Over 75 per cent of the planet’s land area is already degraded

India has lost productivity in about 30 per cent of its land area

This is triggering crop loss, poverty, migration and even wars
If we had viewed Earth from space for thousands of years, we would describe humans as a desert-making species.

ELISABET SAHTOURIS
Evolutionary biologist
Down To Earth

Founded in 1992 to arm you with knowledge critical to shaping a better world

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For videos on land & desertification, scan
THE UNITED Nations Convention to Combat Desertification (CCD) is Rio’s Stepchild, we said. Why? Because it was a neglected and frankly unwanted agreement, signed by the world at the Rio Conference in 1992. It was agreed because African and other developing countries wanted it. It was a sop—give them the crumbs of an agreement, which the rich world did not understand or believe in. In Rio, climate change was the top agenda. Next came the issue of biodiversity conservation—a resource largely surviving in the countries of the South, which need to be conserved and access secured. Then there was the issue of forests—a convention was proposed and staunchly opposed by the developing countries who said that it would infringe on their national resources. In all this acrimony, the desertification convention was born.

Today, close to 30 years later; now when the world is beginning to see the deadly impacts of climate change; now when it is still losing the war against the extinction of species and is faced with the dire prospects of catastrophic changes, this forgotten, this neglected convention, must shed its stepchild image. It is the global agreement that will make or break our present and future. The fact is that management of our natural resources, particularly land and water—what this convention is concerned about—is at huge risk today; our own mismanagement is being exacerbated by weird weather events, which is making millions more vulnerable and more marginalised.

But there is another side as well. If we can improve our management of land and water, we can shave off the worst impacts of climate change. We can build wealth for the poorest and improve livelihoods. And, by doing this, we mitigate greenhouse gases (GHG)—growing trees that can sequester carbon dioxide; improving soil health that captures carbon dioxide, and most importantly, changing practices of agriculture and diets is reducing emissions of GHG. So, this convention, needs to be moved from the stepchild to the parent.

Why do I say this? Sample what is happening in terms of extreme rain events in vast parts of the world—developing and developed; rich and poor; urban and rural. In India, this monsoon, rain has been a curse, not the boon it always is. It has come down in torrents—regions have received 1,000-3,000 per cent excess rain; that is over the average of a day. It has meant that rain submerged vast lands; destroyed homes and livelihoods. But what is worse is that flood becomes a drought within no time. This is because the heavy rain cannot be captured; cannot be recharged; and so, there is drought at the time of flood.

Each of these now, not so natural calamities, takes away the development dividend that governments work so hard to secure. Houses and other personal belongings are washed away; roads and infrastructure destroyed and all then has to be rebuilt. It is also clear that flood or drought is not just about climate change or changing weather patterns. The fact is drought is about the mismanagement of water resources; where not enough rain is being recharged or water is used inefficiently and inequitably. Flood is about the sheer
inability to plan for drainage; for our lack of concern to protect the forests on watersheds or the near criminal act of building and destroying the flood plains.

Then there is also the fact that global temperatures are increasing; intense heat events are being seen in many parts of the world. There is more heat and dust everywhere. In the South Asian subcontinent, temperatures have spiked to unimaginable levels. High temperature means less moisture on ground; more dust and more desertification. It creates the conditions for a dust bowl—which then the winds of over 130 km/hour—over what is called storm winds of 90-100 km/hour sweep away and make a destructive force. In 2018, over 500 people died in northern Indian states from dust storms. Again, this is the double whammy. High temperatures are only adding to the already heat and water stressed lands. Lack of green cover, increases desertification conditions; over-withdrawal of groundwater; and, poor irrigation practices degrades land over time. Then there is the over-intensification of land, largely because of the way we are doing agriculture. A report of the Intergovernmental Panel on Climate Change (ipcc) in 2019 rightly indicted the modern agricultural practices for being over-chemicalised and over-industrialised and so adding to ghg emissions. The report has also called for changes in diets, which will make us tread lightly on earth. Our food and our climate change footprint is now connected.

Therefore, this desertification convention, signed so unwillingly in 1992 at the Earth Summit in Rio, is now relevant more than ever. There is also another critical change. At the Rio Summit, northern countries asked what this issue had to do with them. Desertification was not a global issue and so, why should there be an international agreement at all. In Rio, African nations, who argued for this convention, had drawn important linkages to how price of their commodity was dropping, forcing them to discount their land and this, in turn, was adding to desertification and land degradation.

Today, there should be no doubt that desertification is a global issue—it requires cooperation between nations. The fact is that we are only just beginning to see the impacts of climate change. These will become more deadly as temperatures continue to spiral and this spiral gets out of hand. It is also clear that today the poor in the world are the victims of this “human-made” disaster—local or global. Rich do not die in sandstorms. Rich do not lose their livelihoods when the next cyclonic system hits. But the fact is that this weird weather is portend of what awaits us. The change is not linear—it is not predictable. It will come as a shock and we will not be prepared for it—rich in developing world or the developed world. Climate change at the end will be an equaliser—it will impact all.

It is also clear that one impact of this corrosive change—increasing numbers of disasters because of growing intensity and frequency of weird and abnormal weather will make poor, poorer. Their impoverishment and marginalisation will add to their desperation to move away from their lands and to seek alternative livelihoods. Their only choice will be to migrate—move to the city; move to another country. The double jeopardy, as I have called it, will add to the already-volatile situation of boat people and walls and migrant counting, which is making our world insecure and violent. This is the cycle of destructive change that we must fight. Desertification is then about our globalised world. Inter-connected and inter-dependent.

This is where the opportunity exists. This convention is not about desertification. It is about fighting desertification. The fact is that every way—in which we choose to fight desertification or land degradation or water scarcity—we will improve livelihoods and end up mitigating climate change. The land and water agenda is at the core of fighting climate change. It is at the core of building local economies to improve the wellbeing of people. To fight poverty. To win the war against human survival. This is what ccd is about. Now, let’s push for global leadership that can drive this change. 🌍 🌍 @sunilanar

THE CONVENTION IS NOT ABOUT DESERTIFICATION, IT IS ABOUT FIGHTING DESERTIFICATION

FOR ALL EDITORIALS, SCAN
A QUARTER UNDER

What does this mean for India where more than 60 per cent of the population depends on agriculture?

EVERY YEAR during the monsoon, Hemant Waman Chowre faces a peculiar situation. On the one hand he hopes for good rainfall to water his crops but on the other, he is scared, for even a mild shower can destroy his saplings.

Chowre is a 35-year-old farmer in Daregaon, a village in Sakri block of Maharashtra’s Dhule district. His 1.5-hectare (ha) farm sits on a gentle slope at the tail of the Sahyadri mountain range, or the Western Ghats, that marks the western periphery of the district. The topography is marked by barren lands, scarce trees and shallow soil. “The soil is just 15 cm deep,” Chowre says. The annual average rainfall in Dhule is 674 mm—a little more than what Rajasthan receives—and when it rains, the water rolls down the hill, washing away the topsoil along with saplings. “I had to plant saplings twice in 2018,” says Chowre. “When my soya bean got washed away, I planted bajra (pearl millet).” In neighbouring Vardharne village, Vilas Rajaram Gowli points to a hole, resembling a fox’s burrow, in his field. On July 22, when Down To Earth (dte) visited Dhule, the region had received just over 100 mm of rain. “We have had only 10 per cent of the rainfall this season and you can see holes everywhere. By the end of the season, the entire topsoil will be gone,” he says.

These are clear signs of desertification which, as per the United Nations Convention to Combat Desertification (UNCCD), is degrading 12 million ha of productive land across the world every year. This is over 80 times the size of Delhi and is enough to grow 20 million tonnes of grain. UNCCD, a legally

WORST HIT

Just 10 states account for nearly 65 per cent of India’s total area under desertification

<table>
<thead>
<tr>
<th>State</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jharkhand</td>
<td>68.98%*</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>62.90%</td>
</tr>
<tr>
<td>Delhi</td>
<td>60.6%</td>
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<tr>
<td>Gujarat</td>
<td>52.29%</td>
</tr>
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</table>

*Estimated value
binding international agreement that links environment and development to sustainable land management, defines this phenomenon as “land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities”. Drylands affected by desertification not only lose their ability to support plant life, but also their ability to offer ecosystem services, such as management of water systems and storage of carbon use in global warming.

Desertification has occurred throughout history. But what’s alarming is that its pace has accelerated 30 to 35 times the historical rate in the recent decades. With changing climate, prolonged droughts and increasing incidences of floods, landslides and frost heaving are in any case reducing the amount of productive land. At the same time, growing demand for food, fodder, fuel and raw materials is increasing the pressure on land and the competition for natural resources. Factors like deforestation, wetland drainage, overgrazing, unsustainable land use practices and the expansion of agricultural, industrial and urban areas are the other significant causes of land degradation, says the UN body. For instance, the World Atlas of Desertification, 1997, shows overgrazing is responsible for 90 per cent of dryland degradation in Australia and 60 per cent in Africa. Deforestation has caused 40 per cent dryland degradation in South America and Europe and 30 per cent in Asia. At least one-quarter of the global land has degraded in the last two decades. Some 1,500 million people depend on this degrading land for their livelihood.

A major discussion on ways to reverse land degradation and its outcomes is being held at the 14th session of the Conference of the Parties (COP14) to UNCCD in Greater Noida, New Delhi, from September 2 to 13.

The choice of India to host COP14 is significant for, the country houses 18 per cent of the world population and 15 per cent of livestock on just 2.4 per cent of land. With 195 million undernourished people, India already has a quarter of the global hunger burden. According to “Desertification and Land Degradation of Selected Districts of

<table>
<thead>
<tr>
<th>State</th>
<th>Area under desertification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goa</td>
<td>52.13%</td>
</tr>
<tr>
<td>Nagaland</td>
<td>47.45%</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>44.93%</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>43.01%</td>
</tr>
<tr>
<td>Tripura</td>
<td>41.69%</td>
</tr>
<tr>
<td>Karnataka</td>
<td>36.24%</td>
</tr>
</tbody>
</table>

*Area under desertification
India’, an atlas published by the Indian Space Research Organisation’s Space Application Centre (SAC), Ahmedabad in 2018, some 96.40 million ha, or about 30 per cent of the country’s total area, is undergoing degradation. SAC mapped India’s 76 drought-prone districts and two sub-basins in Ladakh to prepare the atlas and found that in drylands, which span 228.3 million ha or 70 per cent of the country’s total land, 82.64 million ha is under desertification.

This means almost a quarter of India is under desertification. Worse, the extent of desertification and land degradation has increased by some 1.16 million ha and 1.87 million ha respectively in just eight years, between 2003-05 and 2011-13 when SAC conducted the surveys. The extent is more than 2 per cent in nine of the mapped districts. By comparison, data with the World Atlas of Desertification, Third Edition, prepared by Office of the European Union, shows drylands have increased by 0.35 per cent since the 1950s world-wide. In 21 of the 76 districts surveyed by SAC, more than 50 per cent of the area is under degradation (see ‘Making a desert’ on p12).

Recently, the Ministry of Environment, Forest and Climate Change asked The Energy and Resources Institute (TERI), a New Delhi-based non-profit, to assess the cost of land degradation in India. TERI’s conservative estimate shows land degradation costs US $48.8 billion to the country’s exchequer annually. This is almost 2.08 per cent of India’s GDP in 2014-15 and over 13 per cent of gross value added from agriculture and forestry that year. The economic cost of forest degradation accounts for 55 per cent of the total loss. There has been a consistent increase in the area under water erosion, says the report. The findings are startling for a few reasons. Since in 1980s, India has spent a massive ₹10,000 crore a year on watershed programmes. Over ₹3,874 crore has been released for plantation programmes in the past two decades alone.

DTE reporters visited eight districts in different parts of the country where 50 per cent of the area is under desertification. They found a vicious cycle of land degradation, governance failure and absence of knowledge fueling environmental chaos.

**MAHARASHTRA LOSES CONTROL OVER SOIL**

**TIMBER MAFIA EATS INTO THE ALREADY THIN FORESTS, FUELS SOIL EROSION**

In Dhule, where a massive 64.2 per cent land is under degradation, over 5,200 ha has degraded in just eight years. Dhule’s curse, explains M S Mahajan, an agronomist at the Dhule Krishi Vigyan Kendra, is that a major part of the district falls in what is known as the Deccan Trap—rocks made of volcanic magma. Top soil in the area is generally shallow, about 23 cm deep. The soil with little permeability and a poor rainfall supports just one rainfed crop a year and thin vegetation, he says.

The Maharashtra forest department says it controls over 28 per cent of Dhule’s 7,195 sq km land since it is forest area, but as per the latest “State of Forest Report”,...
published by the Forest Survey of India in 2017, only 308 sq km or 4.2 per cent of the district has forest canopy. Moreover, there is no dense forest in the state. Even moderately dense forest is limited to just 69 sq km on the northern fringes of the district range. Most of the forests are open in nature. An additional 108 sq km is scrublands.

Pressure on these patches of forests is tremendous. “These support a million cows, buffaloes, sheep and goats. The buffalo population in the region has increased by almost 15 times, from 6,000 in 2003 to more than 100,000 in 2011,” says a senior forest department official requesting anonymity. Every summer, grazers set these forests on fire so that the land is filled with succulent grass after the rains arrive. The ground is burned before collection of mahuu (Madhuca longifolia) flowers, a commercially traded non-timber forest produce (NTFP). Contractors of tendu (Diospyros melanoxylon) leaf, another NTFP, set forests to fire for better regeneration of leaves.

The forests on the northern slopes of the Satpura range have commercial trees, including teak. Every year the forest department issues permits for tree felling. Between 2005 and 2014, over a million trees were felled through such permits. But another 0.26 million trees were cut illegally, says the official. “The worst was between 2008 and 2010, when illicitly felled trees outnumbered the legally felled ones,” he adds.

The problem in Dhule is that both abiotic and biotic pressures have not allowed new forests to generate. Forest fires have made the existing stock of trees unhealthy and stopped new seeds from germinating. “With rains now coming in extreme bursts, there is very little vegetation that can hold the soil together,” says Prashant Rajenkar, scientist with the Maharashtra Remote Sensing Application Centre, Nagpur, that carried out satellite mapping and ground verification of Dhule for preparing the atlas. “Most of this region witnesses sheet erosion, which means the rainfall gradually wears out the top soil layer,” he says.
Making a Desert

Over 25 per cent of India’s land area is undergoing desertification. Of the 30 states*, 26 recorded an increase in the area under desertification between 2003-05 and 2011-13

Areas where land degradation severity has deteriorated or new land has been degraded between 2003-05 and 2011-13

Source: Desertification and Land Degradation Atlas of India released in June 2016 by the Indian Space Research Organisation

* includes Delhi and Jammu & Kashmir
Going by the atlas, vegetation degradation is responsible for 54.5 per cent of land degradation in the district, followed by 37 per cent by water erosion.

The rate of erosion is extremely high in certain pockets of Dhule. According to Bhoomi, a satellite map-based application developed by the National Bureau of Soil Survey and Land Use Planning, Nagpur, most parts of the district show moderate to very severe erosion, except for the areas around the Satpura. In Sakri, the erosion is between severe to extremely severe, with the land losing between 20 tonnes of top soil per hectare per year (t/ha/year) to more than 80 t/ha/yr. This is more than the global average, which, as per the Food and Agriculture Organization, is 2.9 t/ha/yr.

**JHARKHAND’S GROWTH DILEMMA**

**SOIL EROSION TRIGGERED BY MINING AGGRAVATES WATER SCARCITY**

Just like Dhule, undulating topography is a major factor for soil erosion in most parts of Jharkhand. “Undulating toposequences of the state and rainfed agriculture have led to massive degradation of soil, diverse agricultural practices and low productivity,” a 2015 Niti Aayog report on Jharkhand says.

But in recent years, the state, which is primarily rural, has faced the brunt of extreme weather events. Between 2000 and 2014, the state experienced the highest number of heat waves in its history, notes the Jharkhand Climate Action Plan of 2014. A study published in ScienceDirect in April 2018, reports that central, southwestern and northern regions of the state experienced a temperature increase of 0.077-0.54°C between 1984 and 2014 and a 26-270 mm decline in cumulative rainfall. Small wonder, Jharkhand is among the five states (the others are Rajasthan, Delhi, Gujarat and Goa) where, as per SAC’s Atlas, 50 per cent of the total area is under desertification and land degradation.

In Giridih, where 74 per cent of the district, the highest in the state, is under degradation, another factor is at play. It is part of the Dhanbad mining circle which has the highest coal mine leases (131) in the country and over 500 minor mineral mines.
Giridih has the third-highest number of operational or working minor mineral leases in the state, while adjoining Dhanbad district has the highest number of working coal mine leases (56). Between 2005 and 2017, the Union government’s “State of Forests” report shows that while the percentage of area under forest compared with the total geo-graphical area of Giridih has slightly increased, from 820 sq km in 2005 to 890 sq km in 2017, the “very dense forest” (canopy density more than 70 per cent) has declined at the expense of “open forest” (canopy density between 10 and 40 per cent). The “very dense forest” has reduced from 98 sq km to 77 sq km. Between the 2001 and 2011 census, Giridih’s urban population grew at a rate of around 15 per cent turning the city from a Class II town (0.5-0.99 million population) to a Class I town (1 million and above population). In fact, the number of towns in the state went up from 152, according to the Census 2001, to 228 in Census 2011. And the impact is palpable across the district.

“Strangely, the arrival of monsoon heralds water conflicts,” says Surajmuni Hasda of Barkitand village in Giridih. “Sukha nala, a stream flowing by the village, is our only source of water, but as soon as the region receives the first rain, its water becomes muddy and cannot be used. The 70-odd families of our village have to go to nearby villages where hand pumps still yield some water. But most return empty handed,” he explains. “They say we will exhaust their water too,” he adds. All the wells and tube wells in the village have dried up in just 10 years. Data with the Central Ground Water Board shows that water table in the entire block has lowered from 8 m below the ground level in 2013 to about 10 m in 2017.

Jamil Kiske, deputy village head, says in 2009 when the last hand pump of the village went dry, a new hand pump was set up on the school premise with a depth of around 100 m. “Now this too is going dry.” Cyril Marandi, a teacher at the school, says even the construction of a new building is pending due to the shortage of water that has pushed construction costs in the area.

**GOA DIGGING ITSELF INTO A HOLE**

**RAMPANT MINING AND EXPANDING URBANISATION TAKES A TOLL**

Mining and growing urbanisation have induced land degradation in one of the most unlikely places, Goa, which gets 2,500 mm of average annual rainfall and has a humid climate throughout the year. From up above, its terrain looks gangrenous, without hope for a complete healing.

This is evident in the SAc atlas. North Goa, one of the two districts in India’s smallest state, has over 50 per cent of its area under land degradation. About 86 per cent of the area is under degradation due to loss in vegetation cover. This is the district which has almost 50 per cent of Goa’s mines.

Ramesh Gauns, an anti-mining activist based in Bicholim, says when it rains, the area around the mines becomes red with lateritic soil. “To get one tonne of ore, 2.5 to 3 tonnes of overburden (soil) needs to be...
extracted. This soil is mostly dumped outside mine leased area on revenue and agricultural land which leeches out.” In 2012, a report by the Central Empowered Commission noted that there were close to 750 million tonnes of overburden in dumps scattered across the state, most of these were outside mining areas.

Many of these dumps were from mines that were closed in the 1970s, says Miguel Braganza, former president of the Botanical Society of Goa. But between 2005 and 2012 due to the Chinese demand, even subgrade ore from these dumps was exported. “Companies like Sesa Goa started a scheme called Udaan,” says Braganza, “to identify overburden dumps across the state, including the ones which were 25-30 years old and had a good canopy cover on it.” About 20 million of the 54 million tonnes of iron ore, which was exported at its peak came out of these overburden dumps and as a result Goa lost a lot of canopy cover.

Officially, between 2006 and 2012, some 1,513 ha of forests were diverted. However there is no figure for deforestation caused by illegal mining. “The reason is the Goa forest department does not acknowledge close to 50 per cent of the forest outside protected areas. Goa’s own forest statistics do not match with the data of the Forest Survey of India,” says Abhijeet Prabhudesai of the Federation of Rainbow Warriors, a citizens collective.

One of the reasons for the discrepancy is because of the way Goa defines forests. The state government left out all those areas where the tree cover was less than 40 per cent and on less than 5 ha of contiguous land, terming it private forest. This was not in line with FSI’s definition, where tree cover of 10 per cent on one hectare of land would be called a forest. Since 1997, there have been at least eight committees trying to identify private forests including the most recent one which submitted its report in June 2019. This committee identified 47 sq km of private forests. But the state government rejected the report saying that prior consent was not taken from the private land owners.

Reboni Saha, secretary of Goa Bachao Abhiyan, says, “Most politicians in Goa have bought huge parcels of land hoping to develop it for real estate and tourism. Their plans will fail if the land is declared as forest.” Urbanisation has been growing at breakneck pace in Goa and the government is allowing easy land use changes to promote commercial activity, says Saha.

In 2011, Goa unveiled its 2021 regional plan, but successive governments have kept it in abeyance. Saha says state governments have been framing laws in a piecemeal manner. “First in 2008 they amended the Town and Country Planning Act (TCPA), 1974, which allows single-window clearance for all public-private-partnership projects. Then they allowed commercial establishments to increase their floor area ratio by 20 per cent without looking at roads and fire safety,” Saha says. The worst was probably the Section 16b of TCPA which was amended in 2018. This allows anyone to apply for land use change after paying a fee.
NAGALAND IS SHIFTING
DEFORESTATION, POPULATION TO BLAME

Deforestation and growing population are resulting in land degradation even in Nagaland, known for its monsoons. The SAC atlas categorises it as one of the five states where land is degrading at an alarming rate. In Kohima, the hilly state’s capital city, 62.43 per cent of the area is under degradation. Officials blame this on jhum cultivation where people slash trees and burn them to prepare the land for farming.

The satellite picture shows that eastern Kohima has lost a massive chunk of forest in just 10 years because of jhum cultivation, says Merenwapang, deputy project director, Nagaland GIS and Remote Sensing Centre which conducted ground-level studies on behalf of SAC for the atlas.

There are restrictions on developing orchard land. Only five per cent of the land can be built upon and is limited to ground floor plus one. “With 16b, anyone could get this changed into settlement and build farmhouses,” she says. In July 2019, Goa’s town and country planning minister Chandrakant Kavelkar told the Assembly that he has received 5,350 requests for land conversion of which 30 have been approved.

Such unplanned urbanisation could become the biggest degrader of land in Goa, overtaking mining. Take the example of Mopa, the site for a proposed airport. In the project’s environment impact assessment, the forest department found no tree cover in the area. Later, acting on a court case, it found 54,676 trees, says Prabhudesai. Braganza adds that once the airport was announced in the late 1990s, politicians bought land at prices as cheap ₹10-15 per sq m. Most of this area had trees. Today, this land is marked by severe degradation.
ONCE THERE WERE SPRINGS
Rapidly disappearing Himalayan springs will eventually impact rivers and cause desertification in the plains

ONLY 29 per cent of the water in the Ganga is from glaciers till the river reaches Moradabad in Uttar Pradesh; the rest comes from the springs, says S K Bartaria, member of the drafting committee that prepared Niti Aayog’s 2018 report on the revival of Himalayan springs. This shows the centrality of Himalayan springs in maintaining the flow of the mountain’s rivers, he explains. The mountain range is home to 3 million of India’s 5 million springs. Things, however, have changed quite rapidly in the past few decades. About 50 per cent of the springs have dried up or turned seasonal, says the “Report of Working Group I Inventory and Revival of Springs in the Himalayas for Water Security”.

Drying up of springs is intricately linked to desertification because nearly every river in India has its origins in springs. “Any change in spring hydrology has clear ramifications on river hydrology, whether in the headwater regions, where springs manifest themselves as sources of rivers, or in the lower-reach plains of river systems where they contribute almost invisibly as base flows to river channels,” says the report. In fact, the ramifications of disappearing springs have already become visible on rivers. “A decade ago, the flow of Binsar river was so strong that it would wash away bridges. Now sometimes its water level goes as low as 15 cm,” says Santosh Singh Nagarkoti of Basauli village in Uttarakhand’s Almora district. The number of streams in Almora has gone down to just 60 from 360 in the past 150 years, as per the report. Dharmanand Mishra of Kharak village in the same district vouches for the decline in the number of Himalaya’s springs. “When we went to the Vaishno Devi temple in Jammu in 1985, there was spring water gushing out from pipes near the temple. In 2005, we visited the temple again and found that there was barely any stream water available,” he says.

The drying up of springs is a major worry because they were the only source of water to 50 million people in 60,000 villages of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, Assam and West Bengal (see ‘Indispensable resource’). About 60 per cent of people in rural regions of the Himalayas still use stream water for drinking. With nearly a fifth of the Himalayan population involved in agriculture and 64 per cent of the cultivable land irrigated by streams, the death of streams will have a substantial impact on farmers too.

“The Himalayan springs are drying up primarily due to changes in land use, ecological degradation and the so-called developmental activities. These have depleted aquifers in the mountains,” says Himanshu Kulkarni, a lead author of the report and convenor of Pune-based non-profit
Advanced Center for Water Resources Development and Management. He also links it to climate change and says that the total rainfall in the Himalayas has decreased in the past century while winter rain has almost disappeared.

The drying up of springs has also impacted forests and wildlife. “Many natural watering holes for wildlife are in the form of springs and seeps. Depletion has led to water insecurity inside forests and national parks and on their fringes as well,” it says. “These springs ensure widespread water availability in rivers and provide moisture to the soil. Their disappearance will eventually be felt in the plains,” warns Debashish Sen, director of Dehradun-based People’s Science Institute.

**INDISPENSABLE RESOURCE**

Despite their rapid decline in the past few decades, springs are still a major source of water to many villages in the Himalayan region.
About 20,000 ha of forest is felled every year in the state for jhum cultivation, says T Renben Lotha, additional director, department of land resources. Nagaland’s soil and water conservation department’s annual report for 2017-18 also says that the extensive practice of jhum results in the average loss of 30.62 tonnes of soil area per hectare annually. The report highlights that it also destructs prime agricultural and forest lands in the form of erosion. As per this report, the practice of shifting cultivation involved 61 per cent households covering about 1 million ha in the entire state. It exposes about 5.65 per cent of the total geographical area of the state to soil erosion hazards.

“I don’t know any other way of farming or earning livelihood except for shifting cultivation,” says Vimecho Mekro, a 36-year-old farmer of Kezocha village in Kohima. In December last year, he had shifted to a new patch of the forest, cleared about 0.8 ha. He sold the timber in the market and set fire to the undergrowth. A few weeks later, he sowed maize, cucumber and beans on the patch and harvested a bumper crop. “The yield usually reduces after three to four cropping seasons. Then, I’ll shift to another forest,” he says, adding that slash-and-burn farming has been traditionally practised by his community.

Not far from his village, in Wokha, Chibeni Murry, in her late 40s, says soil fertility has gone down and that she has to shift to new locations every year. Changing land use practices, population pressure and erratic climate have caused major changes, says Lotha, adding that 10 years ago a jhum cycle took 15-20 years. Now, farmers go back to the same patch in five to six years, which is not enough for the land to regain fertility. Besides, vanishing vegetation cover has intensified soil erosion in the state, where 91 per cent of the area is undulating with altitudes varying between 200 to 3,840 m. Heavy rains bring mudflows down the mountain slope, flooding the farmlands, says Lotha.

**DRY AND SANDY ANDHRA PRADESH**

**Dwindling rainfall, dependence on borewell increase soil aridity**

Soil erosion has created a vicious circle in Andhra Pradesh’s Anantapuramu district, infamous for recurrent droughts. Water stress and droughts have always been part of the district’s history, which falls in the rain shadow region of Rayalaseema. But in recent decades, winds blowing over the region have become somewhat hot and ferocious. While rains have become scantier and more irregular, water beneath the ground has disappeared. In Dargah Honnur village, 75-year-old B Tippa does not know how to guard her 2 ha groundnut field from a sand dune adjacent to it. “With wind, the crop gets buried under the sand,” she says.

Dargah Honnur is not a desert. Malla Reddy of Accion Fraterna Ecology Centre, a trust in Anantapuramu which has done a study on the origin of sand dunes, says sand dunes in the village are the result of a natural disaster, which could have shifted the riverbed of the long-dried up Vedavathi river. Wind and water erosions must have led to the rise of sand dunes. Today, the village has around 2,000 ha of sand dunes, prompting people to call it “local Rajasthan” and filmmakers to shoot desert scenes.

Tippa claims the dunes have been there since her grandfather’s time. But covered with trees and shrubs, they were stable. The sandstorms are a recent phenomenon. While the shifting dunes have affected only a part of Tippa’s farm, they have engulfed the entire farms of many others, forcing them to migrate or take up other means of living. One such person is K C Narayanswami, a 63-year-old grocery shop owner in the village, who lost 0.8 ha to sand dunes a few decades ago. “I worked the land along with my father. But slowly, sandstorms rendered it unproductive. Now it is all sand,” he says. As a preventive measure, village residents allow outsiders to take away sand for free. But this destabilises the dunes.

The dunes stop appearing as one moves...
Rapid urbanization and rising consumption of goods make waste management in India a massive challenge. Urban India produces 62 million metric tonnes (MMT) of municipal solid waste every year, 70 per cent of which is collected and only 25 per cent of this collected waste is processed. Figures for recycling are abysmal; for instance, out of 25,940 tonnes of plastic waste generated per day, only 15,864 tonnes gets processed; similarly 95 per cent of e-waste is managed by the informal sector, which is a huge concern.

The need of the hour is to shift the focus towards source segregation, recycle and reuse. This will further strengthen and foster ‘Circular Economy’ by creating and optimizing resource ‘loops’ along value chains and will ensure sustainable consumption and production patterns into waste management systems.

The Centre for Science and Environment (CSE) has been working on policy and implementation with regard to waste management at the national and global levels. The Anil Agarwal Environment Training Institute (AAETI), a CSE initiative, recognizes the need to adopt resource efficient waste management regimes, and offers an advanced five-day training programme on ‘Integrated Waste Management’. The objective of the programme is to provide a better understanding of the key aspects of management of solid, plastic, biomedical, construction and demolition (C&D) and e-waste, feasibility of technologies involved in their treatment, regulatory frameworks; best practices and stakeholders involved.

**COURSE HIGHLIGHTS**
- Status of waste management in India
- Major provisions of the Waste Management Rules, 2016 and its amendments
- Utilization of the concept of circularity and resource efficiency in different waste streams
- Extended Producer Responsibility (EPR)
- Developing decentralised waste management frameworks
- Using information, education and communication for behaviour change
- National and international best practices
- Site visits

**WHO CAN APPLY**
Waste management practitioners, officials from central and state urban departments and municipalities, urban and town planners, village panchayat officials and members, academicians, students, and NGO representatives.

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away from Dargah Honnur, but only to be replaced by rocky and laterite soil. “Soil quality is worsening every year. We are losing more moisture than we get through rains,” explains K C Natraj, soil scientist at the Acharya N G Ranga Agriculture University (ANGRAU), Anantapuramu. He was part of the team that provided district-level data to SAC for the atlas.

One of the reasons for this poor soil quality is dwindling rainfall over the region. A 2017 study published in Journal of Research, published by ANGRAU, on rainfall pattern of 25 years (between 1988 and 2012) shows that aridity in the district has been increasing. Moisture Index (MI), which indicates water content in the soil and is crucial for crops, varies between -67.4 and -84.7 in all the 63 mandals of the district. Such low MI indicates that the rainfall received is not sufficient to meet the potential evapotranspiration demand. Evapotranspiration is the sum of direct evaporation from the land and transpiration from plants, and indicates the degree of aridity in the particular mandal.

“We have eight different climatic zones but all mandals of the district come under only three climatic zones of arid, hyper arid and super arid,” says S Malleswari, agrometeorologist at ANGRAU, one of the authors.

Between 1999 and 2015, acidity in the soil has increased by more than 4 per cent, says the ANGRAU study, while the organic carbon in the soil—considered the building block of soil—has reduced by 84 per cent. The availability of nitrogen and potassium dioxide too reduced by 55 per cent and 43 per cent. The soils are also highly deficient in essential micronutrients like zinc, iron, phosphorous and potash.

LESS SNOW, MORE RAIN AIL HIMACHAL
PEOPLE EMBRACE HORTICULTURE AND DEEPEN THE DESERTIFICATION CRISIS

Santoshi Negi, a 45-year-old farmer from Chango village of Kinnaur district, is grappling with a problem that she was not familiar with a few years ago. “Is there any pesticide available for red spider mite,” she asks the officer manning the recently set up
horticulture office in her village. Hearing a no, she hurries to the block headquarters 40 km away in Pooh. Negi is in search of chlorpyrifos, an organophosphate pesticide banned in several countries, to save her 0.5 ha apple orchard. “About 40 trees have been infected,” she says, adding that the attacks have increased in the past six to seven years. The mites live in the soil and attack the roots. Soon, the plant starts wilting, she says, adding that her investment on pesticides and fertilisers has increased from `4,000 to `25,000 a year in the past decade.

Devinder Singh Loctus, a 62-year-old farmer in Pooh, has an explanation for her problem. “Good soil moisture is needed to keep apple trees’ roots healthy. But it has been reducing due to lesser snowfall. Even the permafrost, which ensures year-round moisture in the soil, is decreasing,” he says. In his orchard, the apple trees are infected with all kinds of pests—stem borer, wooli aphids and red spider mites.

Increasing use of pesticides is disturbing the mountain ecology. It also kills the ladybird beetle and green lacewing bug that are natural predators of pests, compounding the crisis. But most farmers are neither bothered about this, nor about the fact that land is fast degrading in their district. As per the SAC Atlas, over 72 per cent of the district is undergoing desertification and degradation. The mountains which once remained snow-clad now look green, dotted with patches of apple orchards and pea farms. This was not the case earlier. Residents say traditionally they used to grow barley, wheat and potatoes in the cold arid region of upper Kinnaur, while apple orchards were grown only in lower Kinnaur. With rising temperatures, upper Kinnaur has become suitable for apple. Indigenous trees like juniper, pine, wild apricot and Robinia pseudoacacia can rarely be spotted in the landscape.

Along with rising temperatures, the region has witnessed other climatic changes. While snowfall has reduced affecting the soil moisture, the intensity of rains has increased aggravating soil erosion. “Since apple trees are water guzzling, the demand for water supply in upper Kinnaur has shot up,” says Sushil Sana, deputy village head of Pooh gram panchayat. This May, scarcity was so severe that people employed trucks to bring water from distant springs for their orchards. Panchayat members initiated a `45 lakh project to bring water from the Sutluj river using power generators and pipes, but the project failed due to high silt. “In the late 19th century, our ancestors had to leave Rishidogra village and settle in Pooh due to water crisis. If the situation prevails, history might repeat,” says Sana.

POLICY THAT RUINED GUJARAT’S BANNI
A FAULTY GOVERNMENT SCHEME HAS PUSHED BANNI GRASSLANDS TO BRINK

“At one time we had verdant grasslands for grazing cattle. Now there’s nothing,” says Kuber Karamkant Jat of Bagaria village in Kutch district. Jat belongs to the pastoral community of Maldharis, who are the worst sufferers of degradation and desertification of the Banni grassland, spanning 2,617 sq
km in the Kutch region. Earlier, Banni looked like an oasis in the otherwise dry and sandy Kutch. It is still referred to as Asia’s finest natural grassland, but it is now mostly parched land with few green patches. The Banni buffaloes, a breed famous for its milk quality and drought resistance, have depended on this grassland for centuries. While erratic rainfall is a major reason for Banni’s desertification, experts say one anthropogenic cause is also to blame.

In 1960-61, the government introduced a non-native plant, *Prosopis juliflora*, in the region on the recommendation of the third Planning Commission to fight salinity and to stop the advancement of the Rann of the Kutch on the northern fringes of Banni. The seeds were thrown from a helicopter over 31,550 ha. It was done without evaluating the ecological and socio-economic consequences, notes a report by the Wildlife Institute of India, Dehradun. The plant thrived in the non-saline and low saline soils and invaded the pristine grasslands of Kutch. In 1997, only six per cent area was under *P. juliflora*; by 2009, it had covered 33 per cent; and by 2015, some 54 per cent, says Vijay Kumar, director, Gujarat Institute of Desert Ecology (GUIDE), Bhuj, Gujarat. “As it increased, Banni decreased,” he says. “Earlier even during less rainfall, the native grass used to grow well. Now only *ganda babool* (as *P. juliflora* is referred to by local people) sucks all the water,” says Isa Bhai Mutwa, who owns 30 buffaloes.

A 2004 study by GUIDE shows only 33 per cent of the biomass harvested from Banni is suitable for cattle. “The rest is weed,” Kumar says. The Maldharis now purchase their fodder or wait for the government supply, which comes once in 10-12 days.

**FARMING ADDS TO RAJASTHAN’S GREEN CANAL, TUBEWELL IRRIGATION AND SHELTERBELTS INCREASE GREEN COVER**

Farmers living along the 3,670 sq km command area of the Indira Gandhi canal have managed to reverse desertification in large chunks of land in Jaisalmer, the last district served by the canal. Between 2003 and 2013, increase in agricultural activity in Jaisalmer has managed to reverse soil erosion in 1,967 sq km, an area 1.2 times the size of Delhi. This is almost 6 per cent of the state’s total area. The SAC atlas shows “no apparent degradation” in these areas.

In 2013, close to 93 per cent of the land was undergoing degradation as opposed to 98 per cent in 2003. Apart from a small area in the centre of Jaisalmer, where the city stands, most of Jaisalmer is made up of sand dunes. From May to July, high velocity winds move this sand to as far as Uttar Pradesh. Vegetation prevents this movement.

Priyabrata Santra, principal scientist in charge of soil at Central Arid Zone Research Institute, Jodhpur, says that tubewells along with canal irrigation have been the reason for this change. “It is well known that the Indira Gandhi Canal increased agriculture along its command area. But it is little known that when electricity came to villages they started setting up borewells especially in an area southeast of Jaisalmer near a set villages called Lathi and Chandan in the Pokhran block,” says Santra. “Most of Jaisalmer suffers from soil salinity, and underground aquifers also contain saline water. But there are pockets with sweet water, like Lathi and Chandan where farmers have exploited groundwater,” the scientist said. As a result, agriculture in Jaisalmer has grown phenomenally. In 2007 the total cropped area was 0.6 million ha which rose to over 1 million ha in 2016.

The other reason for land stability is shelterbelt plantations. By 2012, the forest department planted native trees like *kehri* (*Prosopis cineraria*) and eucalyptus in 38,000 km across the state to stop sand movement. While greenery is increasing, experts warn that too much of irrigation could reverse the gains. “Initially, irrigation works as it pushes the soil down, but later the salt will come up to the surface, which will be bad for plants,” says Santra.
Pollution monitoring regulations and practices

Manual stack monitoring, technological innovations and experiences

Guidelines for continuous emission, water and effluent quality monitoring

Monitoring Techniques and their suitability: Combustion gases including NOx, SO2, CO and CO2

Monitoring Techniques and their suitability: Trace species for metals, mercury and dioxins

Monitoring Techniques and their suitability: Water and effluent quality parameters

Quality assurance regulations and practices for continuous emission and effluent quality monitoring system

Calibration and operation and maintenance of continuous emission, water and effluent quality monitors

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TAMING THE THAR
What it takes to reclaim the world’s most populated desert
BY P C MOHARANA AND O P YADAV

DESERTIFICATION IS severe in hot and arid northwestern India which comprises the Thar desert. Of the 32 million hectares (ha) of hot and arid land in the country, Rajasthan holds the maximum share with 62 per cent. The Thar is located between the Aravalli mountain range in the east and the river Indus in the west, and both influence the desert’s climate, landform and hydrology.

The weather here is absolutely inhospitable in summers with low humidity and wind speeds of 40-60 km per hour. The seasonal and annual temperature range is high. It may rise to 50°C in summers and dip to as low as -4°C in winters. The annual average rainfall is very low, varying from 100 mm in the west to 500 mm in the east, but pan evaporation (a measurement that integrates the effects of temperature, humidity, rainfall and wind) is a high 1,800 mm, making the desert water-scarce.

The sand covered terrain spreads over 80 per cent of the area, a large part of which comprises sand dunes. Census 2011 shows that 28 million people live across western Rajasthan in over 12 districts and four agro-climatic zones that have a dominant agrarian land use.

Desertification has hit nearly 70 per cent of the state. Wind erosion, a dominant process of desertification in the state, has affected 44.41 per cent area. Vegetation degradation and water erosion also affect desertification.

Wind erosion and deposition causing sand movement and dust storms are the characteristic features of the Thar. Their severity is felt more in summers and is caused due to high wind speed, sandy terrain, sparse vegetation cover and human activity. About 0.15 million ha, or 72 per cent of the area, is affected by wind erosion or deposition, of which 5,800 sq km is very severely degraded, 25,540 sq km is severely affected, 73,740 sq km is moderately affected and 52,690 sq km is slightly affected.

Interestingly, the wind erosion affec-
ted areas decreased between 2003-05 and 2011-13. The Central Arid Zone Research Institute, or cazri in Jodhpur, has taken several steps in the state, particularly in western Rajasthan, to tackle the problem. Strategies for wind or sand control measures have been targeted for dune covered areas and sandy plains.

There are some known mechanical and chemical methods to stabilise sand dunes. Cazri’s afforestation technique has been quite effective for the Thar. The institute targeted old sand dunes formed some 10,000 years ago and which had stabilised naturally. Their mobility was as low as 3 to 5 metres per annum. Cazri’s activities include a) fencing of dune areas to protect against biotic interferences; b) creating micro-wind breaks in parallel stripe or checkerboard patterns by planting locally available brushwood and grass; c) afforestation on dune slopes by directly sowing grass seeds and transplanting seeds of indigenous and exotic species; d) planting grass slips, seeds of grasses or leguminous creepers on the leeward side of the micro-wind breaks; and e) continuous management of dunes till the input cost is recovered.

Leptadenia pyrotechnica (khimp), Ziziphus nummularia (pala), Crotalaria burhia (sinia) and Panicum turgidum (murath) were the species planted as brushwood to create micro-wind breaks. Acacia tortilis, Prosopis spp, Acacia sene-gal, Parkinsonia articulata and Tamarix articulata were planted as trees, and Lasiurus sindicus and Cenchrus ciliaris as grass.

Today, the technique is being used in Rajasthan’s desert districts Jaisalmer, Barmer, Bikaner, Jodhpur and Churu. With help from the state forest department, sand dunes over 0.4 million ha have been fixed. In areas that do not have dunes, Cazri carried out shelterbelt plantation. Vegetative barriers of trees, shrubs and bushes minimise the adverse effects of winds. Trees like A tortilis, E camal-dulensis, D sissoo and T undulata
were planted in some 800 km in Jodhpur, Barmer, Jaisalmer, Churu, Jhunjhunu, Nagaur, Ajmer and Pali districts; 100 km along the railway tracks in Sikar-Loharu, Sikar-Fatehpur and Palsana-Deshnoke sections; and, 250 km in the Indira Gandhi Nahar Project (IGNP) area. In extreme arid districts like Jaisalmer, such plantations have reduced wind velocity on the lee side of the shelterbelt, shows a 2016 Cazri report. It also reduced soil loss by 76 per cent. At least 14 per cent higher soil moisture and 70 per cent more grain yield of pearl millet was recorded on the lee side of the shelterbelt. But shelterbelts are not popular among farmers because in many cases trees hinder agricultural operations and inter-field movements. Nowadays, planting trees on field bunds across the direction of the wind is encouraged.

Plantations in checkerboard or parallel stripes have restricted sand movement on dune slopes. In IGNP area, such systems along with increased vegetation cover have influenced the micro-climate, shows research done by the Indian Space Research Organisation, or ISRO, in collaboration with Cazri in 2015. The wind’s strength has declined drastically; the number of dust storms has declined from 17 in a year to five. In western Rajasthan alone, the wind erosion hazard area has reduced to 73 per cent in 2013 compared to 76 per cent in 2000. During 2011-13, wind erosion on rain-fed cropland reduced by 101,646 ha and on irrigated croplands by 21,390 ha.

Similarly under shelterbelts, the average loss in crop productivity was 17 per cent due to cold waves, in comparison to 30 per cent on farms without shelterbelts. There was also a reduced 5 to 14 per cent pan evaporation values on either side of the belts. The problem of silting of canal beds has also been partially solved. Results of the experiment have revealed that plantation of trees and shrubs at every location may not always be beneficial. On the highways in the western Thar, sand tends to get deposited where plantation on both sides of the road obstructs the passage of summer wind in the sandy plain areas. Scholars, therefore, suggest sand to move across the road that allows faster grain transportation on the hard surface.

It is difficult to control the new dunes barchan and hummock, which are 3 to 5 metres high and devoid of vegetation. Barchans have fastest mobility; their movement has been measured at 31.7 metres per year in summers. In Thar, even the barchan slopes are put to monocropping of pearl millet whenever there is monsoon rainfall. In the Thar margins, barchans occur with superimposed dunes (30 to 40 metre high). It is economical to let barchans move rather than tamper with their form, unless they pose great danger to some existing structures.

MANAGEMENT OF WATER in the desert is critical for residents, and is also the key indicator of desertification. Surface water is traditionally stored in natural systems such as village ponds or in structures like tanka that people construct. Though the IGNP systems have transformed the agricultural scenario...
and ushered economic prosperity, distribution of canal water till the tail end still remains a challenging task. It is now a practice to construct small, rectangular tanks called diggi to store canal water. Such improvements in water resource management have increased the scope of bringing more area under agriculture. Irrigation water is now available to farmers through big canals like the IGNP and the Narmada. Agricultural land use has now changed. Comparative statistics for 1957-58 and 2014-15 show major changes in western Rajasthan—net sown area has increased by 18.25 per cent, double crop area by 14.75 per cent and forest area by 1.61 per cent. There is a decrease in culturable waste, current fallow and old fallow lands.

Data shows a transformation from subsistence to intensive form of agriculture, meaning there is now a desire to grow crops that are economically beneficial. Such radical changes in the mindset of farmers are also due to institutional support and research interventions. Development of improved variety of crops, identification and development of agro-forestry, agri-horticulture, horti-pastoral and silvi-pastoral systems are helping farmers with better livelihood options.

CAZRI has developed Integrated Farming System (IFS) on 7 ha which has the capacity to generate employment of more than 845 man-days and provide up to ₹2.5 lakh per annual returns. The farming community’s rising livestock population and dependency on them is the key to IFS. Crop production technologies such as farm yard manure management, optimum tillage, intercropping, rain-water harvesting and use of pressurised irrigation have helped in sustainable crop production. The use of techniques for efficient rainwater management, the introduction of new arid fruit and fodder crops, forest trees suitable for arid region, the management of plant diseases and insect pests, and enhancing gum exudation from trees have increased the scope for better crop prices to farmers.

To control the degradation of rangelands, salt-affected lands, water-eroded lands and mine-spoils, different packages of practices have been evolved. Once the technologies are known, they are tested on farmers’ fields, and the economic benefits from the practices are worked out and disseminated to the farming community.

The desert dwellers are now witnessing new developments in renewable resources like solar, wind and the hybrid systems. Wastelands are giving space to such energy system installations. Thus, it is likely that in future, “wastelands” such as saline depressions, rocky and gravelly areas will decrease further. This water-deficient region will become a hotspot for the country’s proposed river-linkage programme. If water becomes available, the region will have greater responsibility to manage its resources and tackle other forms of degradation. The lessons learnt from IGNP will definitely help the Thar farmers to combat desertification effectively.

(The authors are scientists with ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan)
Independence Greetings to All Fellow Citizens

All Indians salute the sacrifices made by our freedom fighters to ensure freedom of our country.

Jai Hind

Independence Day Ceremony at the ramparts
Independence Day
Greetings to All Fellow Citizens
by our freedom fighters
in our country

Independence Day
15 August 2019

All Indians salute the sacrifices made by our freedom fighters to ensure freedom of our country

Jai Hind

Independence Day Ceremony at the ramparts of Red Fort to be live telecast by Doordarshan from 6:25 a.m. onwards
IT IS EVERYBODY’S BUSINESS

Private sector is vital to restore land and sustain life

BY IBRAHIM THIAW

WE TAKE for granted the abundance of productive land, assuming that damaged land will heal itself. Left alone for a very long time, it would. Eventually. But that’s not our reality.

Four recent independent assessments show that degraded land is not recovering fast enough and that the drivers and impacts are no longer limited to the local. They are global. That puts the onus of restoration on everyone who rightfully consumes that which is not produced locally. The private sector must be engaged as governments cannot do it alone. Nor should communities have to pick up their slack.

The rising global momentum and demand for environmental action makes this an ideal moment to change how we plan and manage land. The benefits of doing so are far-reaching, and global.

To understand my claim, let me explain first what the science is telling us.

Over 1.3 billion people in the world are directly affected by land degradation, but more than 3.2 billion are impacted indirectly. That is nearly half of the global population, and well over the 2 billion people who live in the world’s dryland areas. Drylands were the primary target of the United Nations Convention to Combat Desertification (UNCCD) when it was negotiated 25 years ago. These lands face the greatest risk of degradation (referred to as desertification) compared to other types of land systems.

And yet assessments in the last two years show that 23 per cent of the land is degraded, mostly in areas outside the drylands. That is about 1 in every 4 to 5 hectares (ha) of land. Moreover, 75 per cent of the land has been altered from its natural state. That’s about 3 out of every 4 hectares of productive land. What’s more, these changes have occurred over the last 50 years, primarily for agriculture.

These changes affect the resilience of land. It makes us more vulnerable to floods, droughts and forest fires. And with habitat loss comes the loss of biodiversity, groundwater and soil fertility, and vast amounts of carbon stored in plants and soil releasing into the atmosphere, worsening climate change.

The political climate for change is ripe. We have an unprecedented opportunity to turn the tide if we can get the private sector to get in on the action.

By private sector, I don’t mean just people in dark jackets. It is the individual farmers and those organised as cooperatives.
seeking to raise productivity of their land to feed a family, create wealth or get their produce to the market. Everyone is saving money for retirement in an investment fund, and desires a return that does not harm their own future and that of their children or grandchildren. And yes, it is the companies that now know that long-term growth and profits cannot be at the expense of healthy land.

Investing in productive land use and management is not all about the environmental good. It is in our self-interest, enlightened self-interest. It is a quick way to create jobs, preserve seeds, replenish freshwater sources, build beautiful and secure homes and chart the path to good health. This is both a low-hanging environment-policy fruit as well as a powerful tool to achieve the Sustainable Development Goals.

Degraded land is a liability for business; indeed for any community. The reverse is also true. Restoring degraded land will help farmers to flourish, communities to thrive, the private sector to grow and the environment system to rebound. The success of the anti-plastics campaign, the emergence of environmental protests by schoolchildren and the growing influence of green parties in Europe herald a new era, and signal that a private sector committed to “sustainable living” must be part of any business model.

There is good progress being made in many parts of the world, including in India, to build upon. Implementation of the Paris Agreements (to limit increase in global average temperature to 1.5°C above pre-industrial levels) starts in earnest in 2020. The post-2020 agreement on the conservation of biological diversity will be defined at the same time. Then there is the new decade of Ecosystem Restoration, which runs from 2021 to 2030, and this will be a great opportunity to scale up the land degradation neutrality (LDN) approach. The approach, whereby countries avoid degrading land, reduce degradation where it is in progress and reverse it in degraded areas, offers multiple benefits for the actors involved, from the household to the global levels.

The time for change is now. Young people are impatient and action from the private sector is lagging. However, political commitment to measurable actions, such as the achievement of LDN and the Bonn Challenge—a global effort to restore 150 million ha of deforested and degraded land by 2020 and 350 million ha by 2030—are unprecedented. The demand for environmental leadership and action has never been more.

India is a global leader on all fronts—policy, technology, economy, consumer base, food production and social action. As incoming president of the UNCCD Conference of Parties through to 2021, it is my hope that people of India will stake a claim in this piece of history by igniting and championing a global shift towards land restoration on a grand scale.

(The author is United Nations Under-Secretary General and Executive Secretary of the United Nations Convention to Combat Desertification)
SILENT SPREAD

More than 100 countries are at the risk of desertification. Left unchecked, this could fuel conflicts and displace 700 million people worldwide by 2050.

On August 17, Sudan’s military council and civilian opposition leaders signed a landmark peace agreement, paving the way for democracy in the most impoverished and volatile country that was under dictatorship for nearly 30 years. As preparations for signing the agreement were still on in capital Khartoum, violence erupted in the country’s far-west wilayat or state, North Darfur. About 25 armed herders, riding camels and motorcycles, opened fire on people working on farms next to an internally displaced persons camp in Shangil Tobyaya locality. People in the camp say it was a “revenge attack”. A few days earlier, the farmers had impounded the herders’ camels and other livestock as they trespassed on the farms and handed over the animals to the police.

Soon after the incident, the African Union-United Nations Hybrid Mission in Darfur (UNAMID)—a joint peacekeeping mission trying to bring stability to the war-torn Darfur region since 2007—issued a statement calling on both farmers and pastoralists to exercise restraint. While confrontations in Darfur are commonly framed as “ethnic hatred”, UNAMID links such incidences to farmers attempting to access land for farming and being prevented from doing so by armed pastoralists. It says the incidences particularly increase during the rainy season. According to media reports, at least 37 such confrontations have been reported from Shangli Tobyaya in July alone.

Water and fertile land are valuable resources in a country where arid and semi-arid lands cover 170 million hectares (ha), or 72 per cent of the area, shows an estimate by Abd Almohsin Rizgalla Khairalseed, professor at the University of Sinnar, Sudan. The study, published in *Afr J Sci Technol* in 2015, identifies Sudan as “one of the most seriously affected countries by desertification in Africa”. While droughts and insufficient rainfall are characteristic...
of western Sudanese territories, primarily in North Darfur, research shows a link between armed clashes and prolonged droughts in the region. Between 1950 and 1990, the region witnessed three periods of droughts—mild in the mid-1960s; relatively heavy between 1972 and 1975; and, almost of catastrophic proportions in 1982-84. These periods of drought were accompanied by the outbreak of armed clashes. The most severe and intense of these clashes occurred in the mid-1980s. Over time, those skirmishes turned into a full-scale war, says a paper presented at 2018 WASD (World Association for Sustainable Development) 16th International Annual Conference held in Geneva.

While isolated drought years have little permanent effect on environment, almost two decades of drought within the last half-century have certainly had a major influence on the vegetation profile and soil conditions, aggravating desertification, fuelling conflicts and increasing the number of war and climate refugees in the region. At present, Sudan hosts over 2 million refugees, most living in camps.

Desertification has created a number of social and economic stressors, such as those related to food security, wealth and productivity, explains Scott Edwards, senior crisis adviser with Amnesty International, a human rights organisation. Populations that lack resiliency to these stressors—which tend to be the poor—may choose to migrate, seek other means of production or become dependent on others for subsistence. These responses to a worsening environment make conflict more likely.
Of the 6.1 billion hectares* of dryland in the world, nearly one billion are naturally hyperarid or deserts. Human action since the dawn of civilization is causing degradation in the remaining drylands.

* as per the 1st World Atlas of Desertification published by UNEP in 1992
Aridity is the degree of dryness at a given location over a long period of time. Aridity Index is the ratio of annual precipitation (P) to annual potential evapotranspiration (PET). Decrease in AI means conditions are becoming drier; in contrast, increase in AI means conditions are getting wetter.

**Land Classifications Based on Aridity Index (AI)**

**Drylands**
- Hyper-arid: AI < 0.05
- Arid: 0.05 ≤ AI < 0.2
- Semi-arid: 0.2 ≤ AI < 0.5
- Dry subhumid: 0.5 ≤ AI < 0.65

**Non-drylands**
- Cold: PET < 400 MM
- Humid: AI ≥ 0.65


For more such infographics visit: [www.downtoearth.org.in/infographics](http://www.downtoearth.org.in/infographics)
Between 1951-1980 and 1981-2010, drylands have increased 0.35 per cent. The areas hit are in India, Africa, eastern Australia, Eurasia and North America, northern China and South America.
Drylands constitute nearly 40 per cent of world’s land area.

- 42.4% of land is dryland
- 20.4% are drylands that have shifted to drier conditions between 1951-1980
- 6.4% are drylands that have shifted to drier conditions between 1981-2010
- 13.6% are drylands that have shifted to drier conditions between 1981-2010
- 11.5% are drylands that have shifted to drier conditions between 1951-1980
- 5.7% are drylands that have shifted to drier conditions between 1981-2010

Areas that have shifted to drier conditions between 1951-1980 and 1981-2010.

Over 70 per cent of the big cities* in non-dryland regions will become drier by 2040. Just 29 per cent of them will become wetter.

* Cities with over 0.3 million population. Currently there are 1,692 big cities of which 1,109 are in non-dryland regions.
“In places like Darfur, where the politics are not geared toward dispute reconciliation, we will be more likely to see conflicts, say, over diminishing resources, over access to power or caused by grievances arising from stagnating economic opportunities and growth. Ironically, places facing rapid desertification are also the places with the least developed politics to manage the conflicts,” he says.

In this period of Great Acceleration in the Anthropocene epoch, Sudan holds a grim lesson for the world. Some 110 countries are at the risk of desertification. The World Atlas of Desertification, prepared by the Joint Research Centre (JRC) of the European Commission and the United Nations Environment Programme (UNEP), released in 2018, shows that more than 75 per cent of Earth’s land area is already degraded and some 418 million ha, or half of the size of the European Union, is getting degraded every year.

Most of this is happening in Africa and Asia, which account for almost 67 per cent of the degradation occurring in dryland areas. By 2040, over 70 per cent of the big cities (housing 0.3 million population) currently in non-dryland areas will grow drier. In contrast, 43 per cent of the big cities in dryland areas will be hit by desertification. (See maps on p36-41)

As a consequence of accelerated deforestation, which is a major driver of land degradation and desertification, it will become more difficult to mitigate the effects of climate change, observes JRC. Together, land degradation and climate change could lead to a 10 per cent loss in global crop yield by 2050, says a press release issued by the European Commission. Most of this will occur in India, China and sub-Saharan Africa, where land degradation could halve crop production.

By 2050, more than 90 per cent of the global land could become degraded and 700 million people displaced. The figure could reach up to 10 billion by end of this century.

Antoine Zoma of Burkina Faso is well aware of this dual threat of desertification and climate change. He owns three hectares of semi-arid land in his village Koroli, five kilometres from the town of Réo. As per the traditional practice, he prepared his field for sowing corn in early May. “But there was no sign of rain over the next two months,” he says. On the night of July 16, just as his tilled field had started looking barren with soil getting blown away, his village received moderate rain showers. “During my childhood, ears of corn used to mature around this time of the year,” says Zoma as he rushes to his field for sowing corn seeds. Uneven distribution of rainfall and high temperatures have become the norm over the past 10 years. This has severely compromised soil productivity, says Zoma, adding that his usage of NPK (nitrogen-phosphorous and potassium) fertilisers has doubled in the past decade.

Agro-ecologist Sam Tokoro Bacyé blames the situation on progressive deforestation of the savannas for firewood, bush fires and preparing grazing land for animals. Population explosion has only worsened the situation. According to Food and Agriculture Organization of the United Nations, one-third of Burkina Faso has degraded.

In Kenya, another factor is at play. On July 6, owners of plush conservancies in Laikipia County called a crisis meeting to discuss a peculiar problem. A foreign plant introduced half a century ago to arrest desertification is now degrading thousands of hectares. *Opuntia stricta*, a cactus native to the Americas, is choking the native flora and reducing land productivity, say owners of the conservancies that have played host to some of the world’s famous celebrities including Prince William of the British royal family.

*Prosipis juliflora*, called mathenge in Swahili, is the other such species threatening the life and livelihood of people in arid and semi-arid parts of the country. Analysts
say both the invasive species have flourished in the country due to recurring droughts. Since 1975, the country has recorded at least 12 major periods of drought. The current one, which began in 2014 and engulfed the entire Horn of Africa, has doubled the number of food insecure people in Kenya—from 1.3 million to 2.7 million. Maize production in the coastal areas has decreased by 99 per cent compared to the long-term average. “The (drought) cycle has reduced over the years, from every 10 years, down to every five years, further down to every 2-3 years, and currently every year is characterised by some dry spell,” according to a study by South Africa-based Institute for Security Studies.

In 2015, the government launched the National Action Programme for Combating Desertification, at a cost of US $425 million. The programme document says drylands are getting more vulnerable to desertification. Frequent droughts, influx of people from neighbouring areas hit by conflicts and natural disasters, overgrazing and subdivision of land into uneconomical parcel sizes have further worsened the productivity potential of the harsh and fragile land, says the document. These drylands account for over 80 per cent of Kenya and support over 20 per cent of the country’s population, 50 per cent livestock and over 70 per cent wildlife. Geoffrey Wahungu, director-general of the country’s National Environment Management Authority, warns the pressures will only increase in the future as the country’s population is expected to hit 50 million by 2020, up from 39 million in 2009.

In Tunisia, which borders the Mediterranean Sea on the one hand and Sahara desert on the other, farmlands in 12 of the 24 states have lost productivity. “The ever-expanding Sahara desert is engulfing our farms. But the government has forgotten us,” says Taoufik Toumi, regional president of agriculture and fishing in Kebelli state. “It claims to be spending 2 million Tunisian dinars (US $0.7 million) a year to combat desertification, but it has hardly helped.”

Desertification and land degradation affect 75 per cent of the country’s 13 million ha farmland, notes the General Directorate for Forestry at the Ministry of Agriculture. Adel ben Youssef, an expert on environment and climate change, blames it on the practice of monoculture, overgrazing and clearing of steppes for the extension of cereal crops. The impact can be seen in Jeffara, one of the most desertified areas, where crop plantations have been established on loose soil. A 2007 paper by the Research Institute for Development, France, which develops...
strategies to reverse land degradation, says the land is “reaching saturation level and soil degradation has intensified”.

Between 1974 and 1999, the areas under cultivation increased by 180 per cent in the mountains, 356 per cent on the piedmonts and 798 per cent on central plain. “This intensification of agricultural land uses stems partly from a state policy which, since the 1960s, has been in favour of land privatisation, and has generated a land rush. Arboriculture has therefore developed at the expense of livestock farming in the piedmonts and the plains, even on land where the terrain is unsuitable. This trend is a threat to a number of ecosystems which indeed are in danger of disappearing.” Desertiﬁcation has so far, driven 792 plant species, 17 mammals and two reptiles to extinction. The toll will continue to rise if concrete steps are not taken.

The impact of desertification is more acute in Senegal, known for its rich agro-pastoralists. The agriculture sector is a major contributor to the national GDP. In 2018, the sector’s contribution stood at 16.6 per cent to GDP, according to the World Bank. The livestock sector contributes 7.4 per cent to the national GDP. “In recent years, there has been a gradual movement of people from the most affected regions of Matam and St. Louis in the north and Fatik in the centre to places like Tambacounda in the east,” says Aminata Diop an independent expert on food security. “Many herdsmen from my village have left for Dakar and other cities.”

Tih Chueni Nadia, environmental scientist with the Senegal ofﬁce of Earth Systems, an environmental and social consulting ﬁrm, identiﬁes the causes of desertiﬁcation in this tiny coastal country. Like other parts of the world, the country is also experiencing extreme hot weather. But intensive agriculture and monoculture-based crops have acted as the tipping point, she says. With monoculture plantations, pest attacks have increased in the region. This type of agricultural practice has increased the use of fertilisers and pesticides, which has affected soil productivity. “People have routinely exploited hectares of lands for decades to the point that they no longer have nutrients to support plant growth,” says Nadia, warning that “if efforts to restore natural vegetation are not proportionate to the rates at which the soil is being degraded, some parts of Senegal could turn into desert before the next decade clocks in.”

This also means Senegal could see North Darfur-like bloody violences between farmers and herdsmen, so far unheard of in the country.
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THINK HOW TO SINK

The best way to remove carbon is by sequestering it in its natural sinks

BY CHANDRA BHUSHAN

HERE IS one thing that worries climate scientists universally: the positive feedback loop. This is a process where changing one quantity changes the second one, and the change in the second quantity, in turn, changes the first. Scientists fear a positive feedback loop may spiral the climate crisis out of control.

Desertification is an example of a positive feedback loop, just as the melting of the Arctic ice cap, thawing of the Siberian permafrost, and the large-scale release of methane from methane hydrate lying on the sea and ocean floors. The climate crisis is causing desertification and, in turn, desertification is exacerbating the crisis. The cycle continues.

Let me explain this, but first a disclaimer: this is an oversimplified version of an extremely complex process.

Soil is one of the largest repositories of carbon on our planet. In fact, there is three times more carbon in the soil than in the atmosphere. Carbon loss from soil has been happening since the beginning of settled agriculture, but this is now being exacerbated by desertification. The emissions of soil carbon to the atmosphere is contributing to global warming. Latest data indicates that land degradation is responsible for annual global emissions of 3.6-4.4 billion tonnes of carbon dioxide ($CO_2$) or 10 to 12 per cent of the total emissions. Just to contextualise, $CO_2$ emissions from land degradation is about 50 per cent higher than the total $CO_2$ emissions of India, the third-largest emitter in the world. So, land degradation is a significant contributor to the climate crisis.

The climate crisis, on the other hand, is further speeding up desertification by increasing the frequency and intensity of droughts, floods and forest fires, and also by the changing the patterns of temperature, solar radiations and wind. Climate crisis and desertification, thus, are reinforcing each other.

The Intergovernmental Panel on Climate Change’s (IPCC) Special Report on Global Warming of 1.5°C makes it clear that we cannot meet the target of 1.5°C without large-scale “carbon removal” from the atmosphere. The best way to remove carbon is by sequestering it in its natural sinks—forests, grasslands and soil. Meeting the 1.5°C target, therefore, requires rapid enhancement in the capacity of natural carbon sinks to suck atmospheric carbon. This is also required to combat desertification. To curb desertification, we need to restore degraded soil via forestry, improving vegetative cover, enhancing water use effi-
ciency, reducing soil erosion and adopting better farming systems. All these will help enhance biomass production and organic carbon content in the soil. Combating desertification and climate change, thus, have the same solutions—enhance natural sinks. So, how do we get these solutions implemented at the scale and pace required to meet the 1.5°C target?

In 2007, REDD+ (Reducing Emissions from Deforestation and Forest Degradation) was formalised to incentivise forest conservation in tropical developing countries by providing them funds and allowing them to sell carbon credits to the developed countries. So far, more than 300 REDD+ initiatives have taken off across the world. A decade later, however, there is no convincing evidence to establish its contribution to halting or reversing deforestation trends. The carbon market has collapsed. The developed countries’ funding commitments for REDD+ have also been much lower than expected. So, the REDD+ mechanism has not delivered, but the lessons learnt can be used to design a new global mechanism to enhance natural carbon sinks. Let’s call this new global mechanism Sink Mechanism.

The first lesson is that any land and forest-related mechanism will work only if it is owned by communities. Studies show that indigenous people and local communities are capable of achieving excellent forest conservation outcomes by investing only a fraction of the total money spent on conservation by all agencies. The Sink Mechanism will work if millions of forest dwellers and farmers work to reverse land and forest degradation, and enhance carbon stock in forests and lands.

Second, it has to be a carbon sequestration-plus approach. In other words, improved sustainable forest and farm management practices have to be the basis of this mechanism. This will lead to social, economic and ecological benefits. Scaling of carbon sequestration would be one of its co-benefits.

Third, land and forest-based mechanisms cannot be sustained on carbon credits. These cannot be left to the mercy of the markets, and a non-market approach is needed to finance them. We, therefore, need to design a non-market mechanism where funds are mobilised to build the capacity of communities and local governments. Based on their performance, they can be rewarded for developing their own ‘sink’ and for achieving emissions reduction and carbon stock enhancement.

Lastly, any global mechanism cannot depend solely on international funding. REDD+ experience shows that once foreign funding ceases, projects become unsustainable. So, funds for the Sink Mechanism have to be a combination of domestic and international resources to build domestic ownership.

Halting forest loss and reforesting them can together provide 150-200 billion tonnes of carbon mitigation between 2020 and 2050. Farmlands in dryland areas can sequester an additional 30-60 billion tonnes of carbon during the same period. Together, the Sink Mechanism that addresses both forests and farmlands can mitigate more than one-third of the climate crisis.

The good news is that countries have recognised the importance of sinks. Many of them have expressed interest in enhancing carbon sinks through their nationally determined contributions (NDCs) under the Paris Agreement. An analysis of the submitted NDCs reveals that more than 100 countries have focused on or considered the land use, land use change and forestry (LULUCF) sector under their climate mitigation strategies. What we now need is to bring all the countries together and agree on the Sink Mechanism as a true collaborative mechanism to fight the climate crisis.
A third of the Earth’s total landmass has become a victim of desertification, threatening the livelihood of a billion people in over 100 countries. The Intergovernmental Panel on Climate Change (IPCC), the global body for assessing the state of climate change and its impacts, released its 1,500-page report on August 8, echoing the United Nations Convention to Combat Desertification’s finding. IPCC sounded a clear warning for the world: adopt sustainable land management practices or face the consequences of land degradation, climate change and desertification.

Its Special Report on Climate Change defines desertification as land degradation occurring in drylands—arid, semi-arid and dry sub-humid areas. And the way we use land is rapidly turning large tracts dry. Three-quarters of the Earth’s ice-free land is already under stress.

Nearly 50 million hectares (ha) of forest land have been acquired since 2000, mostly for agriculture, in Sub-Saharan Africa, Southeast Asia, Eastern Europe and Latin America. As natural grasslands have been replaced with pasturage, forests with cropland, and wetlands have dried up, greenhouse gases (GHG) in the environment have peaked. During 2007–2016, human activities added 13 per cent carbon dioxide (CO₂), 44 per cent methane and 82 per cent of nitrous oxide to the environment. This was largely due to deforestation, wood harvesting and agricultural practices. In most regions, global warming due to GHG accelerated desertification and land degradation. Since 1961, the world has lost 11-14 per cent of its biodiversity due to land use changes. These have had drastic social and environmental impacts, yet there is no sign of stagnation in land acquisitions in the foreseeable future.

By 2050, climate change will lead to a 29
per cent spike in cereal prices, warns the report. It found that increased concentration of CO₂ in the atmosphere will reduce nutritional quality of food. Crop yield, too, is expected to fall in tropical and semi-tropical areas due to rising temperature.

The report does not clearly show the link between climate change and desertification but it does say that desertification is a “function of both human activity and climate variability and change”. Different methods have been adopted to measure desertification, and an agreement has not yet been reached on either historical or projected numbers.

**TRENDS, HOWEVER, SUGGEST** a clear link. Average temperature increase over drylands has doubled the global average. In fact, some temperate drylands may be converting to sub-tropical drylands as a result of increased drought frequency.

Human activities-induced warming has played havoc with climatic zones: dry climates have increased, while polar climates have decreased. The ongoing warming will result in new, hot climates in the tropical regions. Unprecedented heat waves will further intensify in Europe, North America, South America, Africa, Indonesia, West Asia, south and Southeast Asia and Australia. Already, incidences of drought have increased in the Mediterranean, North Africa, West Asia, sub-Saharan Africa, central China, southern Amazon, India, east and south Asia, eastern Australia and parts of North America.

“Drought is not degradation as the land productivity may return entirely once the drought ends. However, if droughts increase in frequency, intensity and/or duration, they may overwhelm the vegetation’s ability to recover, causing degradation,” the report says. Reduction in crop yield in major production areas can trigger cropland expansion elsewhere, either in natural ecosystems or in marginal arable lands. Farming can also be intensified in already cultivated lands. This can further lead to increase in land degradation.

**CLIMATE CHANGE MAY** have brought down rainfall over the years, but it has increased the intensity of rain. The IPCC report shows a three-fold increase in extreme rain events in central India during 1950-2015. This has influenced several land degradation processes, including soil erosion.

A study published in the *Soil Science Society of American Journal* in November 2004 found that high-intensity rain resulted in the breaking up of low-moisture soil much more than high-moisture soil. The breaking up of soil increased its erosion by water.

Changes in rainfall regime can change vegetation cover and composition. This, in itself, may well be an important cause of land degradation. A study published in *Elsevier* in 2005 used climate change projections and found that rainfall patterns play a more significant role in soil erosion than land cover—be it cropland, forests or habitation. In future, however, this relation—
Clear-cutting forests during slash-and-burn operations can reduce land cover from 100 per cent to 0 per cent. Obviously, this will hugely impact soil erosion, says the report. Then again, if forested slopes are clear-cut for farming, the incidence of increased occurrences of intense storms as a function of climate change will certainly exacerbate the erosion problem. Climate change also impacts the biodiversity of plants, making historically cultivable areas no longer suitable for cultivating crops. This process, too, has an effect on land.

In many dryland areas, invasive plants have contributed to desertification and loss of ecosystem in the past century. Extensive woody plant encroachments have resulted in soil erosion because the bare soil between shrubs is susceptible to water erosion during high-intensity rains. Rising CO₂ levels due to global warming favour rapid expansion of some invasive plants in some regions.

In the Great Basin region of North America, 20 per cent of the ecosystems have been significantly altered by invasive plants, especially exotic grasses and invasive conifers. This has resulted in drastic reduction in forage availability, wildlife habitat and biodiversity.

Wildfires is another significant driver of desertification. They reduce vegetation cover, increase runoff and soil erosion, decrease soil fertility and affect the soil microbial community. The predicted increase in temperature and the severity of drought events across some dryland areas can increase chances of wildfire occurrence. In semi-arid and dry sub-humid areas, fire can have a profound influence on observed vegetation, particularly the relative abundance of grasses to woody plants, the report says.

A 2006 study published in the journal Proceedings of the National Academy of Sciences of the USA found a link between human-induced climate change and wildfires in California in western United States. It estimated that human-caused climate change added 4.2 million ha of forest fire area between 1984 and 2015, nearly doubling the forest fire area expected in its absence.

One big threat posed by climate change is the worldwide rise in sea level, particularly in tropical and subtropical regions. This process, combined with scarcity of water in rivers, has led to the intrusion of highly saline seawater inland. This has increased soil salinity and its degradation.

Around 480,000 ha of the 600,000 ha fertile land in the Indus delta, located in the southeastern coast of Pakistan in the North Arabian Sea, one of the six largest estuaries in the world, is now affected by seawater intrusion, says the IPCC report.

Soil salinity varies seasonally, depending largely on the river discharge. During the wet season, the annual average salinity reaches 24 km upstream, while during the dry season, it reaches 84 km upstream, the report says. The freshwater aquifers have been contaminated with sea water, rendering them unfit for drinking or for irrigation. Lack of clean water and sanitation has caused widespread diseases, of which diarrhoea is the most common.

The IPCC report proposes securing land rights of the indigenous communities so that sustainable land use can be ensured. “Land titling and recognition programs, particularly those that authorise and respect indigenous and communal tenure, can lead to improved management of forests, including for carbon storage,” the report says. Local people should be involved to identify land use pressures, species decline, habitat loss, food production and forestry, as well as in decisions-making. This will prevent, reduce and restore degraded land, the report says.

The report will prove to be the key scientific input in two crucial climate and environment negotiations—the Conference of the Parties of the UN Convention to Combat Desertification, or COP14, being held in Delhi, and the UN Framework Convention on Climate Change Conference, or COP25, to be held in Chile in December.
Environmental issues like climate change, water availability, pollution, waste generation and disposal are commanding considerable global attention. Industries, being a major consumer of natural resources and also a significant contributor to increasing pollution and waste generation, have a key role in addressing current and emerging environmental issues. Lack in fulfillment of this role has adversely affected the overall image of the industries.

The key to industrial transformation lies in achieving sustainability by working in harmony with the environment and society. This will require development of expertise among industrial professionals to deal with upcoming environmental challenges along with professional skills for stakeholder engagement. Centre for Science and Environment (CSE) recognizes this need of the hour and is conducting a four-day training programme in November, 2019 at its exclusive training centre at Alwar, Rajasthan to provide hands-on experience to industries. The takeaway from this training programme includes improved understanding on:

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3. Performance evaluation of pollution control devices
4. Protocol for stack monitoring with on-site demonstration
5. Issues and Challenges with Continuous Emission Monitoring System
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WHY INACTION

Land degradation can be avoided, reduced and reversed. But there is no short-cut to it.

RESTORE LAND, sustain future. That’s the theme of 14th Conference of the Parties (COP14) to the United Nations Convention to Combat Desertification (UNCCD) being hosted by India. The theme is centred around the wisdom that land is a fixed resource. If mistreated its topsoil, that takes centuries to build up, can be blown or washed away in a few seasons, exacerbating food insecurity, poverty, conflict, migration and political instability. Thus, says UNCCD, re-establishing land’s productivity by ensuring land degradation neutrality (LDN) is key to promoting peace, achieving development and mitigating climate change impacts. It defines LDN as “a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems.”

The concept emerged from the UN Conference on Sustainable Development (Rio+20) in 2012. It was realised management of land degradation has co-benefits for climate change mitigation and adaptation and biodiversity conservation, in addition to enhancing food security and sustainable livelihoods. In 2015, LDN became a target for the Sustainable Development Goal 15, which is about sustaining life on land. That year at COP12 to UNCCD, Parties adopted LDN as a “strong vehicle for driving implementation of UNCCD” and called on countries to set voluntary targets to achieve “no net loss” by 2030 so that healthy and productive land is maintained.

So far, 122 countries have committed to translating this global target into country-specific targets and actions. Some 43 countries, including India, have finalised the document, while 79 are in the process. Markus Repnik, managing director, Global Mechanism of UNCCD, says these actions will generate multiple benefits, from climate change mitigation and adaptation to zero hunger; from ensuring access to clean water to creating decent work and green jobs.

But not many are hopeful. “None of the countries have set numerical targets for LDN,” informs a highly placed official with...
India’s Union Ministry of Environment, Forest and Climate Change (MoEFCC). For instance, India’s LDN target, released just a few weeks ahead of COP14, says, “By 2030 India commits to halt any further land degradation and rehabilitate at least 30 mha (million hectares) degraded wasteland, forest and agricultural land (covering 10 mha each) out of the total 96.4 mha of degradation land.” The document identifies a few critical and contentious issues, such as “restoring productivity of different land cover classes and land-use classes”, “improving farm incomes” and “resolving land tenure and equity related issues” as priority and focus areas. But it does not say how these changes would be brought about.

“What is written in India’s LDN policy is obscure and largely meaningless bureaucratic verbiage that will leave India worse off than before—socially, economically and environmentally,” says Allan Savory, president, Savory Institute, USA, that promotes holistic management. “A vague LDN target allows governments to implement it in a way that suits them and may not be in line with UNCCD goals,” says the MoEFCC official.

UNCCD prescribes a range of sustainable land management measures so that LDN contributes to and benefits from the achievement of other multilateral agreements like the UN Framework Convention on Climate Change and the Convention on Biological Diversity. But countries appear to be keen on restoration of land through plantations.

With growing awareness of economic costs of land degradation—which represents a reduction of 10-17 per cent of global GDP a year—political leaders are adopting ambitious targets to restore degraded forests and agricultural land, says Chris Reij, Senior Fellow of the World Resources Institute.
Washington. The Bonn Challenge, launched in 2011, aims to bring 150 million ha of the world’s deforested and degraded land into restoration by 2020. In 2014, at the UN Climate Summit, countries extended this target to 350 million ha by 2030 under the New York Declaration on Forests. These global commitments have spurred regional efforts. In 2014, Latin American and Caribbean countries launched Initiative 20x20 to bring 20 million ha into restoration by 2020. Over 20 countries have joined the African Forest Landscape Restoration Initiative (AFR100), which aims to bring 100 million ha of deforested and degraded landscapes under restoration by 2030.

Such large-scale plantation projects are not only expensive but are often mired in controversies, particularly in dryland areas which is home to most of the world’s poor.

On June 17, addressing a workshop on national LDN target, Saibal Dasgupta, India’s additional director general of forest, emphasised the need to do more plantations to prevent land degradation. Some 30 per cent of the country’s landmass is under degradation. Dasgupta said at the current rate of afforestation, only 35 million tonnes of carbon dioxide equivalent (CO₂) e a year can be sequestered. This is way less than India’s commitment under the Paris Agreement to increase carbon sequestration through forests by 2.5 to 3 billion tonnes of CO₂ by 2030. Right now 70.87 million ha, or 24.39 per cent of the country, is under forest cover. To meet Paris Agreement, an additional 25-30 million ha needs to be brought under it. Another 21 million ha of forestland needs to be restored under Bonn Challenge. Is there enough space for the trees in the land scarce country?

Reality can be gauged from what Siddhanta Das, director general of forests and Special Secretary to the Government of India, MOEFCC, has said in Bonn Challenge and India Progress Report-2017: “To bring a minimum of one-third of the total land area of the country under forest and tree cover, an additional 27.8 million hectares of land area need to be brought under green cover... we need to start looking beyond designated forestlands and business as usual scenarios.” To overcome this land shortage, it seems, the government is eyeing degraded forestland, which is home to millions of people.

To make up for the loss of forests cleared for industrial, infrastructure or other non-forest projects, the Compensatory Afforestation Fund (CAF) Act, 2017, allows afforestation on an equal size of revenue land elsewhere. Till February this year, afforestation was allowed on degraded forest land only if revenue land was not available. In that case, the degraded land would be twice the size of the forestland diverted. But that month, MOEFCC brought in a notification under CAF, allowing compensatory afforestation in forestland where crown density is less than 40 per cent. The Forest Survey of India (FSI) classifies forests with crown density between 40 and 10 per cent as “open forest”. According to its latest biennial assessment, State of Forests Report 2017, open forest is second-largest category in the country, spanning...
over 30 million ha. This is 9.18 per cent of India’s landmass or 42 per cent of the forest cover. While opening up of this huge area for plantation works can help the country meet its international commitments, it also opens a Pandora’s box of land tenure conflicts.

The country has some 300 million people who traditionally live in and around forests or depend on it for a living. While The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 recognises their rights over forestland, claims are pending for some 2.4 million people, says the Union Ministry of Tribal Affairs. Each of them are eligible for at least 4 ha, it says. A case is now pending with the Supreme Court, in which non-profit Wildlife First has challenged the court’s order, evicting tribals from forestlands whose FRA claims are yet to be settled. The Supreme Court order came soon after MoEFCC introduced the CAF notification.

Another area the government is eyeing is trees outside forest areas. “The country has some 10 million ha of culturable waste land,” informs the MoEFCC official. “We are trying to empower people and institutions through monetary incentives, improving access to market and reducing regulatory red tape, so that these areas can be brought under plantations.” Last year MoEFCC released the Strategy for Increasing Green Cover Outside Recorded Forest Areas, which says wasteland, fallow land and other degraded lands should be the focus area of afforestation activities. “Plantations would be the intervention of choice for combating desertification as there is big money available for it just like in compensatory afforestation fund and the Green India Mission,” says Rohini Chaturvedi of Global EverGreening Alliance.

Savory says plantations cannot reverse desertification for a number of reasons. Planting trees is not a bad practice in regions that receive reliable rainfall. Unfortunately trees only provide strength to the soil at places where rainfall is above 500 or 600 mm. And most of the world’s desertifying land receive rainfall below this
level. Besides, using technology to plant trees does not address the cause of either desertification or climate change. Since trees are part of the ambient carbon cycle, carbon remains stored in them only until they die. Savory’s claims are not unfounded.

Since 2007, countries in Africa have been trying to create a barrier of trees across the Sahel region of Africa to stop the Sahara desert from expanding. Some 80 per cent of the people in this region depend on rain-fed agriculture. Though the origin of the idea, dubbed Great Green Wall, goes back to the colonial times, it could never take off for the simple reason that plants could not survive in the absence of adequate water and care. Even in 2007, when the African Union (AU) approved the initiative, it faced a great deal of criticism. A clear vision emerged five years later and the aim of the initiative was changed to surround the Sahara with a wide belt of vegetation—trees and bushes greening and protecting an agricultural landscape. The new vision engages all the countries surrounding it, including Algeria and others in North Africa, not just the 11 original sub-Saharan countries of the Sahel. Now, the “green wall” is a mosaic of land use practices whose ambition is to restore some 100 million ha of degraded land, create 10 million jobs in rural areas. Some 28 million ha has been restored in Burkina Faso, Ethiopia and Niger alone. In Niger, which consistently ranks near the bottom in the UN’s Human Development Index and is grappling with desertification, 5 million ha has been restored. The land now delivers an additional 500,000 tonnes of grain a year, enough to feed 2.5 million people.

Communities have also played a major role in taming deserts in China, which has a quarter of its land under deserts. Degraded land in China measures 800-1,000 million ha and is responsible for economic losses to the tune of US $6.9 billion a year. But this experience has also made the country a global leader in greening desert. In Ningxia autonomous province, the authorities have achieved such a miracle in Tengger desert by roping in a million people from local communities for implementing measures like covering dunes with checkboards made from straw. Remote sensing analysis shows wind erosion has reduced—from 163,530 ha in 2000 to 111,440 ha in 2010. But 2030 appears to be a challenging year for China. The youth have already migrated and it’s difficult to ignore the greying hair of workers involved in restoration programme. Will this ageing workforce be able to keep desertification in check?
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VALUE OF SOIL

The benefits of action against land degradation through sustainable management are seven times higher than its cost in 15 years

BY PUSHPAM KUMAR

AND DEGRADATION and desertification are some of the greatest environmental challenges for the world in light of climate change, rapidly growing population and increasing demand for food, fibre and biomass energy. As the latest report of the Intergovernmental Panel on Climate Change says, land “provides the principal basis for human livelihoods and well-being, including the supply of food, freshwater and multiple other ecosystem services, as well as biodiversity.” But the problem of land degradation and desertification is acute in Asia and Africa. Under the Sustainable Development Goals (SDGs) 15.3, a land degradation-neutral world by 2030 would not only depend upon the success of Africa and Asia to combat it, but the overall success would be critically determined by the success in achieving them in the two continents. UN agencies and the scientific community have been in a continuous discourse on identifying and generating empirical and scientific methods for monitoring, assessing and reporting the progresses on land degradation and desertification.

In Asian countries, the degraded areas mainly include the deserts of China mainland, India, Iran, Mongolia and Pakistan; the sand dunes of Central Asia; the steeply eroded mountain slopes of Nepal; and the deforested and overgrazed high-lands of the Lao People’s Democratic Republic. Asia holds almost 60 per cent of the world’s population. Of this, nearly 70 per cent live in rural areas and depend directly on land and land-based ecosystem services. As a result, Asia is most severely affected by land degradation, desertification and drought in terms of the number of people.

In Africa too, the situation is alarming. Under Agenda 2063—Africa’s blueprint for transforming the continent into a global powerhouse—talks about creating a prosperous Africa based on inclusive growth and sustainable development. The continent meeting the SDGs is in line with the aspirations of Agenda 2063. At the sixth special session of the African Ministerial Conference on Environment held in April 2016, the ministers decided to use the outcomes of the Economics of Land Degradation (ELD) Initiative by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the United Nations Environment Programme (UNEP). The 2015 ELD study provides a vehicle for the generation of policy-relevant information that links the biophysical aspects of land degradation with the economic drivers of change and subsequent implications for society.

ASIA, WHICH HOLDS 60 PER CENT OF THE WORLD’S POPULATION, IS MOST SEVERELY AFFECTED BY LAND DEGRADATION, DESERTIFICATION AND DROUGHT
Africa is particularly vulnerable to soil erosion and is the most severely affected continent. Two-thirds of productive land has degraded, as per a UNCCD estimate. To achieve SDGs and to realise the aspirations of Agenda 2063, Africa needs to sustainably manage its natural resources. Desertification has affected 45 per cent of Africa’s land area, of which 55 per cent is at high or very high risk of further degradation. The socioeconomic consequences of land degradation are food insecurity, poverty, social tension, reduced availability of clean water and increased vulnerability of affected areas.

Soil, especially topsoil, is an important natural resource base in the production of food, fibre and biomass energy. It takes 200 to 1,000 years to form 2.5 cm of topsoil under cropland conditions. Land degradation is causing loss of topsoil and the nutrients it contains, which, in turn, leads to reduction in crop production. Nutrient depletion from 105 million ha of cereal croplands in 42 African countries is causing loss of 280 million tonnes of cereal crops a year. The economic value of this was estimated at US $127 billion per year by the ELD study. It shows that benefits of action against land degradation through sustainable land management are seven times higher than the costs associated in the next 15 years.

Economic appraisal (cost of restoration v benefit of restoration) in the ELD Asia study indicates that if all Asian countries invest and develop sustainable land management technologies on its 487 million ha of agricultural land in the next 13 years, the total cost would be $1,214 billion, that is, $2,494 per ha. The present value of the flows of total benefits from investing in sustainable land management is estimated at $4,216 billion, or $8,663 per ha. This
means Asia could create a net present value of $3,008 billion, equal to $6,169 per ha with a benefit-cost ratio of 3.5. China mainland, Saudi Arabia, Uzbekistan, Iran, Myanmar, Indonesia and Japan together account for 88.34 per cent of the net present value, with the ratio ranging from 3.02 in Japan to 6.75 in China mainland. The study also indicates that investing in sustainable land management technologies and becoming agricultural land degradation-neutral by 2030 would help countries reduce the poverty gap to zero, increase the total per capita domestic food crop production to 858 kg across Asia, and result in economic growth and expansion in the agricultural sector.

The drop in annual production in Asia due to topsoil loss-induced loss of NPK (nitrogen, phosphorous and potassium) amounts to 16.7 million tonnes of crops with a total value of $9.9 billion at the weighted average price of crops produced in the region. In other words, preventing top soil loss-induced NPK loss would increase productivity by 0.68 per cent per year. Annual production loss due to top soil loss-induced NPK loss is 1.31 billion tonnes or close to 53 per cent of the annual total crop production in the region. The corresponding value of this annual loss at the weighted average crop prices amounts to close to $732.7 billion. This implies that reducing topsoil induced soil NPK depletion would increase regional productivity from 5.07 tonnes per ha per year to 7.76 tonnes per ha per year. Thus, Asian countries need to act against topsoil loss-induced soil nutrient depletion that is aggravating agricultural land degradation. This may require investment in sustainable land management technologies on agricultural lands.

For both Africa and Asia to attract investment in sustainable land management practices, the study suggests that sustainable land management is the key to control land degradation and to achieve land degradation neutrality. The benefits of action through sustainable land management to control land degradation outweighs the cost of action in all studied African countries. The net present value of action is non-negative against changes in discount rate, prices of cereals and planning horizon.

The cost of inaction measured in terms of cereal crops loss due to soil erosion-induced nutrient depletion over 15 years (2016-30) is equivalent to 12.3 per cent of the GDP of the 42 countries studied. Investment in sustainable land management practices will only be equivalent to 1.15 per cent of the GDP of 42 countries in Africa.

The scientific data and economic analysis indicate that in addition to achieving SDG 15.3, investment in sustainable land management on agricultural land would enable most Asian countries to achieve other related SDGs as well. These include economic growth and employment creation (SDG 8.1 and 8.5), eradicating extreme poverty and reduction of poverty (SDG 1.1 and 1.2), achieving food security through doubling agricultural productivity and income as well as ensuring sustainable food production systems (SDG 2.3 and 2.4). Moreover, results of this study have an important contribution in providing the methods, indicators, and results for measuring and reporting SDG target 15.3 and for integrating particularly the value of soil as a natural capital in the nations’ social accounting matrices. 

(The author is Chief Environmental Economist, United Nations Environment Programme)
CERTIFICATE COURSE on
CEMS, CEQMS and Data Interpretation

Continuous Emission Monitoring System (CEMS) and Continuous Effluent Quality Monitoring System (CEQMS) are mandatory for plants in 17 industrial sectors (classified under highly polluting industries) and for common pollution treatment facilities. In addition, grossly polluting industries (GPIs) need to install CEQMS. The real time data will become the basis for regulators to check compliance, in near future. It can also help industrial sectors/regulators in process optimization and taking timely corrective measures.

Since CEMS and CEQMS are complex and expensive technologies, there are significant challenges and risks associated with its implementation. The challenges include correct technology selection, installation, operation & maintenance and data handling. Data interpretation plays an important role in identifying issues related to data integrity. Therefore, thorough knowledge and skills relevant to CEMS regime, becomes most crucial factor for industries, regulators and other stakeholders.

Centre for Science and Environment (CSE) recognizes this need and announces a 5-day certificate course on CEMS, CEQMS and Data interpretation for environment professionals. The training methodology includes technical classes by experts, group exercises, presentation, technology demonstration and hands-on experience.

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QUASH THE DOGMA

Most policies to tackle desertification are bound to fail. The problem will get solved as soon as they become holistic

BY ALLAN SAVORY

I ONCE heard evolutionary biologist Elisabet Sahtouris say, “If we had viewed Earth from space for thousands of years, we would describe humans as a desert-making species.” Over that time, we would have watched the few natural deserts that receive almost no rainfall, expanding into regions that receive rainfall as high as 1,000 mm, or more. Such environmental degradation caused by one species is terrifying and it is entirely due to humans. This desertification is occurring in regions that experience seasonal rainfall with long dry periods and is the greatest visible sign of human presence.

Before I go any further, let’s look at the symptoms of desertification, which include increasing frequency and severity of droughts and floods, poverty, social breakdown, mass emigration, violence, war and climate change. I do not include biodiversity loss as a symptom because desertification itself is a symptom of biodiversity loss, starting with the loss of vital soil-covering plant material. Exposed soil between plants results in the available rainfall becoming less effective as water runs off the soil surface or evaporates out of soil, which is why droughts and floods increase.

Over millennia, desertification has led to the failure of many civilisations. During my lifetime (and I’m 84), trillions of dollars have been spent and millions of lives lost because we continuously address only the symptoms. We all know that to be successful, we must address the cause of a problem.

Throughout history we have blamed livestock for causing desertification—too many sheep, goats, cattle or camels overgrazing. Today, thousands of academic papers and reports attribute desertification to overgrazing by too many animals. As a young man in the 1950s, I began to notice desertification occurring in national parks and tsetse fly-infested areas in Africa, but in these areas there were no livestock at all. This made me begin to question the dogma that was being taught and my training as an ecologist.

In a 2013 TED Talk, that went viral, I showed severe desertification on research plots and land managed by usa’s National
Parks Service, which did not have any livestock on it at all. What could possibly be causing desertification if it wasn’t livestock? Finding it difficult to do meaningful research in an institution, in 1964, I decided to become an independent scientist. I was helped by thousands of ranchers, farmers, pastoralists and scientists on three continents, and we established the cause, and a remedy, over the next 20 years.

What we discovered is that the cause of both desertification and climate change are the same: management and policies that have never been able to adequately deal with the inevitable web of social, cultural, environmental and economic complexity. We have always believed that we have many tools to manage our environment, but all of them are aspects of ever-advancing technology, right from our first stick and stone tools. Other than technology in various forms, the only tools we actually do have are: fire and the idea of resting our environment. Both these tools (fire and rest) lead to desertification in seasonally arid regions. The third tool, technology, can never be used to prevent, or reverse, desertification which is a biological problem that we can only solve using a biological solution. As I explained in the TED Talk, we have no option but to use much maligned livestock to help us mimic the vast herds of the past, which all soils and vegetation (in areas of seasonal rainfall) evolved with symbiotically.

The first piece of this puzzle was how would we do it? For thousands of years, knowledgeable pastoralists herded their animals, fully aware that their entire culture was dependent on their land and stock, but this had resulted in desertification. Then, a century of modern science devised a plethora of rotational and other grazing systems, which accelerated desertification, including in those nations where range science was developed!

I DO NOT INCLUDE BIODIVERSITY LOSS AS A SYMPTOM OF DESERTIFICATION BECAUSE DESERTIFICATION ITSELF IS A SYMPTOM OF BIODIVERSITY LOSS
THERE WAS SIMPLY no known way of running livestock without exposing the soil between plants over millions of hectares, which would result in desertification. Except in the areas of our planet that experience constant humidity: in these places, no matter how livestock are managed, desertification does not occur.

Seventy years ago, French pasture scientist Andre Voisin had established the reason why, even when using the best of rotational grazing, it leads to a loss of biodiversity in Europe although not to desertification in that environment. This is because of well-distributed humidity. Voisin had also discovered that some sort of “planning process” was needed to prevent rotational grazing causing biodiversity loss, and proved that overgrazing was not a function of animal numbers, as society and institutions still believe to this day.

Overgrazing is a function of time. It all depends on how many days plants are exposed to grazing and how many days before they are grazed again. We simply had to find a way of managing livestock, that catered for many variables, such as the rate of plant growth, number of herds, types of animals, while ensuring repeated, high physical animal impact (to mimic past herd behaviour under threat of predation), and cater for wildlife, crops, other land uses, as well as for erratic seasons. Only by doing this could we begin to reverse desertification.

We knew what we had to do but no one knew how to do what was needed. Following Voisin’s clue that some form of planning process was essential, we began management in all fields, to see if anyone had ever dealt with such complicated, ever-changing situations successfully. We found what we were looking for in military colleges of Europe. Over centuries they had learned how to plan in immediate battlefield situations by breaking the situation down into small components that any human mind could easily comprehend. While this idea was easy to grasp, battles are fought for short periods but livestock movements had to be planned for many months ahead, catering for erratic seasons. Again, the solution was simple: use a paper chart to express several dimensions, including time.

Our early efforts using this military method of planning worked immediately, with evidence of improvement of land. However, over the next few years some livestock owners began experiencing failure. Analysis showed that this was not due to the grazing planning process, but because I had failed to consider the social and economic aspects. We had, in fact, only learned how to plan livestock/land management in what amounted to dealing with complicated and ever-changing circumstances. What we had not yet learned to manage was the web of social, cultural, environmental and economic complexity that is always present and inevitable. It took us a further four years to learn how to do that successfully, at which point the word holistic was added to the grazing planning process and it became Holistic Planned Grazing.

We managed complexity by using a Holistic Management Framework, and when used correctly, the results were consistent. Desertification is being rever-

OVERGRAZING IS NOT A FUNCTION OF ANIMAL NUMBERS. IT IS A FUNCTION OF TIME AND DEPENDS ON HOW MANY DAYS PLANTS ARE EXPOSED TO GRAZING
sed economically and profitably in a holistic context using livestock. We all need to take action to meet our needs, desires or to solve problems, but we avoid reducing the web of complexity to simple objectives by developing an overarching holistic context to guide all our actions.

I had originally set out to understand and solve the problem of environmental degradation, which I first saw in Africa, in the 1950s. And as I searched for answers, more by accident than intent, it resulted in the profound realisation that we had a far, far greater problem that needed to be solved: humankind’s inability to manage complexity.

This profound development and realisation resulted largely due to the US Department of Agriculture (USDA) engaging me to train 2,000 scientists and others over a two-year period. I don’t believe that any management process has ever been subjected to such a grilling, by so many scientists challenging the science and logic behind it, which enabled us to refine and perfect the Holistic Management Framework. In summary: if we are ever going to seriously address desertification rather than its symptoms, it is essential that we do so at two levels. First, with farmers and pastoralists using livestock as a tool with the Holistic Planned Grazing Process (or a better process when it is developed). Second, at the policy level, with our governments and other institutions using the Holistic Management Framework to develop policies holistically.

Over the past 50 years, there have been many impressive results on the ground from farmers, ranchers and pastoralists. So much so that there is now a network of 43 locally led and managed Holistic Management hubs on six continents, affiliated with the Savory Institute, Colorado, USA. Among these is the first university-led hub (Michigan State University) in the US.

Results at the policy level have been confined to analysis of existing, or planned, policies because no government has yet developed any policy holistically. The large sample of 2,000 scientists and managers (from USDA, World Bank, the United States Agency for International Development and American universities) analysed hundreds of their own policies, concluding that all would fail because they were reductionist. One group in training made a statement that we published: “We now recognize that unsound resource management is universal in the United States.”

I provided similar training about 30 years ago to the Indian Forest Service in Bhubaneswar, which resulted in those officials analysing 12 of their existing or planned policies. Their conclusion was that all of the policies would lead to damaging consequences to the people, the land and the local economies.

Desertification is no longer either a mystery or a technical problem. It is now a people’s problem that will be solved as soon as people insist management and policy be holistic, thus addressing the reductionist management that is responsible for desertification.

(The author is president of Savory Institute, Colorado, USA. He has made a significant breakthrough in understanding what causes degradation and desertification of grassland ecosystems)
Neither a short-term solution nor a one-size-fits-all approach will help fight desertification. Governments tend to commit this mistake, but communities across the world are building on their traditional experiences to achieve land degradation neutrality.

**Mixing it up to save Banni grasslands**

**GUJARAT’S PASTORAL** Maldhari community is trying to revive the Banni grasslands that are fast degrading due to the onslaught of invasive plant species *Prosopis julifora*. The members, along with non-profit Sahjeevan, started a project earlier this year where they are replacing the invasive species they call *gando babool* with mixed varieties of native seeds in six plots spread over 125 hectares (ha). “Rainfall is erratic. So we are using a seed mix that can withstand heavy, normal and low rainfall,” says Pankaj Joshi of Sahjeevan. They are also reclaiming the grassland portions where some of the community members started illegal farming. “We are sowing small pellet balls of mixed seeds, manure, soil and water in 15 ha,” says Joshi. The members are also sensitising the young members of the community to draw them back to livestock rearing.
Acacia to Tunisia’s rescue

**THE PROJECT** Acacia For All is a boon for the farmers of Bir Sala village in the north African country Tunisia. Farmers here traditionally grow almond and olive crops, which take up a lot of water. But climate change has made rain scarce in this arid and semi-arid region. In 2012, social entrepreneur Sarah Mag Toumi provided them a new farming opportunity with acacia. The tree can grow in desert areas and has roots up to 100 m, providing soil with nitrogen that restores fertility. Its plantation is an internationally recognised method to halt desertification. In 2012, the farmers planted 1,500 trees and another 5,000 the next year. The aim is to create two green belts through the country that will prevent desertification, fertilise soil, and enable people to sell the Arabic gum that the trees will bear.

Rain harvesting, water budgeting work wonders for Maharashtra

**NESTLED IN** the rain shadow side of the Sahyadri range in Maharashtra, Kumbharwadi village receives an annual rainfall of just 500 mm. The village in Ahmednagar district is also regularly ravaged by droughts and as a result witnessed mass migration in the 1990s. But things started changing for the better in 2002 when non-profit Watershed Organisation Trust introduced its watershed development programme to harvest rainwater. Next the non-profit rolled out the water stewardship programme under which they institutionalised water budgeting to arrest consumption.

Now, the village panchayat office has a whiteboard with two partitions. The left partition lists the water resources of the village and the right partition enumerates the water requirement. The budget is made twice—one in May before the kharif season and, depending on the rainfall, another budget is made before the rabi season and in case the water usage is more than water availability, farmers are advised to grow less water-intensive crops. The programme also uses meteorological support and promotes the judicious use of irrigation practices.

In 2015, the groundwater table had increased to 2 metres below the surface, from 6.5 metres in 1997. The interventions also improved the quality of soil. In 2016, when trains were carrying water across Maharashtra, Kumbharwadi could manage its own water resources.

The non-profit has completed watershed development in 1,516 villages in seven states and has implemented the water stewardship programme in about 190 villages.

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**Back to life**

**AUSTRALIA-BASED** firm Wide Open Agriculture is undertaking regenerative farm practices to transform highly-degraded landscapes into productive farms and healthy ecosystems. In 2017, the company bought large tracts of land in the Western Australian Wheatbelt area, which was once as bio-diverse as a rainforest but turned dry in the late 20th century due to unsustainable farming practices. The company leased it to regenerative farmers, who practice organic methods such as permaculture, which revitalises soil. This has had a remarkable effect and communities that had migrated have started returning. The company is also establishing tree zones (forests) and an agro-ecology buffer zone to be used for grazing to revive the biodiversity.

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**TUNISIA**

Large-scale planting of acacia restores soil fertility and has helped arrest desertification.

**AUSTRALIA**

Regenerative farming has helped repopulate the Wheatbelt area.
Israel’s perennial plant cover

THE REVOLUTIONARY Project Wadi Attir is transforming the land and lives of people living in 40 ha of once-barren land scarred by soil erosion in Israel’s Negev desert. The Bedouin community, descendants of nomads who came to the region from Saudi Arabia, has dramatically reversed land productivity and increased the diversity of plant and animal species. In 2009, the community started establishing a perennial plant cover with native trees and shrubs on the heavily-eroded gullies and slopes. They combined traditional knowledge with modern farming techniques to plant nitrogen-fixing, soil-improving trees that provide watershed protection, wind breaks, food and also control soil erosion. Everything here is connected to green technologies. The area is now an eco-farm that produces energy, protects land and saves water. Biological productivity, along with food and fodder, has increased. The number of rare plants and animals too is rapidly increasing.

Chile’s focus is on water and energy conservation

IN 2007, the United Nations and the European Union launched the Programme to Combat Desertification in central Chile to aid communities fight the driest decade (2003-13) in the region in 150 years. Under the initiative, 88 communities, involving about 20,000 people, have been able to build and run six programmes in different villages of the region to mitigate the adverse impacts of their activities on the environment.

These initiatives can be divided into three categories—water, energy and farming. Under water, four initiatives were started—recycling (small biofilters to clean water to wash dishes and for bathing were installed in homes); bringing water from a 2,000 metre high mountain and storing it in household tanks; developing a mechanism to catch and convert fog into water; and, rainwater harvesting systems in households. The energy initiative involved reducing the use of firewood, which was a big drain on forests. To this end, six microenterprises were formed to build and instal solar power technologies. The farming initiative involved the exchange of native seeds among families. Native seeds are handed down through generations and have evolved to survive in different climatic conditions. This exchange has helped preserve biodiversity.
Holistic approach to halt Spain’s deserts

Spain is not usually associated with deserts. Surrounded by water on nearly all sides, the western European country with a pleasant Mediterranean climate is a major tourist destination. However, about two-thirds of the country will turn into desert by 2100 under business-as-usual scenario. The situation in the dry and arid regions of Almeria and Murcia in southern Spain in particular is getting worse and estimates suggest that 3 million ha of wet areas will become arid by 2100. To fight the spread, an initiative is being undertaken in Altiplano, Murcia, to restore 0.63 million ha.

Dutch non-profit Commonland is aiding the project that aims at “an integrated production system which combines almond and local trees with aromatic oil crops, beekeeping, and sustainable grazing of the endemic lamb species”. This project will decrease erosion, restore water balance and enhance biodiversity. Hundreds of farmers are part of the initiative which has also identified 30 business cases that can contribute to land restoration.

Traditional zai claims lost land in Burkina Faso

In 2018, Yacouba Sawadogo, a farmer from Burkina Faso won Sweden’s Right Livelihood Award, also labelled “alternative Nobel prize”, for popularising a traditional farming technique to reverse desertification. Known as “zai”, the technique involves planting crops in small pits 20 cm wide and deep. These pits trap runoff and aid collection of nutrients, allowing crops to withstand drought. The technique has been used to restore thousands of hectares (ha) of dryland and in doing so reduced hunger in Burkina Faso and Niger since Sawadogo began to teach it in the 1980s. Lucie Yaméogo is making a success in Sourgou, 17 km from Koudougou, the capital of the Central West region. In her 40s, she has recovered, in less than 10 years, more than 5 ha. The United Nations Food and Agriculture Organization says that a third of Burkina Faso’s land is degraded and the area is estimated to expand at an average of 0.36 million ha per year. It is conducting projects to make agricultural and pastoral production climate resistant in five regions of the country. Zai is an integral component of its strategy.

Spain is diversifying its crops and practising regenerative agriculture to prevent desertification.

Murcia, to restore 0.63 million ha. Dutch non-profit Commonland is aiding the project that aims at “an integrated production system which combines almond and local trees with aromatic oil crops, beekeeping, and sustainable grazing of the endemic lamb species”. This project will decrease erosion, restore water balance and enhance biodiversity. Hundreds of farmers are part of the initiative which has also identified 30 business cases that can contribute to land restoration.
DESERTS AS WE DON’T KNOW THEM

These unforgiving lands may appear lifeless only to the unacquainted, but they are a unique and living ecosystem

Deserts, the natural ones, are rarely deserted. Most are full of floral and faunal activity, at times harbouring surprisingly high biodiversity, including some of the world’s most endangered species. Even as an economic resource, it would be incorrect to assume that these deadly landmasses are deadbeats for their host country.

The Arabian desert in west Asia, for instance, fuels the region’s economy and has led to the rise of some of the world’s richest countries like Qatar, whose per capita gross domestic product today is more than that of the US. The Arabian desert is an exception due to its vast oil and gas reserves, one might argue, but one would be wrong. Deserts often punch above their weight, financially. The deserts of Australia have a $90 billion economy, with 1.5 times the national output, states a working paper published by the Australian Agricultural and Resource Economics Society in 2009. They are home to gold, iron, nickel, uranium and many other mineral resources. The Atacama desert of south America was so rich in minerals, particularly sodium nitrate, that for much of the 19th century, Chile, Bolivia and Peru fought over its control. The Great Basin Desert of the US produces most of the country’s gold. Even the Arctic (yes, it is technically a desert) has a huge unexplored resource of gases, with Russia in the past few decades staking claim over the territory, much to the chagrin of other nations in the region. It is just a matter of time before the sound of drilling machines tearing into the ice will reverberate in the region. (Global warming and rising sea levels be damned.)

It is the formation and geology of deserts that makes them full of resources. Deserts that were once submerged in water, such as the Sahara of Africa, and rose up due to tectonic movements, witnessed millions of
years of churning under huge pressure. This transformed the dead hydrocarbons underneath into something we consider valuable today. Wood turned into coal, algae and plankton into oil, and so forth. On the other hand, deserts that were formed as a result of climatic factors, or on account of being located in rain shadow areas, like the Atacama, leaching of groundwater and evaporation over aeons enriched them with minerals. “Some mineral deposits are formed, improved, or preserved by geologic processes that occur in arid lands as a consequence of climate. Groundwater leaches ore minerals and redeposits them in zones near the water table. This leaching process concentrates these minerals as ore that can be mined. Of the 15 major types of
Thorny devil, a lizard endemic to Australia, has evolved to collect dew on its body and drink as it trickles to its mouth.

Boojum cactus of the Sonoran desert in North America takes unique shapes due to its spongy trunk that stores water.

Darkling beetles of Africa’s Namib Desert have the unique ability to extract water from fog.

The Atacama desert in Chile witnessed a major bloom in August 2017 after a rare rain brought dormant seeds alive.
mineral deposits in the Western Hemisphere formed by action of groundwater, 13 occur in deserts,” says the United States Geological Survey website. “Evaporation in arid lands enriches mineral accumulation in their lakes... Water evaporating in closed basins precipitates minerals such as gypsum, salts (including sodium nitrate and sodium chloride) and borates,” it adds.

Apart from material resources, deserts are also rich in biodiversity. “Although all deserts are dry, there is extreme abiotic and biotic variability among the world’s deserts—perhaps more so than for any other biome. This arises in part from the varied causes of desert formation, their disjunct distributions, and their independent floral histories,” says a study published in Plant Sciences in 2014. Some deserts have over 100 plant species in 0.1 hectare (ha), states The Biology of Deserts published in 2010. Of course, life cannot be found across the deserts but only in pockets that have some water. But then the greenery in those areas can sometimes be surprising. Parts of the Sonoran of north America are so naturally green that visitors might not even identify them as desert. The vegetation too is extremely diverse. Apart from the trademark gigantic saguaro cactus, it grows barrel cactus, yucca, prickly pear, century plant, ironwood, elephant tree, mesquite, creosote bush and the boojum tree. Among the flora, it has bighorn sheep, mountain lions foxes, bats, tarantulas, birds and rodents in abundant numbers. Same is the case with the Great Victoria Desert of Australia, which has great floral and faunal diversity.

Some desert species are so well adapted to their surroundings that they are extremely vulnerable to climate change. One such creature is the horny devil (Moloch horridus), an Australian lizard. It drinks the dew that gets collected on its body and trickles to its mouth. The Darkling beetle (Tenebrionidae), found in the Namib desert of Africa, is another freak of nature that can extract water from thin air. “The Namib Desert has a remarkably high variety of Darkling beetles and a handful of them actively exploit fog for water intake... Some of these construct sand trenches or ridges to catch the fog, while Onymacris unguicularis and O bicolor instead utilise their own body surface as a fog water collector,” says a study published in 2010 by PubMed Central, an archive of biomedical and life sciences journal literature at the US National Institutes of Health’s National Library of Medicine. In terms of conservation efforts, deserts are perhaps the most neglected ecosystems. This needs to be corrected, particularly because protecting land and biodiversity can increase the productivity of these harsh landscapes.
DESERT ROSE

“I dream of gardens in the desert sand, I wake in vain”

LAL SINGH

I OFTEN wonder if the world outside even knows that we exist. Every time there is shortage of rains, people talk about farmers and crop loss. But livestock keepers like me get equally affected. That is seldom mentioned in the media.

I am the 10th or 11th generation livestock keeper. Some 700 years ago, my forefathers settled in this Rajasthan village of Netsi, which is just 50 km from the Pakistan border. When I was young, my family owned 200 camels, 50 cows and 200 goats and sheep. Today, I am left with just a flock of 200 goats and sheep and 15 cows. I had to abandon the camels because there is no market for them.

Rains affect my livelihood in two ways. The sewan grass or Lasiurus sindicus, which we use as fodder, grows suddenly after the first showers early July. But over the past few years, the rain comes as late as mid-July and it is usually deficit. Therefore, most of the grasslands have vanished and the dunes have become barren. The past two years have been extremely dry, with a rain deficit of over 50 per cent. Now I have to buy animal feed which costs ₹850 a katta or a bag of 35 kg. I need 10 such kattas a month to supplement the nutritional needs of my weak and pregnant ruminants.

Rains also decide whether my cows will produce calves. They conceive only when there are sustained rains. None of my 15 cows has conceived in the past two years. As a result, I am not able to sell cow milk, which fetches me up to ₹15,000 a month during normal rains. Goats are also finicky animals. They conceive during erratic rainfall but have a miscarriage if their nutritional requirements are not met. My herd assures 60 offsprings during a good monsoon, of which nearly half are males and are easily sold in the market. They fetch me ₹90,000 on a productive year. But last year, I could sell only 15. This year I expect similar numbers to be sold.

Less rainfall also means that I have to hire a tractor to ferry water from long distance. Earlier we used our camels but now I spend over ₹7,000 a month. Earlier, I had a well, but the water is slowly turning brackish.

There is no profit in livestock rearing in the desert. My son takes no interest in it and helps me out only during the time of birthing. The only reason I am in the profession is because this is all I know.

(As told to Arnab Pratim Dutta)
ABOUT THE TRAINING

Lakes are an important component of the urban hydrological cycle, they act as source of water, run-off controller and play a significant role in enhancing groundwater recharge, regulating micro-climatic conditions and improved overall resilience of the area. Various ministries, departments, city-level public institutions, NGOs and research institutes are dedicatedly working on lake conservation but still the effort is inadequate given the scale of work required for lake management across the country.

AIM

To develop capacity of various stakeholders on conservation, restoration, planning and management of lake for water and environmental sustainability in urban areas.

OBJECTIVES

Improved knowledge on urban lake management – the concepts, tools and techniques.

Develop skills in mapping of lake (and its catchment) and cleaning of urban lakes/wetlands.

Understanding of lake as a source of urban water supply, groundwater recharge and wastewater treatment

Prepare Urban Wetland /Lake /Flood plain Management Plan.

PART I

Basic - Theory, science, practice, tools, approaches, regulatory framework

Date: October 15 - 18, 2019

FIELD VISITS

Date: October 19-21, 2019

PART II

Advanced - Studio on Urban Lake Management Plan

Date: October 22 - 25, 2019

COURSE FEES:

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₹52,800 (for single occupancy accommodation)

FOR INTERNATIONAL PARTICIPANT

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$1530 (for single occupancy accommodation)

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• 30% off for college students

• 30% off for full-time working representatives from registered NGOs

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Opportunity for interaction with the real implementers/beneficiaries

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