the world. The US great plains are reverting to bison and native americans as the population leaves their farms and small settlements and moves to the urban areas. The Chinese are building ten cities from scratch to house rural migrants. The villages in Russia are dying as the young migrate to the city. The same is happening in Africa. And the same forces are at work in India. They are unstoppable. The challenge is to build even more cities. To build the dams, power plants etc that enable large cities to function. To build the road and rail that connect them, to build the infrastructure."*

These are powerful points. The traditional model of an Indian village and a city, do display several characteristics that make people prefer to live in the relative anonymity of a city that affords individual freedom, versus the superstitions and backwardness of the village where people have far too much time on their hands and tend to interfere in others' lives too much. Electric power was rare even where there were power lines; roads were little more than rutted dusty trails; medical care was often unreachable, telephone connections were difficult. A trip to shop for most products would take all day; reaching any government office might take more than a day. Schools were terrible, sports and arts facilities for youngsters were minimal. Although land might be inexpensive, building a home with modern conveniences faced the high costs and delays in importing all materials, tools and labor from the cities. Maintenance was equally difficult: there was no reason for skilled technicians to live in the village. People migrated to cities at the first opportunity, in search of opportunity to get an education and make a living. The rest of the world was simply far far away.

However today, conditions have changed. To an increasing extent, people's definition of 'community' has changed: they do most of their social interactions via the Smart Phone, with WhatsApp groups spanning continents and time zones. Education can at least in part, come via satellite and Internet. In fact the higher the education level, the easier the access to the best in the world. Access to sophisticated healthcare is potentially as close as one's computer and TV set, with self-operated diagnostics and some local skilled medical workers to help. Product delivery could be by drone aircraft, even if roads will continue to be terrible until the tax base of the village rises. Rising income makes parks and playgrounds possible; after all land is cheaper than in the city! Certainly, people will expect good law and order in order to live in the villages, just as they do in the city. The reason for this conference is to bring awareness of what has changed, and how that opens massive opportunities to tap existing and upcoming technologies.

Getting back to our simple model of urban evolution, cities, like stars, started reaching the point where the density began to choke further progress. Land prices shot up exponentially, so that downtown businesses became more and more expensive and less competitive. People started moving out into the suburbs, increasing commute time and distance. The demand for roads and vehicular traffic made the downtown areas less and less livable and in fact deserted and insecure especially after working hours. As land ran out, road-building became harder, and the roads became more congested. People started having to spend hours on the road just commuting. A trip to the airport from downtown, once taking 15 minutes, might now take 2 hours, negating the point of being in the center of the community served by the airport. With cars sitting on the road, air pollution went sharply up. Buildings in close proximity had to be enclosed and air-conditioned to function; the heat pollution from cities built upon itself, and became worse and worse. Air quality deteriorated; residents began to experience lung and eye disease. In some cities such as NewDelhi, one can buy exotic gas masks at the airport for INR 4000 (around 60 US dollars) each, they appear to be part of *haute couture*. The waste and effluent from cities had to be dumped in huge quantities that far surpassed the ability of the land to absorb and break it down in a sustainable manner. Thus immense waste dumps, and dumping of sewage into rivers, became a curse of modern society. Residents organized to demand that waste dumps be moved further and further out from their own homes. In fact in many Indian cities, improper enforcement of codes and regulations drives residents of expensive, 'luxury' high-rise developments to dump their kitchen waste including animal parts, along the roadside in plastic garbage bags. With high land prices came micro-division of urban land, with ever-increasing density of population.

Meanwhile, the concentration of industry in the cities meant that incomes, partly driven by real estate and housing prices, rose sharply in the cities compared to the rural areas. Rural residents could no longer afford to buy things in the cities. With infrastructure demands ever rising in the cities along the lines described by *"We* *generate 90% of the tax base, why are we being denied the infrastructure that we need?"*, the rural areas were starved of infrastructure. Khapre [1] cites the refusal by the Finance Ministry to honor the 'commitment' made by the Prime Minister to bridge the 'viability gap' of 660 Crore Rupees in the Mumbai Metro project, a vital project to alleviate the misery of Mumbai's commuters on the overcrowded Metro system. Mumbaikars lamented that *in return for 73,000 Crores of tax money, Mumabi gets **this!*** An interesting note: As an Internet postor "RM" remarked,

> *"Tax is tagged to the place where income is reported, not where income/goods are generated. For examble a company with factories all over India earns say Rs 1000 Crore rupees, and if its head quarters is in Mumbai, then as per tax 'records', all income will appear as if it were generated in Mumbai."*

Others wondered whether large cities should not have much greater autonomy in spending the tax revenues that they collect, so that investment in development keeps pace with actual productivity and the size of the population. As some political leaders have experienced in India, the danger with the State acceding to constant demands for more resources to urban development, is that the rural areas might vote out the government at the next election.

In time, the salaries paid to workers in the cities rose to be an order of magnitude or more compared to what rural residents, mostly dependent on farming, could make. Villagers got left further and further behind the advances of society, even as they lost the traditional self-reliance mechanisms that they had. As life became less and less viable in the villages, people started giving up. Farmers and their families sometimes committed suicide. Others simply migrated to the cities in search of some City Job that would let them send money back to the village. They added to the congestion in the cities, and the problems that came from inadequate facilities for those at the bottom of the economic spire.

The above describes, in simplistic terms, why we believe that it is imperative to reverse urban migration, by making the villages more viable. We believe that technological progress, and the evolution of human labor priorities, make this feasible, but it must be done thoughtfully and deliberately with much discipline and support. In India, ancient traditions provide strong support to do this.

1.3 What would it take to move to a rural-based society?

Others have tried this in various forms, with disastrous (intent and) results. The People's Republic of China in the 1960s went through a Cultural Revolution. Urbanites were expelled to go and do manual labor and live in rural collectives/ concentration camps, to "re-educate" themselves away from the so-called evil ways of Capitalist societies. Cambodia (Kampuchea) did much worse to their population. The Taliban, generated by the Pakistani military based on fundamentalist teachings to conquer Afghanistan, banned many modern conveniences as well as the ancient solace of music, song and dance, and all signs of culture, even destroying ancient monuments such as the Bamiyan Buddha statues. More recently, the ISIS went through Iraq, Syria and Libya like a locust infestation, mass-murdering and enslaving entire populations, as the armies of Genghis Khan, Nazi Germany and Pakistan in Kashmir and Bengal, did in the past. However these were hardly altruistic movements, they were driven by hatred and greed.

We support nothing of the sort. Our quest is to make the villages more attractive than the cities, not to make the cities less attractive. We submit that technology makes it timely to rethink the reasons that drove urbanization in the first place, and urban migration later.

Papers by [2, 3] discuss aspects of the Concrete Jungle nature of modern cities. Evidence abounds that the extremely unnatural setting of the city causes stress and other problems for many who come from rural areas, or are otherwise not naturally tuned to such an existence and culture.

When the Earth is renewed, the rural areas become far preferable as places to live, than the crowded cities. Many costs and environmental impacts can be alleviated if we could persuade people shift to the villages and live there.

But why would people choose to live in villages if they have to commute far to earn a living? This requires the second part of the Roadmap elucidated in Working Group 1: that

Energy + Knowledge = Independence + Wealth

Modern, high-value jobs are shifting steadily more into the "Knowledge Economy", where the economic value addition comes from people who work in small groups or in the privacy of their homes. They work over the Internet. The Knowledge Worker can work from any place where there is an Internet connection and electric power. Why should that worker work from, say, a high-rise apartment in a crowded urban area? Rather than from a spacious rural home?

The remaining problem is physical proximity to large workplaces. However, in India, one must seriously question the advantage of living in an urban area: commute times are unacceptably long, and commuting stress and risk are unacceptably high. We can do better. With intelligent use of technology, we can eliminate much of the commuting, thereby greatly reducing the congestion for the remaining workers who must live within commuting distance of city centers. Thus we argue that the value of tele-commuting, video conferencing, e-banking, e-governance and telemedicine are far higher in a nation such as India which lags in transportation infrastructure, than in Advanced industrialized nations. The time to make this revolutionary change is BEFORE the infrastructure advances.

A distributed economy that puts many workplaces in rural areas, is much more than the same urban economy, distributed. It offers significant opportunities for growth at vastly lower costs. It also slashes the Carbon Footprint of transporting food and other produce from villages to cities. Markets will use barter or Internet-based contract and price negotiation instead of the traditional physical Bazaar: this is already well underway in India. Many things that required a half-day headache-ensuring journey to Moor Market in Chennai from Adayar, also in Chennai, in the 1970s, are now ordered over the Internet and received in convenience at home. On the other hand, one does not have to go to Chennai to find the item at all: one could find it on FlipKart from the comfort of one's home in suburban Kerala and get it delivered within a few days.

1.4 The right questions?

Rapid development is needed, to advance the quality of life. This development must reach everyone, including the vast number of people who are metaphorically at the Bottom of the Development Pyramid. How can this be done while minimizing damage to the environment?

But is that even the right question? An improvement in living standards by orders of magnitude, while trying to "minimize ecological impact" appears to be a recipe for disaster. The minimum might be far too high an impact. Recently at a panel discussion conducted by the MIT Sloan School, speakers were arguing with evident horror at the prospect of, say, *Asians starting to acquire airconditioning systems*, since that would increase heat release, if not leak greenhouse gases. Perhaps the right question is to ask whether the massive development can be done, starting with a relatively "clean sheet of paper" (very little development now, little or totally outdated infrastructure, etc) and do things very differently? This opportunity exists in much of rural India, and surely Africa if not Central and South America, today: very little development exists.

The question about the right questions is seen in many examples of present debates. For instance, take the rising panic about Global Warming. All the regulations about which nations and communities argue, are having little discernible effect, as the sea levels rise, extreme weather events cause disaster, and tensions turn into conflict. Perhaps one should ask what positive steps can be taken to lead by example, rather than focus on telling people to hold back their own aspirations to keep from ruining our future.

1.5 A view of the Indian Village that should be

Let us try to visualize one of infinite variations, on what these villages should have. Each of the items except for the hydrogen economy, is already based on an existing Model Village demonstration; the hydrogen village demonstration is being planned as part of the 1st Abdul Kalam Conference in July 2019, to be implemented at a village in Andhra Pradesh. Here is a brief list of elements:

1. Energy self-sufficiency through solar PV, biogas, intensified solar and where possible, wind/micro-hydro sources.
2. Internet connectivity to all homes and public places, preferably WiFi in public spaces.
3. Energy-enabled enterprisea that brings income for investment
4. Vertical farming in controlled environment buildings, fo rnon-grain produce.
5. Reforestation of land now used for vegetable (non-grain) farming, with orchard tree cover.
6. Schools with climate control to operate year-round in comfort
7. Rainwater harvesting, lakes, overhead tanks and underground tanks to store water.
8. Piped and drip irrigation
9. Solar intensifiers to generate hydrocarbon fuels as well as hydrogen-oxygen.

10. Hydrogen-oxygen and hydrogen-air transportation architecture.
11. Modern, well-turfed playgrounds and athletic facilities.
12. Medical facilities with satellite and Internet telemedicine connections
13. Public-rental use video/3D conferencing facilities for telecommuting workers to use.
14. Garbage disposal by means of recycling bins placed at many points, and regular pickup and disposal to processing plants.
15. Concrete/ recycled plastic roads.
16. Air connectivity by UAVs for goods, and access to local airports for people.
17. Strict regulations against littering.
18. Small "industrial complexes" in the village with shared Maker Village facilities such as 3D printing and machining, woodworking, electronics hardware and software development.
19. Well-appointed public gathering places, indoors and outdoors.
20. Religious places of worship and festival space, but with noise and pollution regulations uniformly enforced.
21. Ban on open burning.
22. Sidewalks suitable for barefoot walking.
23. Bicycle paths.
24. Law enforcement aided by sensors and cameras at public places.

1.6 Problems and Successes

Below we sample some of the problems that are cited today as environmental degradation or contributors to Anthropogenic Climate Change.

1.6.1 Sampling of Problems

A small list of problems:

1. Slash-and burn deforestation
2. Topsoil erosion

3. Concrete jungles
4. Traffic pollution
5. Industrial pollution in the atmosphere
6. Water contamination
7. Habitat destruction
8. Wetlands destruction
9. Fertilizer pollution
10. Noise pollution

Against the above list, are a few examples of successes achieved in the past.

1.6.2 Examples of Success

A small list of successes:

1. Eliminating the DustBowl dust-storms of the American MidWest
2. Banning indoor smoking
3. Slashing factory smoke
4. Mandatory greening of roadside embankments
5. Curfews on loudspeaker use
6. Airport curfews
7. Eliminating Freon refrigerant.
8. Jute/ biomass bags
9. Biomass construction materials
10. Recycling of paper
11. Recycling of metals
12. Captive biogas generators
13. Chemical toilets
14. Biomethanation of sewage
15. Reducing outdoor sewage
16. Rainwater Harvesting and Groundwater Replenishment

17. Terraced farming
18. Controlled-burn reforestation

Chapter 2

Synergy With Sustainable Development Goals

In this chapter we will see how the mandate of this Working Group maps to several of the United Natons Sustainable Development Goals (SDGs). The other SDGs are addressed in the other Working Groups.

LeBlanc [4] lists and discusses the Sustainable Development Goals. He describes them as an integrated network of targets. Beyond the added visibility that the SDGs provide to links among thematic areas, attempts at policy integration across various areas will have to be based on studies of the biophysical, social and economic systems. The SDGs succeeded the Millennium Development Goals (MDGs) as reference goals for the international community for the period 2-15-2030. The SDGs cover a much broader range then their predecessors. Uitto [5] wonders whether the environment is being neglected in the evaluations based on SDGs. This may be because of renewed focus on inclusive and equitable development that is aimed at reducing disparities in society between different groups. He views this as a positive development.

The 17 Sustainable Development Goals are:

1. No Poverty
2. Zero Hunger
3. Good Health and Well-Being
4. Quality Education
5. Gender Equality

6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life On Land
16. Peace, Justice and Strong Institutions
17. Partnerships for the Goals

Figure 2.1 lays these out along with the metrics used for each, shown below the goal. The mandate of this Working Group includes most of the SDG, while Goal 3 (Good Heath and Well-Being) is expanded further in Working Group 5, while Goal 7 (Affordable and Clean Energy) is the topic of WG 1, and Goal 16 (Peace, Justice and Strong Institutions) is covered under Working Group 4.

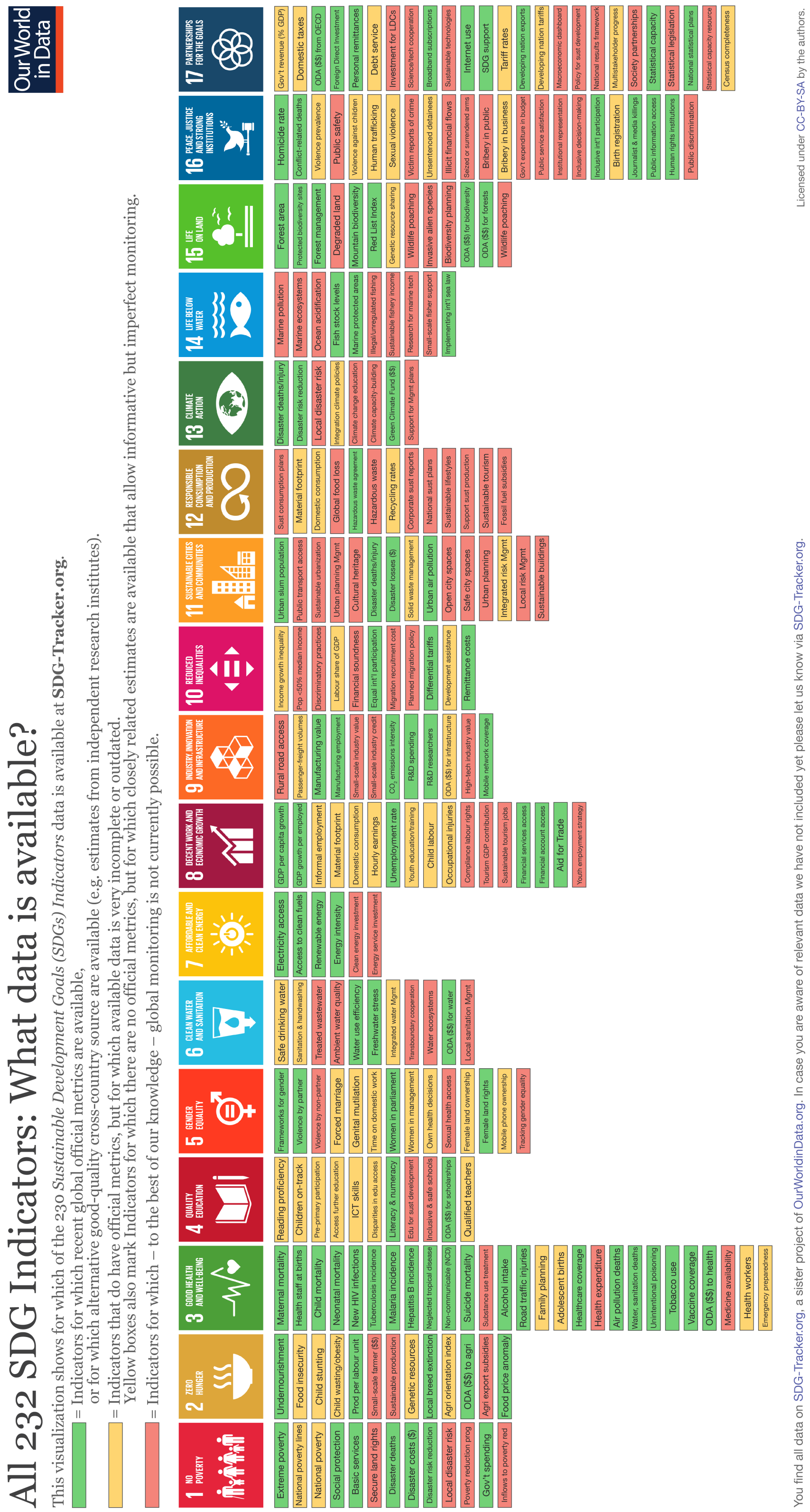

Figure. 2.1: Matrix of Data on all 232 Indicators associated with the Sustainable Development Goals

Chapter 3

Solutions

3.1 Synergy with Rural Energy Self-Reliance

One idea is the roadmap for Rural Energy Self-Reliance discussed in Working Group 1. The roadmap lays out a way to make the villages desirable places to live. Renewable energy brings not only electric power, but also ways of generating heat and power from gases such as methane that would otherwise aggravate atmospheric heat retention. The residue from biogas generation becomes benign, environment-friendly fertiliser that can renew the Earth. Renewable energy brings the ability to bring water to the community. It allows the water to be filtered and otherwise purified. It brings drinking water. It sharply reduces disease.

3.2 Running Water

Running water also provides a large step up in standards of living. It enables not only modern homes, but two-storey homes. It enables other construction projects. Villages can be as well planned for the 2030s and 2050s as the Ancients planned their villages in the Sapta Sindhu region thousands of years ago. Early North American villages set up integrated systems where water running a small level drop was harnessed to provide energy for industrial enterprise through wood-and metal turbine wheels before being used in the community.

3.3 Reversing Climate Change

One larger question is how we are going to stop and reverse Climate Change to the desired extent, now and in the future. There may be several overlooked opportunities. Here is one:

3.3.1 Microscale Carbon Credits

Today, Carbon Credits or Carbon Emission Unit (CEU) are awarded by the IPCC to entities who can prove that they have saved emission of greenhouse gases. Each CEU recognizes 1 ton of CO2 prevented from being emitted into the atmosphere. The certification process is arduous, long and expensive. It includes detailed quantitative proof using certified instruments and processes before the IPCC accepts the number of tons of CO2 emission saved. If this process could be brought within reach of everyone, without swamping the IPCC with requests, a large step will have been taken towards reaching a sustainable economy, and stopping Climate Change. We point to Indias rapid advances in enabling mobile-phone and Aadhar-based banking, retail transactions and government interactions and suggest that this provides a unique opportunity pilot retail, micro-level Carbon Credits. For instance, a homeowner or school-teacher can accumulate Carbon Credits gradually by measuring and tracking the performance of their solar-powered, biogas and other qualifying systems.

3.4 Model Villages: Some Thoughts

A commonly-seen approach is for some wealthy and generous entity to adopt a village, usually their own ancestral village, and turn it into a Model Village. After the 2014 General Elections in India, Prime Minister Narendra Modi exhorted Members of Parliament from his National Democratic Alliance to adopt at least one village in each of their constituencies, and develop infrastructure there using their Member of Parliament Discretionary Budget. He adopted two villages in his Varanasi constituency in Uttar Pradesh, both of which have been subjected to negative reviews by media representatives of the Opposition Parties starting immediately after the announcement until recently, and also very positive reviews recently before the 2019 Election, presumably by entities more friendly to the PM's party. These video-based and professionally prepared pieces were widely seen, and offer a stark contrast in attitudes. Both thus have tremendous analytical value to measure villagers' reactions to development initiatives by the government.

Legendary cricket batsman Sachin Tendulkar, upon retirement from professional cricket, was appointed to India's Rajya Sabha, the Upper House of Parliament. Perhaps using his Member of Parliament budget, or more probably his own generous use of personal wealth, he adopted a Model Village and appears to have done a tremendous job of development. These are just a very few examples, out of thousands that must exist all over India.

Model Village projects offer a great set of Case Studies. They have numerous strong positives, which should be obvious: these are carefully planned, and innovative. They result in changing these villages into post-modern places. However, one must ask why the Model does not propagate, except when others set up Model Villages. Part of the answer comes from watching the two types of videos of the PM's two Model Villages.

The negative videos focused, predictably, on first the delay in implementation (as in asking why after two whole years after project announcement, the project was not complete). The more recent versions focused on deficiencies in quality of construction (broken or discontinuous tiles on sidewalks, rain drains backed up presumably by blockage). They recorded reactions from some local residents who complained that the construction projects were all done by contractors from the PM's native state of Gujarat, who spoke their language instead of the local Hindi dialect. The implication was that the speaker was not able to find opportunity to share in the wealth of the construction contract. Then the video focused on three youths lounging on a motorcycle by the side of the road. They pointed to the broken tiles on the sidewalks, the backed-up drains etc.

In contrast the positive video looked at the architecture and topology of the Model Village. The newly-built homes were clustered into a townhome model, with two-storey construction of the small contiguous homes. The homes had good facilities. There were fairly broad, straight roads built in front of these residences, as opposed to the usual Indian village reality of winding, very narrow lanes. There was a common gathering hall for the community (of course with a plaque at the front stating how it was built and when). Around this cluster of residences, were orchards of trees, planted in regular patterns suitable for modern mechanized farming. This made for a very pleasant and shady scenery and a garden/ park like environment.

Then they showed a small weaving enterprise run by a family. A lady in a traditional Islamic costume operating the loom was very articulate and positive about her work and their products. The young lady who ran the plant spoke of how her family invested in this enterprise. It turned out that the electric power than they used, came from an off-grid, stand-alone solar photovoltaic system: the electric power through the grid was not very dependable. The huge difference between the videos was in the attitude of the people shown. Many people simply expect the government to do everything for them. They sit around, discontented. Others take the initiative and risk to become entrepreneurs, and succeed in the same village, and become positive. Thus one danger of the Model Village concept is that inhabitants of other villages, and even the same village, may become complacent in their expectation that the government should give them everything.

3.5 Smoke and carbon sequestration in outdoor burning

Much of the air pollution in New Delhi is attributed to farmers in surrounding areas burning the dried hay from their fields, in open fires that pump clouds of smoke into the air. In 2018, the government struck a deal to use the hay to make cattle fodder. This addressed the growing fodder shortage, while removing the cause of air pollution. In other parts of India this outdoor burning continues to be a primary source of pollution. In urban areas, people sweep up dried leaves, paper and other waste and burn it in heaps in the open. This practice could be ended, by providing garbage bins that are regularly taken away and emptied into re-processing plants.

Many Indian cities have already banned the use of petrol and diesel vehicles for public transportation. Vehicles burn compressed natural gas (CNG) carried in cylinders.

3.6 Biomethanation versus sewer/septic tank systems

A major problem in many Indian cities is that septic tanks have been built in close proximity in housing developments, and many of these are very old and not well-maintained. When extreme climate events occur, such as incessant torrential rain for several days that occurred in Mumbai and Chennai, the groundwater and drinking-water wells get contaminated. This has finally caught the attention of governments as a critical problem. One solution is biomethanation: rapidly decomposing sewage and generating bio gas, dominantly methane.

Prof. Indumati Nambi's research group in the Civil and Environmental Engineering Department at IIT Madras, have been working on this problem. Getting public acceptance for sewage-origin biogas as a cooking fuel is still a tall barrier, but they have helped set up new luxury housing developments where all the street lights are powered by biomethane. As biomethanation becomes more common and established, it provides a good fuel for Combined Heat and Power generation at the village scale to operate small enterprises. Gas turbine power generation is better suited to this than internal combustion piston engines, because the demands on the standarization of fuel quality are much lower. Along with biomethane gas turbines, ammonia gas turbines are also very attractive because the latter do not emit any carbon dioxide.

3.7 Reforestation

Reforestation is by far the most effective way to reduce the accumulated carbon dioxide in the lower atmosphere: one tall tree sequesters a very large amount of carbon. However, farmers are not going to accept conversion of their hard-won tillable fields into forests. Instead, the trees must be chosen carefully to provide farmers with a supplementary income source wit not much continuing effort. The grain crop area lost, must be made up by more efficient methods of grain cultivation, utilizing terracing.

3.8 River Valley Renewal

3.9 Increasing Rural Resilience to Natural Disasters

Chapter 4

Restoring Forest Cover

4.1 Arguments

One of the big changes proposed here is to actually reverse deforestation, and dramatically increase tree cover. Tall spreading trees capture and store immense amounts of carbon from the atmosphere. They absorb a good deal of solar radiation and use it to convert carbon dioxide, oxygen and water to hydrocarbon wood and foliage. Forest-covered mountainsides somehow appear to induce more rain (scientific basis not certain). Trees with their root systems certainly stabilize mountain slopes against soil erosion and landslides in wet weather. Trees provide habitats for many species of wildlife.

A very rough estimate from North America is that unmanaged forest sequesters roughly 100 metric tons of CO2, 27 tons of just Carbon, per acre. This is only 27 tons of actual carbon, which implies a rather low density of trees per acre. Tropical regions may allow for higher density of trees per acre, and so can 'managed plantings' of forests. One difference between managed forests and the natural variety is that in the latter, dead trees and lower-level brush are allowed to decay out in the open, releasing methane, which is per unit mass, 20 times as harmful as CO2 in terms of Global Warming potential. Managed forests can presumably keep removing trees and prevent growth of underbrush to cut down this problem.

To put the problem in perspective, cumulative anthropogenic carbon emissions into the atmosphere since 1870 are estimated at 230 Gigatons of Carbon. Thus, to absorb all of that using new forests, one would have to reforest 8.5 billion acres, or 3.44 billion hectares. The present forest cover of Earth is rougly 4 billion hectares, down

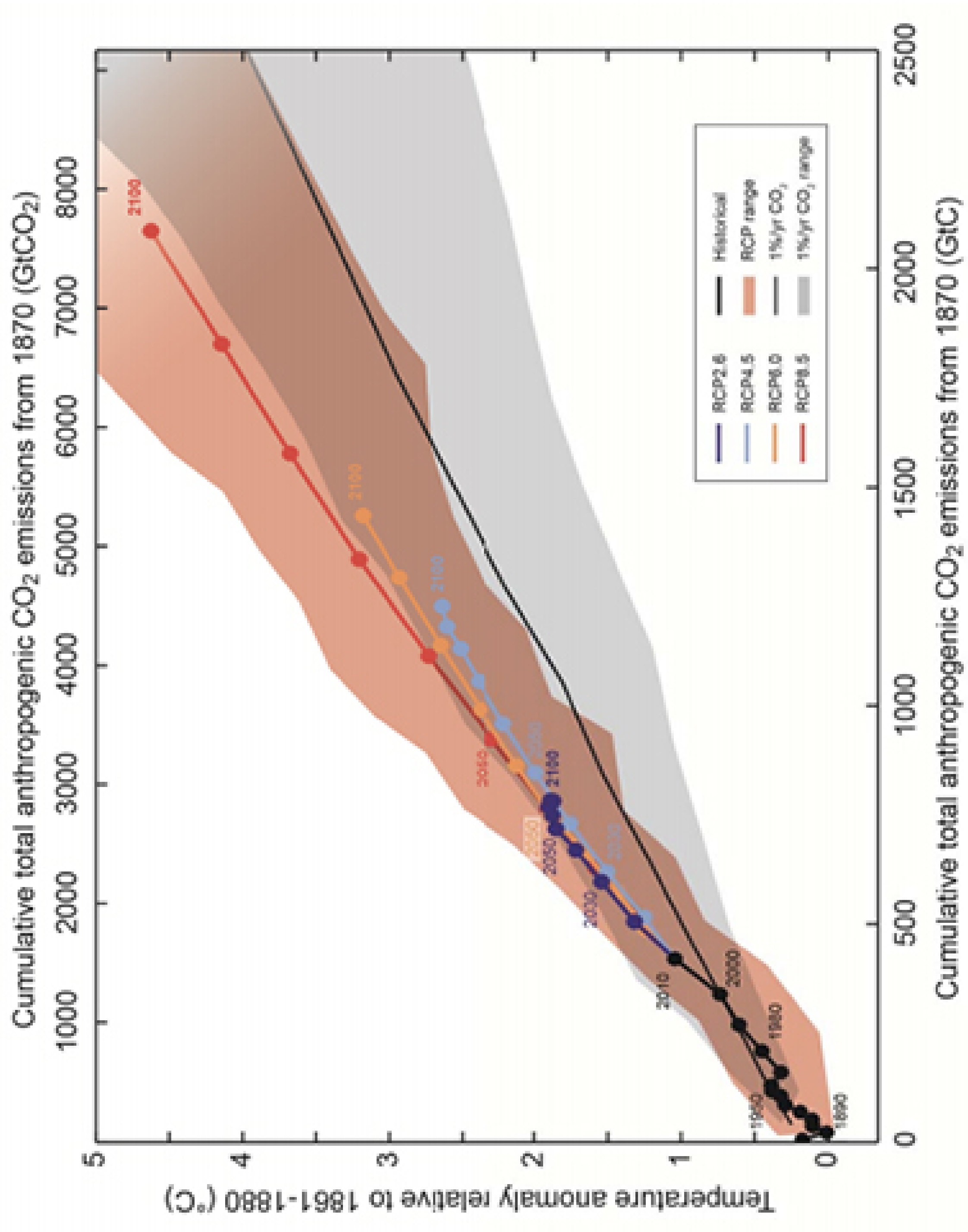

Figure. 4.1: Cumulative anthropogenic carbon dioxide emissions (atmosphere, land and sea) since 1870. Courtesy, IPCC

from nearly 6 billion hectares in the pre-industrial age. Clearly this is too tough a target. Roughly half those emissions are estimated to have occurred since 1990, the target cut-off of the original Kyoto Protocol. This, per our calculations above, require only increasing forest cover by less than 43 percent - essentially approaching the same wood cover as existed in the pre-industrial age. This is perhaps an achievable goal. Clearing of forests to grow food predates the industrial age by quite a long time.

The IPCC's 5th Assessment quantifies the maximum that Earth can take in terms of temperature rise: this is 2 degrees C above the pre-industrial temperatures. Their current urgency is to stop the rise of carbon emissions before they essentially double the cumulative rise since 1870. Some nations are more ambitious, seeking to limit rise to 1.5 deg. C above 1870.

On the other hand, as discussed in Working Group 3 and summarized elsewhere in this report, sequestering carbon is not the only way to stop and reverse Global Warming, and particularly the sea-level rise that is its most visible symptom. Reflecting a small part of sunlight (insolation) before it gets scattered and absorbed by Earth, is perhaps quite an effective short-term approach, until reforestation and measures to cut emissions can take hold for the longer term.

4.2 Recapturing tree cover over agricultural and residential land

People clear trees for three reasons. The first is to make space for their homes ad roads, and then for their gardens and their crop fields. The second is to get wood to chop and burn as fuel. The third is to chop up and use in construction of their homes and feed their industries. The 2nd and third uses can be made sustainable, with usage less than growth. The first however is controversial. What happens to agriculture if the fields are converted to forests with tall trees? The answer to this is as follows:

1. Given that the objective is to have tall trees for forest cover, and not so much any dense undergrowth, orchards and other commercial tree-growth is acceptable. Certainly not all areas nor all farmers can benefit from this.
2. Vertical farming (see Fig. 4.2) offers a technological solution that has been adopted in countries with shortage of land area, and harsh climates. These grow large amounts of food efficiently by providing light, water, air and nutrients with controlled temperature and humidity. Energy is required in plenty, and is

a strong component of the cost.

3. Vertical farming does not work yet for grain cultivation on a large scale, so grain cultivation will have to be on relatively flat surfaces open to sunlight. However, with technological investment, the amount of water and soil needed, and the means for delivering those for grain plant growth, the means for supporting plants and harvesting grain, can all be made much more efficient. There is a large investment of energy and capital needed for these, so it must be a gradual shift unless a massive increase in grain yield per unit area can be shown.

4. Research by Professor Ganti's group at the University of Oregon looks at biomass utilization, biofuels, and wastewater treatment technologies focused around nutrient-energy-water nexus could be interesting to the audience. In particular, they have a low-cost wastewater treatment technology that requires 90% less electricity compared to conventional WWTP and produces algal biofertilizers. We have conducted greenhouse studies in the last two years using the algal biomass from the pilot plant (200L/Day). This technology is claimed to be ready for scaleup to commercial scales and I have discussed this with some of the scientists at CSIR-NBRI, Lucknow. They also work on Agrivoltaics projects, where they are investigating growing tomatoes under solar PV cells. this strategy reduces water usage (up to 50%), increases crop yields (due to the optimization of incident solar energy), increases the effectiveness of the solar panels (Due to cooling effects of the evapotranspiration) and increases the resilience of the farmers. This is similar to efforts in other parts of the world, including in Anand Agricultural University but with much depth into soils and crops.

5. The recycling of grain plants can be improved. Already in North India, around New Delhi, there is an experiment with synergy between the hay disposal and cattle-feed production, that is projected to slash the emission of smoke from open hay burning that is blamed for much of New Delhi's extreme air pollution. Synergy with biogas and bio-fertilizer extraction could yield greater reduction in the amount of Greenhouse Gases such as methane emitted into the atmosphere.

6. On Kerala in 2019, legislation requires planting of a mango tree or jackfruit tree with every new house-building permit issued. These are large spreading trees with long lives and continued fruit yields.

4.3 Sacred Groves: The Ancient Impetus for Forest Preservation

Many communities around the world have an ancient tradition of preserving at least a grove of forest as a sacred space. Socio-environmental experts have been attempting to support and build on these traditions to restore forest cover.

4.4 Rally For Rivers: Erosion Control

An interesting twist on reforestation is the Rally For Rivers initiative from the ISHA/Sadhguru foundation. This aims to plant trees along river banks to control topsoil erosion and silting-up of rivers. They have released a Draft Policy Recommendation titled 'Revitalization of Rivers in India'. The main thrust is to supplement crop based agriculture with tree based agriculture as a way of reversing soil erosion. Many case studies from across the world are documented.

4.5 Garbage Disposal

Efforts at reforestation will be defeated if green and forested areas are allowed to degnerate into garbage/sewage dumps as appears to be happening even inside the most advanced institutions of higher education in India. Strict controls and enforcement of severe penalties for illegal garbage dumping appear to be essential. A major culprit is the construction industry, both formal and informal. All over India, it is common to see piles of rubble, stacks of bricks, demolished concrete, all mixed with glass, plastic and plastic bags of chicken parts and worse, adorning even city streets, not to mention any area left untended. There is no excuse for this; removing these and forcefully preventing further installments is absolutely essential. Equally, viable means must be provided to dispose of all these in real time in future. Concrete debris is perhaps the toughest problem, requiring landfill access if not expensive high-power grinding plants. Transporting these to shore up eroding hillsides and seashores is one option that could be carefully considered; again, the loading, unloading and transport costs must be paid, perhaps initially using revenues from fines imposed on wilful violators.

In the urban areas, regular garbage collection and disposal is a must. These could be privatized to improve the efficiency over the systems whose record of effectiveness is poor. In rural areas as well, local collectors can take garbage to sorting/collection stations for removal to larger plants. Modern society discards a great many items that do not quickly biodegrade: thus systematic garbage collection and disposal is a must even in rural areas. In any event there must be strict, enforced bans on dumping onto open ground and particularly into water bodies, rivers and the ocean. Without completely stopping the influx of garbage, efforts to clean up India are bound to fail.

The economics of recycling and proper disposal must be revisited with thoughtful initiatives. While privatization of this industry seems an obvious course, the business plans of these companies are often borderline at best (their input is after all, considered devoid of value!!) so that external revenue is essential. The service component of their business must be value significantly higher, and this revenue must come from government at all levels. For instance in the city of Atlanta, USA, intense efforts at recycling started many years ago, driven by the alarming growth of waste disposal 'landfills' that started becoming hills, with continuous burnoff of flammable gases. Recycling became more sophisticated and started accepting glass and plastic in addition to aluminum cans and paper. Efforts were driven towards ' single-stream recycling' to minimize the difficulty in pre-sorting and collecting various bins in mult-stream recycling. However, recently the service providers have refused to accept glass - a large component of recyclable materials from the jars in which beverages, pickles, jams etc are purchased. The glass shatters, and the shattered pieces mix with the rest of the waste. This damages the processing machines. A suitable solution is yet to be found, despite the fact that glass is a useful recyclable product. In India in the distant past, the ' glass-and-paper man' used to come to homes to collect glass and newspapers, trading them for alumnium pans if not cash. These practices may have to be revived as the automated large-scale solutions are not necessarily proving to be viable.

Plastic can be converted to many useful products, and this is a subject of ongoing projects. Examples are construction materials used to build the toilets coming up all over India, as well as other constructions, or to mix with road-building material as a way to control cracking and erosion of roads in the intense monsoons. In the floods of 2018 in Kerala, newspaper photos showed bridges filled to a depth of a foot or more in plastic bottles, as floodwaters receded. This may have been a result of a particular bottling plant or plastic bottle disposal area being flooded, but there is rising concern. Initiatives to clear beaches and the coastal sea of plastic bottles, could perhaps be combined with conversion plants to produce materials to shore up the beaches as erosion increases with rising sea levels.

4.6 Wastewater Treatment

Conventional wastewater treatment processes are energy and maintenance intensive. Microbial activity in the secondary treatment step demands energy-intensive aeration, accounting for 40 - 75% of total plant energy costs, and CO2 emissions. The secondary treatment is also very sensitive and failure-prone. Mahapatra and Murthy [6] describe a low-cost wastewater treatment technology that requires 90% less electricity compared to conventional WWTP and produces algal biofertilizers. They have conducted greenhouse studies in the last two years using the algal biomass from the pilot plant (200L/Day) with success. Their Multimodal Algal-bacterial treatment/cultivation Bioprocess (MAB) is based on cascading biological processes that involves an array of microbes working as a function of redox (Anaerobic-Microaerophilic-Aerobic). MAB enables efficient nutrient removal, and recovery as algal bioproducts. They claim that this enables efficient processing of municipal wastewater, also delivering bio-fertilizer.

4.7 Reversing the Shift Towards Animal Protein

Around the world, as societies become more affluent, there appears to be a shift towards consumption of animal proteins. This is not necessarily a healthy trend. On the one hand, the rise in captive cattle and poultry populations causes a great deal of the methane emissions into the atmosphere. On the other hand, there is increasing evidence that diets derived from animals aggravate health issues, notably diabetes and cardiac health. Warnings numbered f and g from climate scientists deal with the biomethane issue.

However increased demand for agricultural products in turn demands more use of phosphorus to assure soil health. India must import phosphorus, from relatively less stable international sources.

Chapter 5

Conquering the Annual Flood-Drought-Famine Curse

5.1 Prelude

One focused project that has developed out of these Working Groups is the common interest in tackling this perennial problem. The Monsoons are the dominant Climate and Environmental feature from the perspective of people residing in the Indian subcontinent and its neighborhood. The SouthWest Monsoon starts somewhere north of the equator between East Africa and India, and sweeps north-east, arriving around June 15 in much of southwest India and Sri Lanka, followed shortly by north India, Pakistan and the Himalayan watershed. The Northeast Monsoon arrives in late November/Early December, again in Sri Lanka, eastern India, Bangladesh, Myanmar and Thailand, again riding up against the barrier of the Himalayas and their eastern outcrops. While the SouthWest Monsoon brings a buge amount of rain, it is more or less gentle compared to the frequent development of cyclonic storms in the Bay of Bengal as part of the North East Monsoon. Both Monsoons bring plenty of water to the Himalayas, with some falling beyond. Flooding in Assam can occur from both, as the Brahmaputra River and its tributaries bring water from the northward slopes of the Himalayas and southern Tibet, through a gap in the mountains.

The mountains are the dividing features. The Western Ghats of south/west India, the Vindhya mountains, and of course the Himalayas, constitute massive natural barriers, and watersheds. The Himalayas also provide an immense water-storage system as the monsoon precipitation freezes in the ice fields.

In the summer, melted snow from the Himalayan slopes brings water to the otherwise dry parts of the north Indian plain, the Ganga and Jamuna rivers, and the Indus/Sutlej system in Punjab and Sindh. There can thus be floods in summer, and this water is absolutely vital to agriculture for the densely populated plains.

But other than the monsoons, there is little rain in most of India. By February, the heat builds up. By April/May there are Heat Waves. By early June all eyes turn skyward in hope. If the monsoon is delayed by even a couple of weeks, disaster can result. And in recent decades, with uncontrolled congestion overrunning the sluggish advancement of urban infrastructure, one finds that even a 10 percent increase in average rainfall, and a few incidents of sustained rain for a few days, can bring massive, devastating floods - not only to the flat plains with the swollen rivers, but to the huge urban centers. Mumbai, Chennai, Kochi, Dhaka, have all seen extreme events in recent years. As for broader areas, Pakistan was deluged by the Indus a couple of years ago. Assam was devastated in mid-2018. Bangladesh gets hit nearly every year. Kerala, and south-west Karnataka, saw floods unprecedented in the last century. There is no reason to believe that next year will be different. Or perhaps the next.

All of which means that drainage has to have immense capacity, to prevent India drowning in floods. Which is the other side of the problem.

What if the monsoon brings less rain than usual, or the wind patterns are a bit off? Drought stalks the land. Images of dry/cracked earth where there should be green fields. Starving rural residents. Mothers carrying kids on their hips, a load on their heads, and trudging miles in search of food-for-work opportunities.

The particularly cruel note is that devastating floods that open up drainage channels and strip vegetation clear off river beds and banks, also drain the water fast and leave the groundwater tables low, as drought grips the land.

5.2 River Interlinking Proposal

For many decades people have dreamt of a north-south and east-west river interlinking network. The best known is the 'Ganga-Kaveri Link' proposed by Irrigation Minister Dr. K.L. Rao in 1972 which was supposed to bring the snow-melt floodwaters from the Ganga in the northern plains, down to the arid Kaveri in Spring before the monsoon. However with receding glaciers, and Chinese dams controlling flow in the Brahmaputra and possibly the Ganga, this is less viable. In 1977 Capt. Dastur proposed a Garland Canal around Himalayan, Central and Pensinsular India. In 1980 the Central Water Commission formulated the National Perspective Plan for Water Resources Development, envisaging transfer of warer from surplus basis to deficit ones. This 'Proposed Inter Basin Water Transfer Links' shown in Fig. 5.1 has two components: the Himalayan component and the Pennsular Component.

The NPP website gives several recommendations. On the problem of Kerala experiencing floods during the Southwest Monsoon while Tamil Nadu, just across the Western Ghats. stays arid, the site has this to say:

> **Part-IV Diversion of West Flowing Rivers** The narrow coastal plains of India along the West Coast stretching from Kanyakumari in the South to the Tapi in the North have special and distinct features both in topography and water resources. Bulk of the rainfall is contributed by the South-West monsoon and a good part of it precipitates on the Western side of the Western Ghats because of the high mountains in this region. The rainfall varies from 1500 millimetres to 5200 millimetres. The narrow coastal belt has numerous rivers and streams which empty into the Arabian Sea. The West flowing rivers in Kerala alone carry an average annual flow of 62 million acre feet and those in Karnataka 50 million acre feet. All the waters that flow down the rivers cannot be utilized for several practical reasons.
>
> The problem in Kerala is, therefore, one of storage and conveying water from one river basin to another and transferring the surplus portion of it from west to east for irrigation in an economical manner. Fortunately, there exists a possibility of such economic transfer along the Kallada river ridge. A short tunnel in the upper reaches of the Kallada river will enable transfer of water from east to west by means of a tunnel. Other possibilities could also be studied.
>
> The construction of a canal along the west coast at about elevation of 500 feet MSL should also not present any insurmountable difficulties. It could be contour canal in some reaches, cut and cover section in a few parts and pass through tunnels in some difficult sports. A few storages may also be feasible which could feed the inter-linking canal and also release water for Kerala lower down. The capacity may be planned to meet all the requirements of the Kerala areas uncommanded by other projects, and for transfer of some waters.
>
> **Benefits and Phasing** The overall scheme is estimated to cost approximately Rs.50,000 crores and would give additional benefits of 25

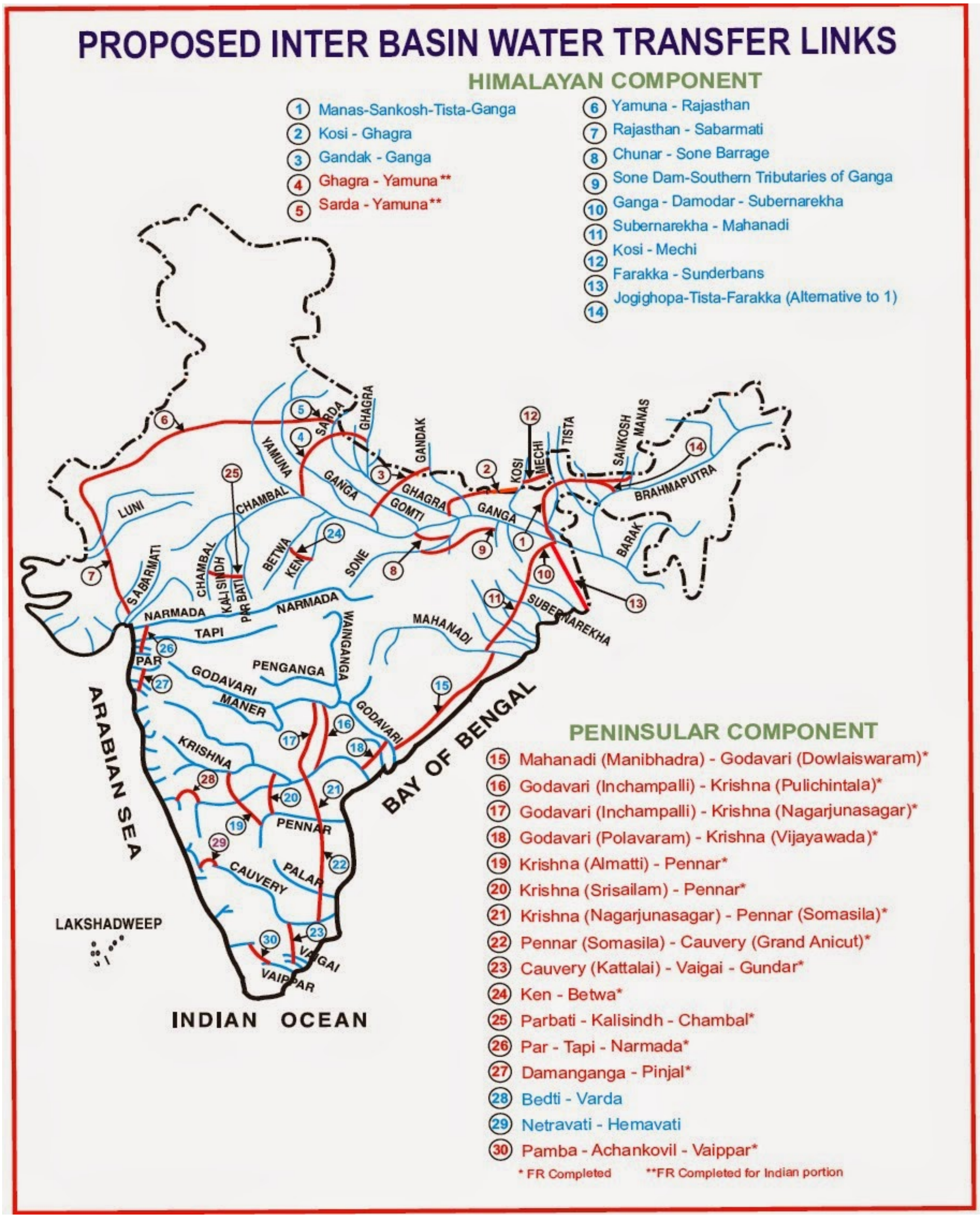

Figure. 5.1: River Interlinking Plans, Govt. of India

> million hectares of irrigation by surface waters, 10 million hectares by increased use of ground waters and generation of 40 million kilowatt of power, apart from benefits of flood control, navigation etc. The distinctive feature of the scheme is the transfer of water essentially by gravity and only in small reaches by lifts not only technically feasible but also economically viable when compared to the present cost of development of irrigation facilities. The technology proposed in this scheme is already known and tried successfully in our own country and does not involve experimentation or research. Besides, it is capable of planning and implementation entirely by the Indian experts without any foreign assistance.
>
> Initially, priority is proposed to be given to the development of storages and gravity links in order to exploit maximum benefits of hydro-power generation in initial stages and at the same time extend irrigation benefits to large areas. This could be later on followed by lift components.

We are not able to see evidence of any projects implemented or started, on this website.

However, the site reports on the great anticipated benefits of the National Perspective Plan:

1. 25 million hectares of irrigation from surface waters, 10 million hectares by increased use of ground water, totaling to 35million hectares.
2. 34,000 MW of hydro-power generation.
3. Mitigation of Droughts
4. Flood Control
5. Domestic and Industrial Water Supply
6. Navigational Facilities
7. Employment Generation
8. Fisheries
9. Salinity Control
10. Pollution Control
11. Recreation Facilities
12. Infrastructural Development
13. Socio Economic Development

One wonders how to get these projects, visualized back in 1980, really moving towards implementation. There is some indication that the agency is averse to anything other than the river linking.

5.3 Proposed Approach

Clearly India has no lack of Planning organizations, that generate numerous conferences and reports. What is in short supply is any evidence of actual work. This calls for a focus on small, local projects, but as part of an overall strategy, worked out in fine-scale detail. At the top-down level, this calls for modification of the present strategies to bring in planning that goes down to fine-scale detail in vertical streams, proceeding to swift deployment.

While big dams and national-scale canals cannot be done in this manner, some ideas are obvious candidates. One is local rainwater harvesting, quickly connected to allow the overflow to be stored at the lowest points in the locality. This is an extension of the 'teppekulam' that used to be in the center of many TamilNadu towns through the 1960s. In Kerala these were called 'Chira', again usually a square depression bordered with sandstone/granite steps that went down to considerable depth. Generally these were built around natural springs as well, so that they did not run dry in summer although the level might go rather deep.

On a larger scale, urgent attention should be directed to minimal flood-alleviation projects, using pipelines and tunnels through the Western Ghats, connecting from the upstream ends of dam reservoirs. These could be mostly gravity-fed, given that the reservoir at peak level is a few thousand feet above sea-level, while the plain on the eastern side is much lower.

The Prime Minister of India, Shri Narendra Modi has sent a letter to every Sarpanch in India, citing the urgency of conserving Monsoon water. The English version of this letter is reproduced in Figure. 5.2. The steps outlined there include

1. construction of check dams and embankments along rivers and streams
2. bunding in fields
3. digging and clearing of ponds
4. tree plantings
5. building reservoirs

The PM emphasizes building a large water reserve.

सत्यमेव जयते

प्रधान मंत्री

Prime Minister

New Delhi
08 JUNE, 2019

Dear Sarpanch ji,

Greetings.

I hope that all my brothers and sisters in your Gram Panchayat are doing well.

My heartiest congratulations to you for enthusiastically participating in the recently concluded mega-festival of democracy and electing a government committed to building an empowered India. The building of a New India is possible only with your active participation and contribution.

The monsoon season is around the corner. We are fortunate that God has blessed our country with adequate rainwater. But it is our duty to respect this gift from nature. This is why, as soon as the monsoon begins, we have to make arrangements to conserve as much rainwater as possible.

Let us come together for construction of check dams and embankments along rivers and streams, bunding in fields, digging and cleaning of ponds, tree plantation, building reservoirs etc. for the storage of rain water, so that the water of the fields gets conserved in the fields, and the water of the village gets conserved in the village itself. If we are able to do this, then not only will the crop yield increase, but we will also have a large reserve of water, which we will be able to utilize for many purposes in our village.

I urge you to take a meeting of the Gram Sabha to read this letter out and discuss these issues further with the community. I am confident that we will make every effort at the rural level to improve our village environment by collecting and conserving every single drop of water.

Just as you made Swachhata a successful mass movement by making cleanliness a people's movement, I urge you to also lead this water conservation campaign and make it a people's movement as well.

Let's make the impossible possible and contribute to the creation of a New India.

Yours,

(Narendra Modi)

GRAM PANCHAYAT- ADILMAGIRI
BLOCK- CHOKPOT, DISTRICT- SOUTH GARO HILLS
MEGHALAYA

Figure. 5.2: Letter dated June 8, 2019 to every Sarpanch from Prime Minister Narendra Modi urging water conservation measures

5.4 Preview: Flood Predictor

Our proposed solution has broad long-term aspects, as well as very specific short-term projects.

1. A GIS (Geographic Information System) based water-logging App that people can use to predict worst-case flooding from a given amount of rain. This is doable with 100-meter spatial resolution, and water levels down to 1 meter. It can be refined for local use with locally-measured data and updated maps.
2. The GIS-based software, enhanced with a Continuity Equation solver as well as a time-resolved hydrodynamic solver, to predict the evolution of flooding - away from immediate river vicinity.
3. The above, enhanced with rudimentary river flow models.
4. The above, enhanced with the actual resistance characteristics and soil absorption/ evaporation models coming from local measured data.
5. A region-wide GIS model, from which a network of water channels is developed.
6. Storage points identified on the network, starting with major dams, and going down to local water retention tanks in villages and towns.
7. A set of tunnels/pipes to cut across mountain ranges in several places, and connect between storage locations, to relieve pressure on dams in the rainy and dry seasons.

We have started work on items 1 through 3 in an informal collaboration involving teams at Georgia Tech, Amrita University, and a corporate partner in Kochi. Further work on items 4 on down is being contemplated.

Looking at news items, we note that there are commercial software packages that have been developed for use in major cities where there has been flooding in the US. These are other vendors have been contracted by Indian government entities. The technology level in these software packages appears to be less than those in software developed for the US government by federal agencies. However, those are supported by centuries of systematic data acquisition and cataloguing by the US Army Corps of Engineers and other agencies.

We point out that the usual approach of going to partner with a foreign technology provider, and buying an expensive software set is not a good approach here: the basic software is simple enough to be an undergraduate 1-semester project, while the full-blown software can use its own capabilities only if filled up with LOCAL, up-to-date data. For instance, a spatio-temporally distributed model for absorption and evaporation of water is only as good as the local data that are put in, and how well the rain history is recorded, to predict saturation. Similarly, river flow models are only as good as the actual measured data on river flow rates and levels, that enable one to back out the resistance coefficients.

5.5 Broader Questions

Several issues related to the above have been raised by others, who suggest some commnalities betwen the incidents of major flooding in urban areas. We also note that in every major catastrophe, post-mortem analysis suggests opportunities for decisions, that were missed. The blame is laid on the top administrator/lawmaker, particularly by their political opponents. However, the basic issue may be the inability to conduct timely, accurate predictions that support decisions.

For instance, take the example of the recent floods in Kerala. Kerala has a chronic shortage of electric power, with rolling blackouts a common feature throughout the year even in the urban areas. Hydroelectric power from dams is a major resource, and so maintaining a good water level through the summer until the next rains, is critical. For this reason lawmakers are very reluctant to release water during the latter part of the rainy season. In 2018, after a relatively strong monsoon through June and July, dams and rivers were quite full, and the flatlands were saturated. In the first part of August, there was an unprecedented period of sustained heavy rain over most of the state, attributed to a depression that stayed stationary over the Arabian Sea. As inflows to dams rose alarmingly, dam engineers requested permission to release water. However, the Minister was reluctant to release water and reduce dam levels so late in the season, fearing shortages next May. Meanwhile the rain only grew stronger. Concerns rose about the safety of several old dams, where maintenance had not kept up with the required standards - as the engineers well knew. Finally, after nightfall one day, the orders went out to release dam waters - and the ancient shutters were opened wide. The rivers and streams were already full and overflowing, and so where the saturated fields, with water already at street level. The dam outflow could not be accommodated in the river channels, it flowed right across the land. Water levels rose by several meters, inundating homes and businesses in areas where flooding had not been seen for over a century.

How could this have been averted? Perhaps by providing much more timely and accurate predictive data. Some blame was ascribed to poor rainfall prediction, but the reality appears to be that there was little sophistication in the modeling of how dam-release water would impact downstream areas. Thus it appears that rudimentary predictive ability with temporal and spatial resolution, is the first essential tool for the repertoire of dam engineers, administrators, as well as the general public. Perhaps media-based forecasters armed with such tools could play a competing and hence increasingly accurate role.

Chapter 6

Response To Climate Change

There is global acceptance today that the Climate is changing at an alarming rate. The polar ice caps are disintegrating: the long-sought Northwest Passage around the Arctic Ice Cap is now wide open. Many islands, hithero under thick ice, are now bare of ice, so that competition for oil and other resources is heating up. Large chunks are breaking off the edge of the Antarctic Ice Cap and melting. Mountain glaciers are receding. Permafrost in the Canadian and Siberian tundra is melting, bubbling up immense amounts of methane-rich natural gas from the decayed vegetation buried under the permafrost for millennia. The oceans are rising. many island communities, and the continental edge where most of the world's major cities are located, are facing inundation. More intense storms, and various Extreme Weather events, are getting increasing publicity, if nothing else, leading at least to the impression, and probably the reality, that they are increasing in frequency and intensity - and occurring in densely populated areas. The rates of temperature rise and sea-level rise are said to be rising, feeding on each other. The latest estimate from the Intergovernmental Panel on Climate Change (IPCC) is that the Earth's atmosphere is retaining heat at the rate of 2.92 Watts per square meter of Earth's surface area. And that number is rising.

Scientists claim that much of this increase is Anthropogenic in origin, that is, due to human activity. They call for measures to slow down the rate of increase - which will at best buy a little more time. We suggest that it is feasible to actually stop and reverse the anthropogenic part of Climate Change through focused, determined effort. The most obvious way is to remove heat-retaining Greenhouse Gases (GHG) such as Carbon Dioxide and Methane from the atmosphere. The best way to do this is reforestation, which sequesters the carbon in the form of trees. However, reforestation takes decades, which may simply be too slow. To buy time, there is a rising clamor for ever-tighter laws and regulations that reduce human activity. This has immediate economic impact, and in many cases, life-and-death consequences, so this is an extremely controversial topic.

6.1 Controversial Nature of Carbon Regulation

In talking to well-informed, thoughtul and caring people in India and other parts of the world, we notice that the terms Sustainability and Ecological Cost, bring out some angry reactions. There is a reason for this.

The word *Sustainability* has today come to be synonymous for *Reducing Emissions of Greenhouse Gases*. Congratulations are due, mostly to the European Union, for their Communication Skills in making this happen. They have most of the world jumping up and down about Climate Change. Coincidentally, the steps that we are urged to take, are ones where we will have to turn to Europeans for expertise. Someone with a 40-year memory might remember several other burning issues: Air traffic curfews to reduce aircraft jet engine noise and buy European-led high-bypass turbofans with thrust reversers on the fans, not the hot core flow. If you have sat at an Indian airport waiting for the 2AM boarding time to a Europen transit airport, the above explains why. Choloro-Fluorocarbons that were punching an Ozone Hole in the atmosphere, threatening to allow UV to burn up people lying out on beaches in their birthday suits. That eliminated most of the efficient refrigerants, and we are now going towards Carbon Dioxide as the only acceptable refrigerant/air conditioner fluid. European luxury car makers are in the lead. Total Quality Management and ISO2000. Products that came from companies that had not paid the $100K consulting fee to get that, were heavily taxed or banned from Europe. Efficient Manufacturing, likewise: if you used castings that used sand in a foundry, your products were probably banned or taxed punitively. While France has led the world with 80% its electric power coming from nuclear reactors, the rest of Europe has vehemently rejected nuclear power, instead going with wind turbines and solar photovoltaics. They would urge the rest of the world to do so as well - though there is no evidence that the ever-larger behemoth wind turbines, each a monument to the concrete industry, have any hope of breaking even on costs, even with subsidies from punitive and retro-active taxation against the competing carbon-emitting fossil fuel based power generation industry.

Around 2007, the Carbon Market was being hyped up as being about to surpass the world's stock markets as the largest global trading entity. The market price of saving a ton of CO2-equivalent GHG emissions, went from around $40 then, to around $2 a year later, and has not quite recovered. If you read the PowerPoint Presentations coming from Africa, along with those emanating from Europe and East Asia and North America, in the runup to the Copenhagen Summit of the UN Framework Commission on Climate Change (UNFCCC), you would see the very sharp divide between priorities. And India, at least in the editor's opinion, has realities that, like it or not, resemble those of Africa far more than those of Europe and North America, at least if one takes one's eyes off Bollywood movies and looks around. Then again, Bollywood movies never show anyone evn heading towards a toilet/restroom - probably because they didn't have any. They were perhaps modelled on the *tres elegante* Paris Charles De Gaulle airport where that was apparently the case even in early 2019.

At the other extreme, college students in Texas and California universities in 2019 are learning that *"The IPCC is bullying America to cut emissions and destroy our economy, while turning a blind eye to the EGREGIOUS behavior of India and China in emitting greenhous gases!"* This echoes the modern 'Science' argued on distinguished discussion fora in the USA by self-proclaimed Apollo Veteran Engineers and others claiming to be environmental expert Scientists. A cursory glance at the data published by the US Department of Energy, shows that India emitted, per capita, around 1.7 tonnes of CO2 equivalent per year. China 7.2. The United Arab Emirates 23. And the United States of America, a whopping 16.5. Even correcting to total emissions rather than per capita, it is seen that very strange arithmetic would be needed to arrive at the conclusions being taught by the self-proclaimed Scientists in the USA.

On the other hand, we will point to the danger advanced by some astronomy-credentialed experts of a different political color. This holds that the Solar System is currently moving through a part of the interstellar clouds of our Galaxy, that has a slightly higher density. Accordingly the Bow Shock formed as the solar system hurtles through at a high supersonic speed through this gas cloud, causes some heating of the cloud. Hence the small rise in the net heat retention in our atmosphere, as the balance between absorption and radiative loss to the deep Space background is slightly altered. One day the Solar System will come out of this cloud into much less dense, freer Space. The temperatures will suddenly start falling, plunging us towards the next Ice Age.

An Insight Report generated with support from McKinsey & Company [**?**] for the 2018 World Economic Forum pointed to some stark facts. Although most of the 114 nations surveyed were transitioning their energy portfolios from fossil to renewables, the performance in environmental impact was the poorest of the indicators studied.

Particulate emissions were actually up over previous years.

Elsewhere in this document we will also present technical and policy arguments on how to not just slow down or stop, but *reverse* Global Warming and Sea Level Rise, in a totally feedback-controlled and reversible maner. Thus we will argue that given the will and fairly moderate resources, Climate Change can be reversed completely, to whatever level we want, even without reducing concentrations of GHG. This can buy the time needed for reasonable GHG-reduction measures to take effect.

With that outrageous Introduction, let us remember that Renewing Mother Earth has far wider objectives and implications than just the controversial and acrimonious debates over Global Warming. We will try to lay out paths to address all of those. The problems are massive, but so are the opportunities.

Chapter 7

Prior Work

Let us survey some of the thinking on the topic of Renewing Mother Earth. Some want to call it Rejuvenation, but we will for the moment stick with Renewing. This implies reversing the visible and jarring signs of development, eliminating anthropogenic toxins and impurities from water and the earth, re-creating green cover over formerly denuded forests and hillsides, for example.

Prior examples include

1. Impact of rural electrification as nations developed.
2. Financing of rural enterprise, particularly those leaging to non-agricultural employment.
3. Reversal of the DustBowl situation that existed in the American midwest and prairie in the 1920s.
4. Mandated greenery and grass embankments along highways.
5. Replenishment of aquifers.
6. Reforestation
7. Cleanup of rivers and lakes.

7.1 Discussions on Climate Change

Karl [3] wrote about Climate Change. Hirschfield [7] writes about the leaders of the Sunrise Movement, who claim 'guerrila tactics' in seeking to influence governments on Climate Change. Sunrise leaders argue that there is simply not enough time left, to continue at present rates of progress towards slowing down, let alone reversing, the disastrous effects of Climate Change. They are viewed as radical even in today's US Democratic Party. Leaders describe being deeply affected by extreme events such as the disastrous flooding in Chennai a few years ago. This made them realize that while leaders in the USA and elsewhere were talking about Climate Change as a danger that is 30 to 40 years away, the disasters are occurring right now. Their movement has joined hands with those of people who have gained visibility through social media such as US Representative the Hon. Alexandria Ocasio-Cortex in the USA. On the other hand, experienced political leaders argue that nothing can be done at the drastic pace sought by such campaigners. One dichotomy is caused by the debate over the cost of available approaches. Those arguing for drastic action are demanding taxes and other regulations that are viewed as being far too extreme to have any chance of passing as laws in democratic societies. However it is clear that even in the USA, the level of attention being given to Climate Change issues in the political arena, is rising fast.

7.2 Rural Electrification

Pearce and Webb [8] did a reappraisal of rural electrification in developing countries in 1987. Barnes [9, 9, 10] studies the impact of rural electrification on agriculture and rural growth. He studied how access to electricity affects rural life, and identifies electrification as the challenge for economic development. Sinha *et al* [11] studied the economic factors in planning decentralized grid electricity for rural India. Ranganathan [12] studied the long-term impact of rural electrification in Uttar Pradesh and Madhya Pradesh. Van Campen *et al* [13] reviewed solar photovoltaics for sustainable agriculture and rural development. Cecelski [14] discussed current thinking and major activities in energy, povery and gender in enabling equitable access to rural electrification. Chakrabarti [15] presented an island case study about a rural electification programme with solar energy in remote areas. Shui [16] correlated economic growth to electricity consumption in China. Chaurey [17] presented technology and policy insights into electricity access for geographically disasdvantaged rural communities. Modi [18] reported on improving electricity services in rural India. Cabraal [19] discussed productive uses of energy for rural development. Bhattacharya [20] studied whether rural electrification is indeed the answer to the problem of energy access for poor people in rural India. Hiremath [21] reviewed decentralized energy planning, modeling and application. Kanagawa [22] analyzed the improvement in energy access and its socioeconomic impact in the rural areas of developing countries. Nouni *et al* [23] presented an approach to identify potential areas for decentralized electricity supply, in providing electricity access to remote areas in India. Pachauri [24] reported on the transition in household energy in India and China. Hiremath [25] extended the prior study to the scope, relevance and applications in India. Moharil [26] presented a case study of solar photovoltaic power systems at Sagardeep Island, India. Kirubi [27] wrote about the effect of community-based electric micro-grids in contributing to rural development in Kenya. Liming [28] compared strategies in China and India in financing rural renewable energy. Kumar [29] reviewed the current status and potential of renewable energy in India. Ekholm [30] studied determinants of household energy consumption in India. Dinkelman [31] studied the effects of rural electrification on employment, with new evidence from South Africa. Buluswar [32] set out a roadmap for universal electrification in India using solar mini-grids

The editors of the Economic Times [33] argued that rural power is more than just laying power lines. Nagesh Singh, the Consul-General of India in the US South-East [34] presented the realities, achievements and opportunities in the rural areas of India with respect to energy access.

7.3 Rural Finance

Prasad [35] studied the reactionary role of usurer's capital in rural India. Hazell [36] presented rural-urban growth linkages in India. Dev [37] presented evidence at a disaggregate level about non-agricultural employment in rural India. Repetto [38] revisited the issue of the "second India", discussing population, poverty and environmental issues over two decades. Binswnager [39, 40] studied in turn how infrastructure and financial institutions affect agricultural output and investment in India, and the impact of formal finance on the Indian rural economy. Fan [41–46] studied various aspects interlinkages between government spending, growth and poverty. They argued whether developing countries invest more in less-favored areas, based on an emprical analysis in rural India. Fan looked at targeting public investments by agro-ecological zone to achieve growth and poverty alleviation goals in rural India. They also looked at returns of public investments in the less-favored areas of India and China, as well as investment, subsidies and pro-poor growth in rural India. Lanjouw and Lanjouw [47] presented issues and evidence from developing nations, on the rural non-farm sector. Burgess [48] presented evidence from the Indian social banking experiment to argue about the merits of rural banks. Crebert [49] discussed the connection between the 'Ivory Tower' referring to academic research, to the 'Concrete Jungle' of urban life.

7.4 Biofuels

Pohekar [50] reviewed the dissemination of cooking energy alternatives in India. Gangopadhyay [51] studied how reducing subsidies on household fuels in India would affect the poor. Ravindranath [52] analyzed technical, economic and policy aspects of sustainable bioenergy alternatives for India.

7.5 Dustbowl Reversal and Mandated Greening of Highways

In the USA and many developed nations, rules on highway construction and maintenance require that grass or flowering plants be used to cover the roadside embankments. This vastly reduces dust blowing from highways as vehicle wakes drag over the surface. It also retards soil erosion and hence prolongs life of the roadways. Environmental rules on replenishing agricultural lands and regulating the number of harvests, sharply reduced and eliminated the immense dust storms that used to choke Midwest American cities during the Dustbowl era of the 1920s that followed a period of unregulated expansion in agricultural exploitation of land. These are notable successes by intelligent public policy, guided by science and implemented by engineering.

7.6 Reforestation

Reforestation was perceived to be important to reduce soil erosion and recognized to have an impact on rainfall. But in recent years, reforestation has taken on critical importance as the most obvious means of carbon recapture from the atmosphere. Publications include [53–57].

Ledig [53] argues for genetic diversity in planting forests to prepare for Climate Change, since there is large uncertainty about which species are likely to thrive. Thomas [56] study where are so few reforestation or afforestation projects under the Clean Development Mechanisms funded under the Kyoto Protocol. Zomer [58] did a spatial analysis of global land suitability for afforestation under the Clean Development Mechanism of the Kyoto Protocol, towards mitigating Climate Change.

They indicate that the complexity of project funding under the CDM is a factor. Leblond [59] looks at reforestation experiences in Thailand. One finding is that most reforestation occurured after forced evacuation of the area, and when those conditions evaporated, forests were cleared again. He argues that Forest Transition Theory emphasizes socially benign processes, which appear to be too optimistic. Salman *et al* [60] used a case study in Indonesia for an integrated analysis of forest policies and their impacts on landscape and lifescape dynamics. They found that in the case area in the past 26 years, the primary forest changed to secondary forest and shrubs, and then into dry land agriculture mixed with shrubs. The increased income of the local population came at the expense of the forest cover. They concluded that forest protection policies needed support.

On the other hand, Meyfroidt and Lamblin [61] report on the reforestation of the mountains of Vietnam. Here de-collectivisation of agriculture led to forest lands being turned over th local villagers. The result appears to be a strong resurgence of the natural forest, even when plantation tree cover is separated out. Nagendra [62] wrote about the drivers of reforestation, and appears to have concluded that more studies are needed in order to derive predictive models.

Aide *et al* [63] have studied deforestation and reforestation occurring in Latin America and the Carribbean over the period from 2001 to 2010 using remote sensing imagery of forest cover. They tried correlating the results to migrations, increased farming due to rising food demand, and reforestation occurring where the land was too steep for farming.

7.7 Terrace Farming

Terrace farming is prevalent in Southeast Asia's hilly regions. It was recognized early as a method to do farming, which requires retaining water over a large area, in regions where the ground is mostly sloped. However, besides retaining water and providing better exposure to sunlight, this also provides a barrier to soil erosion and runoff. On the other hand, sloped hillsides previously considered unsuitable for farming were now levelled into terraces with the trees removed. Early use of terrace farming concepts is reported from Israel before the Christian era [64]. Other works are seen in [65–67]

7.8 Replenishment of Aquifers

The issue of replenishing ground water has drawn serious attention. A few representative works are [68–70]

7.9 Cleanup of rivers and lakes.

Gaining in recognition and urgency around the world, cleanup of rivers and lakes is studied by [71–77]. The related field of removing toxins from groundwater, and the ground, is much wider in complexity and methods [78–94] Bernhardt [72] used confidential telephone calls to assess 317 river cleanup project managers' views on how projects were assessed. They found that ecological degradatio typically motivated restoration projects, but post-project appearance and positive public opinion were the most commonly used metrics of success. They concluded that "merely conducting and publishing more scientific studies will not lead to significant improvements in restoration practice; direct, collaborative involvement between scientists, managers, and practitioners is required for forward progress in the science and application of river restoration."

Hiscock [81] studied how ground water pollution could be attenuated by filtration through the banks. Kishimba [84] reported on the status of pesticide pollution in Tanzania. Kulshrestha [85] studied metal concentrations of PM 2.5 and PM 10 particles and seasonal variations in urban and rural environment of Agra, India. Lamers [86] discusses a case study from Northern Vietnam on pesticide pollution in surface and groundwater by paddy rice cultivation. Higa [95] has been advancing the concept of "Effective Microorganisms" (EM). Microbial inoculants have been shown to improve soil quality, crop growth, and crop yield. They provide viable alternatives for farmers to change from chemical based, conventional farming systems to more sustainable agriculture. Xu [96] reviewed the overuse of chemicals in agriculture, under capitalist pressures in China. Pimentel [91] looked at the environmental and economic costs of pesticide application, primarily in the USA.

7.10 Rainwater Harvesting

Rainwater Harvesting was practised thousands of years ago in the semi-arid regions where trading outposts of civilizations have been found - such as the well-known ancient cities of Mohenjodaro and Harappa near the Indus River, and the less-known but much larger Sarasvati civilization, well east of the Indus. Many communities even in relatively rainy South India had stone and brick-walled tanks that served as bathing and swimming lakes, as well as sources to replenish the water table that fed the wells that supplied most homes. While these were de-emphasized and allowed to run to ruin as Municipal Water was chlorinated and delivered through pipes from dams, they are now coming back in force. Building codes in many parts of the world including India dictate construction of rainwater harvesting from roofs either into tanks on the terrace or into underground tanks. This has multiple benefits. One is to replenish wells using rainwater rather the now-dubious urban groundwater which may be heavily contaminated. Another is of course to reduce the demand on scarce Municipal Piped Water whose supply may run dry for much of the day in major cities, and become very scarce in summer. A third is to reduce erosion and run-off into rivers during the rainy season, thus helping to reduce flooding.

Papers on the topic include [97–104]. It is interesting to note that private rainwater harvesting is illegal in parts of the American West, where the homeowner is not presumed to have the right to rain falling on their property! Pelek and Porporato [105] showed how to size a rainwater harvesting cistern by minimizing costs. Kurniyaningrum [106] used microscale topography to study the sensitivity of flow to depth of inundation, in the Krukut river in Jakarta, Indonesia.

7.11 Smart Village Initiatives Worldwide

Leary [107] Zavratnik discusses the history of Urban Regeneration initiatives, and emerging conceptualizations of urban regeneration. He aims to demonstrate "how locally-based regeneration continually adapts and manoeuvres within the structural constraints and opportunities presented by globalization and neo-liberalism".

[108] reviewed initiatives and practices towards Smart Villages. Digital technologies are increasingly used to address many challenges of rural life. They focus on European Union practices and show the parallels between the findings and insights from different regions. They argue that rural areas are not uniform, and that smart rural development has to be applied in combination with a location-specific approach. They present the cases of Slovenian pilot practices and support their argument by proposing the FabVillage concept. An example of diversity in approaches comes from comparing the US case in Wisconsin with EU thinking. The Wisconsin effort defines six smart growth goals: (i) creating new housing choices and opportunities;

(ii) making communities more accessible by foot; (iii) enforcing the sense of place in communities; (iv) preserving different environmental zones; (v) connecting new and the existent developmental aims; and (vi) more varieties in terms of transportation. The European Union meanwhile emphasizes application of the smart growth through a knowledge based economy. The case of rural Hungary shows that innovations in Agriculture brought self-sufficiency in food and more wealth, which in turn led to better education and healthcare facilities, and rising rural population. The digital technology dimension is important, but need not be the only driver. The smart label could also be intertwined with other dimensions, as in the case of SDGs. They conclude by presenting the pillars of the EU approach to Smart Villages:

1. Responding to depopulation and demographic change
2. Finding local solutions
3. Exploring linkages with small towns and cities
4. Accelerating the role of rural areas in low-carbon circular economy
5. Promoting digital transformation

The concern about depopulation of rural areas is worldwide. They point out a major difference between Europe and developing nations: In Europe, the basic infrastructure is already established, whereas, in some other un-developed regions, the infrastructure is yet to be established.

7.12 Conclusions

So we submit that there ARE ways to accomplish orders-of-magnitude advances in development through the mid 21st century, that are very different from what was done even at the start of the 21st century, in other countries, and even in India. Ways that will actually reduce the impact on the environment below what is encountered today. In other words, an HDI or 0.98 with an EF of below 2 hectares per person, is quite achievable.

The ways to do this may be uniquely Indian, because there is an excellent knowledge base still to be tapped. This comes from India's ancient memory base, going back thousands of years. A thriving economy with international trade existed, thousands of years ago, spanning the region from Hanoi to Haifa, and from Mongolia to the southern tip of Indonesia and the Phillippines. This was a very advanced economy for the time, it had some small cities, but the vast majority of wealth generation came from rural-based enterprise. There are numerous concepts from there, that can be applied intelligently today.

Chapter 8

Model Villages

According to The Urban Update, The Sansad Adarsh Gram Yojana Sansad Adarsh Gram Yojana (SAGY) has visualized a self-reliant Smart Village model that

> offers inhabitants increased opportunities for holistic growth apart from basic amenities.
>
> Inspired by the principles of Mahatma Gandhi, Prime Minister Narendra Modi launched the Sansad Adarsh Gram Yojana (SAGY) on 11th October 2014. The objective of the Yojana is simple. Each Member of Parliament (MP) is expected to adopt a village, ensure development of physical and institutional infrastructure in the adopted village and turn them into Adarsh or model villages. The ultimate objective is to develop three Adarsh Grams per MP by March 2019. Thereafter, five such Adarsh Grams (one per year) per MP will be selected and developed by 2024.
>
> Funding for SAGY will be raised through voluntary contributions at the local level. Additional resources will be tapped from programmes like Pradhan Mantri Gram Sadak Yojana (PMGSY), MGNREGA, Indira Awas Yojana, MPLADS fund, Centre and State Finance Commission Grants and CSR funds.
>
> SAGY envisages integrated development of the selected village across multiple areas such as agriculture, health, education, sanitation, environment, livelihoods, etc. It aims at instilling values such as gender equality, social justice, spirit of community service, eco-friendliness, local self-government, transparency and accountability in public life etc. in the villages and their people so that they get transformed into models for others.

> SAGY, launched by the Ministry of Rural Development, Panchayati Raj, Drinking Water and Sanitation aims to realize the vision of Gram Swarajya
>
> A Lok Sabha MP has to choose a Gram Panchayat from within his/her constituency while a Rajya Sabha MP has to choose a Gram Panchayat from the rural area of a district of his/her choice in the State from which he/she is elected. Nominated MPs may choose a Gram Panchayat from the rural area of any district in the country.

SAGY officials look at existing model villages to replicate their infrastructure.

8.1 Case Studies of Model Villages in India

There have been numerous efforts to set up Model Villages in India. A few are studied below with the available information which is scanty. Our intent is to capture:

1. What is considered to be important
2. What was planned and what was done
3. Where possible, what has happened since construction

8.1.1 Jayapur, Uttar Pradesh

Two villages were adopted by Prime Minister Narendra Modi in 2014. Jayapur was the subject of an Indian Express report in 2016 . An image from that article from 2016 is seen in Figure 8.1. Another image is in Figure 8.2. Another report in 2019 called these villages 'work in progress', but showed a weaving shop at work in Figure 8.3. A separate video presentation, taken by PM Modi's supporters, interviewed the owner, a young lady, who mentioned that the weaving shop is a family-run concern employing village women. They mentioned that their electric power comes from local solar photovoltaic systems, not dependent on the power grid.

Facts cited in media reports include:

1. Around 650 toilets have been built, but it is yet to achieve the ODF status. Toilet maintenance is a challenge due to vandalism with apparent impunity.
2. Two 25 kV solar panels have been installed by private companies, providing 12-14 hours of electricity but universal electrification still eludes the village of 4000 inhabitants. 100 solar street lights have been erected and 600 solar lamps

Figure. 8.1: Jayapur Village, Varanasi Lok Sabha constituency, Uttar Pradesh, India, pictured in January 2016

Figure. 8.2: Jayapur Village, another image

Figure. 8.3: Weavers at Jayapur Village, 2019

were being distributed.

3. Under the Atal Awas Yojana, the Vanvasis (forest-dweller) tribal community has been allotted one-room pucca houses.
4. Roads have developed potholes due to lack of coordination between government and private agencies.
5. Compared to other villages which have minimal toilet coverage and get only about 5 to 6 hours of electricity, Jayapur is in better condition. Better coordination between goverment agencies, and penalties for wilful destruction of public property, and improved infrastructure are cited as needs.

8.1.2 Puttamraju Kandriga, Andhra Pradesh

The Criclife portal reports on how star cricketer Sachin Tendulkar, now a Member of the Rajya Sabha, has adopted and transformed a model village: Puttamraju Kandriga in Nellore district of southern Andhra Pradesh. A poster from there is shown in Fig. **??**:

According to The Urban Update,

> The village suffered chronic water shortages and did not have adequate toilets but everything changed once Sachin took the village under his care. He released about Rs. 3.69 Crore from the MP Local Area development scheme (MPLAD) to begin the transformation of the village.

Facts cited include (source: HindoOnline):

1. As of March 2019, 2017, the village had round-the-clock water supply.
2. It is Open Defecation Free (ODF).
3. It has an underground drainage system and Sewage Treatment Plant.
4. The 399 residents feel privileged to enjoy Shri Tendulkar's generosity. Anecdote: Resident D Chenna Subbaiah is quoted as saying, Sachin has provided roads, water and drainage in the area.
5. Anecdote: Kokolu Bujjaiah, a lemon farmer says, I earn about Rs. 1800-3000 for 80 kg of lemons that I get from my 1-acre farm. I have two sons but my livelihood is not enough. I am happy with Sachins efforts but would feel relieved if my livelihood also improves.
6. A 300-capacity community hall built at a cost of Rs.1.15 Crore is the pride of

Figure. 8.4: Poster on the changes at an Andhra village adopted by Sachin Tendulkar

the village and is used for a variety of functions.

7. In addition to the MP's funds, the State government has spent Rs. 4.5 Crore.

There is no indication of a cricket ground, let alone enterprise growth or other local initiatives triggered by the MP's generosity and determination.

8.1.3 Kitam Manpur, Sikkim

Source is again Urban Update. The village was adopted by Prem Das Rai, MP from Sikkim. It lies in the rain shadow area of Darjeeling hills, receiving water from the 'Dhara' mountain springs that come from unconfined aquifers, through gravity-based pipes. Rising population and climate change mean acute water shortage from December to May. Rai's Dhara Vikas initiative aimed to enhance the groundwater recharge. A series of trenches along the contour lines were complemented with horticultural and forestry plantations in the barren lands to prevent soil erosion. Small ponds at regular intervals arrest water flow and facilitate groundwater recharge. Much of the work was carried out under the MGNREGS. This has raised groundwater levels and lessened episodes of drought.

8.1.4 Dharnai, Bihar

Per The Better India Dharnai with 2400 residents is one of 15 villages that would 'make you want to ditch your city life and move to the villages'. A GreenPeace-funded solar-powered 100 kW microgrid has given it energy independence, eschewing cow-dung and diesel generators.

8.1.5 Payvihir, Maharastra

Under a United Nations Development Programme biodiversity award, Payvihir, located in the foothills of the Melghat region of Amravati district turned a barren 182-hectare land into a community forest. They sell organic Sitafals organic applles and mangoes in Mango under the Naturals Melghat brand.

8.1.6 Hiware Bazar, Maharastra

With meager rainfall, Hiware Bazar adopted horticulture and dairy farming, with water conservation measures raising groundwater levels. Today it is has 294 open wells brimming with water, and 60 millionaires and the highest per capita income in India.

8.1.7 Odanthurai, Tamil Nadu

A panchayat in Mettupalayam taluk of Coimbatore district, is self-sufficient in electricity using solar and wind farms, and sells power to the Tamil Nadu Electricity Board. A new Rs. 5 crore wind/solar initiative aims to bring free power to its 8,000 residents.

8.1.8 Chizami, Nagaland

Chizami practises socio-economic reforms with women playing an important role in a sustainable transformation rooted in traditional practices.

8.1.9 Gangadevipalli, Andhra Pradesh

In this hamlet in Warangal district, every house has the bare necessities. Regular power supply, a water-filtration plant, community-owned cable TV, and well-lit concrete roads, the disciplined and determined community is gaining in prosperity.

8.1.10 Kokrebellur, Karnataka

This village next to a bird sanctuary builds on its reputation as home to rare bird species.

8.1.11 Khonoma, Nagaland

With a 700-year-old Angami settlement, terraced fields and ecofriendly jhum agriculture that enriches the soil, the village bans all hunting and is considered to be India's first 'Green' village.

8.1.12 Punsari, Gujarat

: Less than 100 km from Ahmedabad, Punsari has closed-circuit cameras, water purifying plants, biogas plants, air-conditioned schools, Wi-Fi, biometric machines all set up in the past 16 years at a cost of Rs. 16 crore. The 33-year-old tech-savvy sarpanch Himanshu Patel proudly states that his village offers the amenities of a city but the spirit of a village.

8.1.13 Ramchandrapur, Telangana

Ramchandrapur Ramchandrapur was the first village in Telangana region to win the Nirmal Puraskar in 2004-05. It has smokeless chullahs and toilets with tap-water facilities. It is the first village in the state to construct a sub-surface dyke on the nearby river and solve drinking water problems by constructing two over-head tanks in each house. The village does not have drainage system and all the water generated from each house is diverted to the gardens, which are planted by the villagers in each house.

8.1.14 Mawlynnong, Meghalaya

Billed as the cleanest village in Asia, 600-resident Mawlynnong prohibits plastic, and has spotless paths lined with flowers, bamboo dustbins stand at every corner, volunteers to sweep the streets at regular intervals and large signboards warning against littering.

8.1.15 Piplantri, Rajasthan

This village started planting 111 trees for every girl child born, and sets up term deposits for their education. The effort has grown to over a quarter million trees, with 2.5 million aloe vera plants to keep termites away from the trees. The latter now provide a livelihood for several residents.

8.1.16 Eraviperoor, Kerala

This is the first gram panchayat to provide free Wi-Fi for the general public. They also have a free palliative care scheme for the poor and is first in the state to get

ISO-9001 certification for its Primary Health Centre. It has also been recognised as a Model Hi-tech Green Village, by the Horticulture Department, for its green initiatives.

8.1.17 Baghuvar, Madhya Pradesh

Every house has its own lavatories and there is a common toilet complex for social functions. The village has underground sewage lines as well as the highest number of biogas plants in the state, used as cooking fuel and to light up the village. Water conservation enables it to survive drought-like conditions for years.

8.1.18 Shikdamakha, Assam

Shikdamakha, near Guwahati, is also plastic-free and earned the Open Defecation Free status recently.

Chapter 9

Conclusions

1. The brief survey of Model Villages shows that energy self-sufficiency using solar, biogas and wind, water conservation measures, vertical/ organic farming, and planting tree cover, are keys to prosperity.
2. Cleaniliness is shown to be possible.
3. Some villages are showing the way with Wi-Fi and modern enterprise.
4. On the other hand, one gets the feeling in reading these that many of the initiatives are driven by foreign funding, not by simply building on native initiative and enterprise.
5. Where the Indian government puts in money, even vandalism appears to be an unfortunate response from villagers. There are clearly some societal, cultural and perhaps political barriers to be overcome.
6. There are examples where native traditions are used to reinforce Green initiatives.
7. Reforestation is shown possible - even in arid Rajasthan.
8. Adoption of vertical farming and water conservation technologies is seen to improve the stability and resilience of villages in the face of drought, with examples of the groundwater table being raised by systematic practice of common-sense techniques.

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Index