Environment
IN INDIAN CONTEXT

1

PREVIEW

Towards a green village
A village can be considered as an ecosystem of rural India

An urban nightmare
An insight into the issues that accompany unplanned urbanisation

Urban floods
Are these an indicator of environmental degradation?

Green buildings
Future lies in zero-energy use

SYLLABUS TRACKER

This chapter covers the following topics from the UGC syllabus for environmental studies

- Concept of an Ecosystem (Unit 1)
- Pollution (Unit 5)
- Water Conservation (Unit 6)
- Urbanisation (Unit 7)

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SUMMARY

● Natural resources ● Economy ● Population

India has witnessed a rapid economic growth in the past decades, raising people's standards of living. But this growth has come at a terrible price. Today, the country's air is polluted like never before. According to a 2010 World Health Organization (WHO) report, air pollution kills nearly 0.8 million people annually in Southeast Asia; India alone accounts for more than 75 per cent of the casualties. A June 2015 report by the Indian Space Research Organisation (ISRO) shows that over 50 per cent of the country's land is under desertification, leading to low land productivity. Thus India faces the tough challenge of striking a balance between economic well-being and ecological sustainability.

This challenge assumes more importance because India is a biomass-based economy. Close to 65 per cent of the country's population is dependent on natural resource-based livelihood, such as agriculture, fisheries and forestry. Agriculture employs some 234 million people through 100 million farm holdings. Forests contribute 40 per cent of the country's energy needs of which more than 80 per cent is utilised in the rural areas. They also support 30 per cent of fodder needs. This is crucial given that the economy of livestock is bigger than that of the foodgrains. Tribal communities living in or near forests derive about 30 per cent of their diet from forest sources. As per estimates, 270-300 million cubic metres of fuelwood, 250-300 million tonnes of grass and green fodder, over 12 million cubic metres of timber are harvested from Indian forests annually. Similarly, the Indian coast, the densest coastal region in the world, has a large percentage of population dependent on fisheries for sustenance. Given that close to 93 per cent of India's employment comes from informal sectors that include most of the resource-based livelihoods, environmental degradation has a huge impact on the country's economy.

The situation will only exacerbate with growing population. India, which makes up 2.4 per cent of the world's land, already supports 16 per cent of the global population. Every million hectare of the country supports 7.27 million people, shows the National Sample Survey 2011. To meet the growing demands, we have to optimise the use of natural resources available in a way that the country's ecosystems continue to yield high productivity in a sustainable manner.

POINTS

1. **Natural resources are being exploited at an ever increasing rate. The total weight of all the materials extracted around the world is around 60 billion tonnes and this equals to around 25 kg each day for each person on the planet**

2. **The population of India is growing at 1.93 per cent per annum. Taking into account the total land resources, including hills, lakes and rivers, the availability of land per head in India comes to only 0.58 hectares**

3. **The economy of India is the sixth largest in the world when measured by gross domestic product (GDP). But this economic growth is not resulting in employment. Jobless growth is the country's biggest challenge**

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TOWARDS A GREEN VILLAGE

The biomass-based economy

India lives in its villages and the country's biomass base holds the key to make villages sustainable

An ecosystem is a dynamic complex of biotic components like plants, animals and micro-organisms and abiotic components like soil, air and water—all interacting as a functional unit. Thus, a village can be considered as an ecosystem, taking into account its distinctive structure and function. A village ecosystem typically consists of agricultural lands, grasslands, forests and wetlands. Together, they form an important resource base that supports diverse forms of life. Close to 70 per cent of India's employment comes from the livelihood options provided by these natural resources. Agriculture alone contributes 16 per cent of India's GDP (gross domestic product).

Importance of ecosystems

If we were to accept the growth of biomass as a vital objective of India's planned economic programme, then we also have to recognise the fact that India is a country with extremely diverse ecosystems (see 'Ecological regions of India', *p15*). Within the same country we can move:

- from the hot desert of Rajasthan to the cold desert of Ladakh;
- from areas with very low rainfall (less than 200 mm/ year) to areas with extremely high rainfall in the Northeast and Kerala (more than 4000 mm/ year); and
- from the sub-temperate high mountains of the Himalayas to the tropical high mountains of the Nilgiris and plains in Tamil Nadu.

Between all these systems are numerous plateaus, hill ranges, riverine deltas, unique wetlands like the Sundarbans and massive alluvial Indo-Gangetic plains whose productivity is probably unmatched in the world.

The same kind of biomass cannot be grown in all the ecosystems on a sustainable basis. So, to maintain a high biomass productivity, efforts must be made to understand the social and ecological dynamics of the ecosystems and develop biomass production dynamics of these ecosystems. High productivity on a sustainable basis is possible only by observing the laws of nature, not by contravening them.

Ecosystem and the economy

The landmass within any ecosystem can be divided into three basic functional components: croplands, grazing lands and forests and tree lands. A balance between these is crucial for ecologically sound land use within an ecosystem. This can be understood by looking at any of the three terrestrial ecosystems of the country—the Indo-Gangetic plains, the Thar desert and the Himalayas. A major component of land use in the Indo-Gangetic plains can be croplands with grazing playing a minor and supporting role. In the Himalayas, the major component of land use will have to be forestlands with grazing and croplands playing a minor role.

The occupational structure also reflects the land use in a specific ecosystem. For instance, people can follow agriculture as their main occupation in the Indo-Gangetic plains but in the Thar desert, they will have to adopt a mixed enterprise in which farming is strongly backed by animal husbandry. In the Himalayas, farming will have to go together with forest- and tree-based occupations.

Since India is a biomass-based economy, its ecology or its ecosystem dictates the local economy and livelihoods of people. Indian villages are highly integrated agrosylvopastoral

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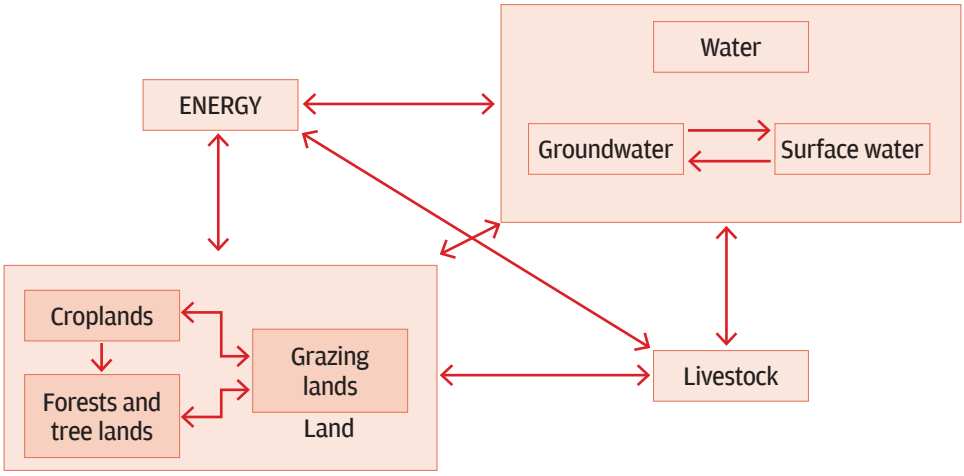
NEXT

↘Case study
How a village regenerates ecology to bring in economic benefits

↘Case study
The role of ecosystem planning and conservation

The complex Indian village ecosystem

An Indian village is a complex land-livestock-vegetation system in which the land sub-system, the water sub-system, the livestock sub-system and the energy sub-system, all interact with each other. The village ecosystem has evolved in such a way that it brings about an holistic enrichment of the entire ecosystem without destroying the synergy between the various sub-systems.



systems, or a combination of ecological systems based on agriculture, grazing and trees. Each village has its own croplands, grazing lands and forests and tree lands (see 'The complex Indian village ecosystem'). Each of these components interacts with each other and thus, the entire ecosystem is held in a fine ecological balance. Trees provide fuelwood and help the farmer avoid the burning of cow dung and maintain the productivity of their croplands where the dung can be used as manure. Currently, 75 per cent of rural households continue to use biomass and dung to cook (Census 2011). Grass is generally available from grasslands during the monsoon. With the onset of dry months, the grass availability decreases. The crop residues obtained from croplands and leaf fodder obtained from trees help animals tide over the scarcity period.

What happens when an ecosystem is disturbed?

This finely tuned system can be easily split apart. If too many trees were cut for commercial purposes or growing population pressures were to force local people to expand their croplands, the area of the adjoining forest and grazing lands would be reduced. There would be a shortage of firewood, and people would be forced to burn cow dung as fuel, leaving little manure for their croplands. In the long run, this will lower the productivity of their croplands. As resources decline, animals will starve and cow dung production will be affected. Overall biomass production in the village ecosystem will steadily go down. The village ecosystem will increasingly be susceptible to the vagaries of weather, such as extreme rain events, and will soon take on the shape of a pseudo-desert. According to the Desertification and Land Degradation Atlas of India, 29.32 per cent of the country's total geographic area (TGA), or 96.40 million ha, has undergone land degradation during 2011-13. Around 23.95 per cent (2011-13) and 23.64 per cent (2003-05) of desertification/land degradation is contributed by Rajasthan, Maharashtra, Gujarat, Jammu & Kashmir, Karnataka, Jharkhand, Odisha, Madhya Pradesh and Telangana.

Indian farmers have always understood these inter-relationships. So it is not surprising to find that they are not just practitioners of agriculture but a mix of agriculture, animal care and sylviculture. This requires them to increase the productivity of all the components of the village ecosystem—grazing lands, forestlands, croplands, water systems and animals. There is also an increased focus of the government on integrated development of rural areas through the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which legally mandates village planning based on local natural resources (see 'Case study # 1', *p16*).

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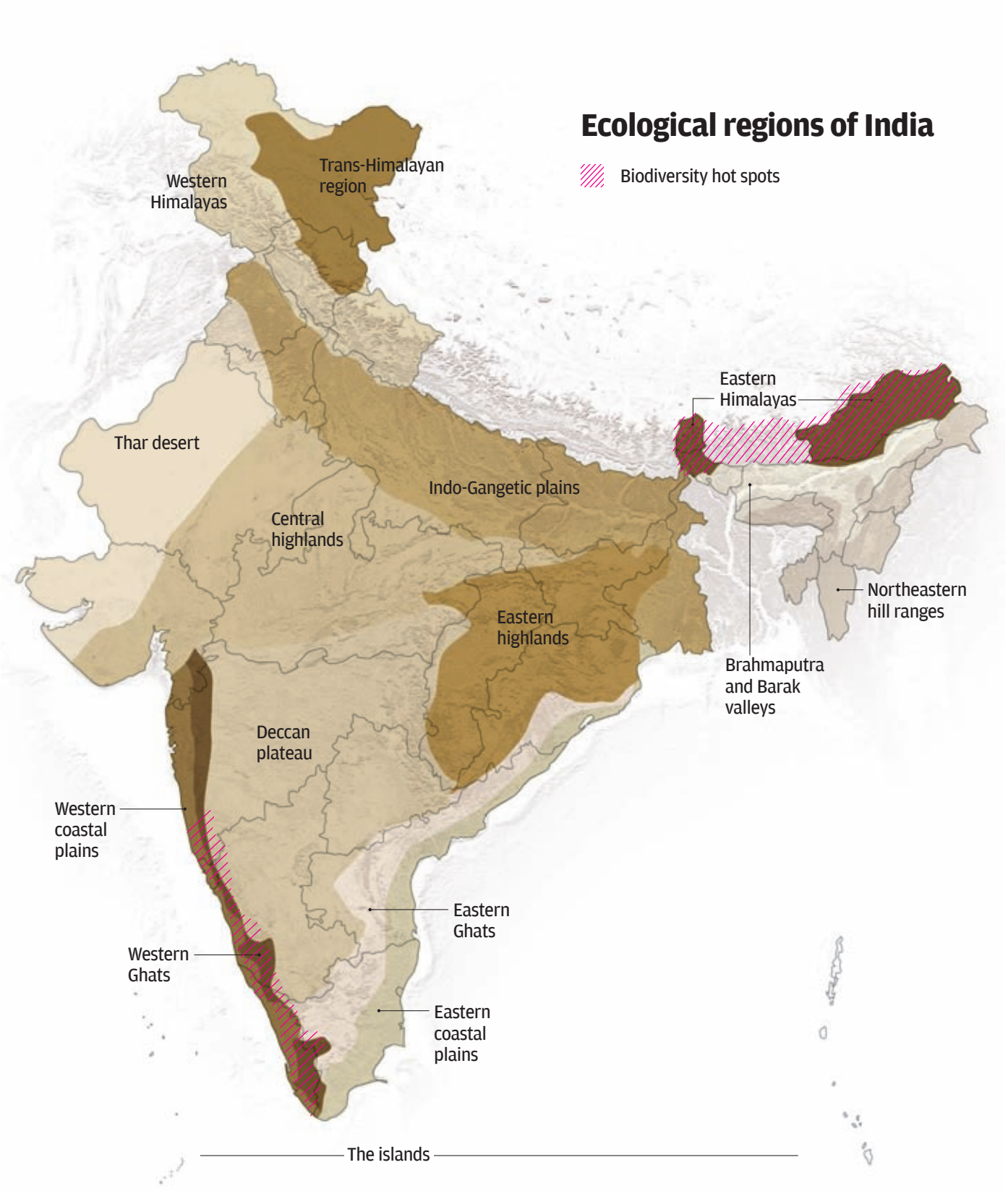

Source: Towards Green Villages: A strategy for Environmentally Sound and Participatory Rural Development, Centre for Science and Environment, New Delhi

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RELEVANCE

Water conservation is a must to secure the future of India, which is fast becoming water scarce

CASE STUDY #1

A Village of Lakhpatis

A water scarce village adopts simple methods to increase the income of farmers by 700 per cent

IN THE drought-prone Marathwada, a region of Maharashtra, residents of Kadwanchi village in Jalana district are least worried about the drought or the next monsoon. In fact, they have not been bothered by any drought in 20 years, including the drought of 2012, the worst in 40 years. Rather, as one enters into a conversation with residents, the discussion is about agricultural expansion. And not without reason: in the past 20 years, the income of its residents has gone up by 700 per cent.

The village has seen a sharp decline in drought vulnerability since 1996, when the Kadwanchi watershed project was launched. At that time, 100 per cent farmers in the village would report crop failure during a drought. The project, launched under the national watershed development programme, was implemented in the village between 1996-97 and 2001-02 with a financial outlay of ₹1.2 crore. "We did not think much of the work the officials were doing. They constructed *bunds* and trenches, and planted trees on a patch of forestland in the village to showcase how effective these methods were in fighting drought. These steps slowed the flow of running water, increased seepage and recharged groundwater. They had an impact on the nearby areas as well. Within two years, the wells in surrounding areas started recharging and the soil gained moisture. This compelled us to understand the techniques," says Vishnu Bapurao, 58, a farmer who earns more than ₹10 lakh a year. The project helped increase the total cultivated area in the village from 1,366 ha in 1996 to 1,517 ha in 2002.

JITENDRA / CSE

Once the water scarcity was over, the farmers started growing grapes, apart from rice and wheat. This required drip irrigation for which farmers constructed small farm ponds by taking loans from banks. The ponds store rainwater and provide water throughout the year. The village had 357 ponds in 2015. For grape cultivation and pond construction, the farmers received training by the Krishi Vigyan Kendra (KVK) of Jalana, which also oversaw the implementation of the project.

Grape farming phenomenally raised the income of the farmers. According to a 2012 survey by the Central Research Institute for Dryland Agriculture (CRIDA), the average annual income of farmers in Kadwanchi increased from ₹40,000 in 1996 to ₹3.21 lakh in 2012—a 700 per cent rise. As per the data by the National Sample Survey Office (NSSO) in December 2014, the nationwide average annual income of farmers is around ₹72,000. Farmers in Kadwanchi earn four times the national average.

LESSONS

- **Watershed development should be an integral part of ecosystem conservation**
- **Water conservation should be at the core of village development planning**
- **Revival of traditional water harvesting structures makes both ecological and economical sense**

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RELEVANCE

Chemical free farming pays rich dividends to the village community

CASE STUDY #2

The Domino Effect

The story of a drought ravaged village that adopted a simple sustainable practice to change its fortune

IN THE Bundelkhand region of Uttar Pradesh and Madhya Pradesh, a few villages are overcoming consistent drought by innovating. In 2010, Haldin Patel, a 36-year-old marginal farmer from Majhout village in Chhatarpur district of Madhya Pradesh, was struggling to feed his family of five with an income of around ₹10,000 a year. He had to do odd jobs in Delhi and Jammu and lease out part of his field to tenants and share croppers. On his 1 ha, he used to spend more than half the cost of inputs on chemical fertilisers.

JITENDRA / CSE

Things changed when farmers were trained to make organic fertiliser using cow urine, neem leaves, water and gram flour. In March 2011, an advocacy group Harit Prayas funded by Caritas, a Rome-based non-profit that works on livelihood issues, started training small and marginal farmers in making the organic fertiliser.

"I was the only person who dared to prepare my own fertiliser in a village of 250 households after the training," says Patel. Though social pressure made him throw the fertiliser in a corner of his field, a little after a month, everybody saw the results. Not only did the ginger sapling mature before its time, it was much better in quality.

Today, the cost of production for Patel has reduced to less than ₹5,000 and his income has increased to more than ₹30,000, after integrating livestock with agriculture.

Following Patel's example, many small farmers in Majhout opted for organic farming and saw an increase in their income. The effect was also seen in adjoining villages. In a tribal village 13 km from Majhout, agriculture had become a loss-making venture. Farmers had to work as labourers in Jhansi and nearby towns. Till 2013, the village wore a deserted look. Patel decided to travel with the Caritas team and convince the farmers about the benefits of organic farming.

Many people, like Mohan Manjhi, stopped migrating since they started organic farming in Karoundia village in Chhatarpur district. "Everybody now rear cattle and prepare their own fertiliser," says 42-year-old Manjhi, who owns 2 ha of land.

The initiative has been catching up in village panchayats like Bhasaur, Cylon, Kavar, Saliya, Dongariya, Amronia, Lahar, MajgowanKota, Tapara and Dharmapara of Chhatarpur district.

LESSONS

- **The expensive and environment polluting chemical fertilisers can easily be replaced by self-made organic fertilisers**
- **Organic fertiliser is easy to make and inexpensive**
- **Organic farming requires less inputs and thus benefits marginal and small farmers. It has the potential to prevent their migration to cities**

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SUNITA NARAIN

Director General,
Centre for Science
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LECTURE #1

The Environmentalism of the poor

IS POVERTY THE biggest polluter? No. Our policy to keep poor out of environmental discourse has led to a highly polluted nation

WE KNOW that the poor are the worst affected by environmental degradation. They live in poverty; have the highest exposure to pollution; drink contaminated water, breathe polluted air; and depend on depleting forest resources for survival. Research over the years has made it clear that the poor, through their intensive use of natural resources, are not responsible for environmental degradation. It is the extensive use of resources on a commercial scale, involving highly energy-intensive and extractive industrial methods, by the rich that is primarily responsible for degradation.

In the 1970s and '80s, it was widely said that the "other energy crisis" is firewood for cooking as supply was short and women had to spend hours walking to collect this basic need. It was also said that this use of energy by the very poor would destroy forests. In 1973, after the first oil shock, the Indian government set up the Fuel Policy Committee, which noted that the widespread use of non-commercial sources of energy had led to a large-scale denudation and destruction of forests. But there is little evidence of that.

Anil Agarwal, founder of the Centre for Science and Environment, was always fascinated by women's requirements for cooking energy. In the early 1980s, he organised the country's first conference on this issue. In 1982, writing in the first citizens' report on environment, he warned of an impending firewood crisis, as demand would outstrip supply. He also said there was little evidence to suggest that the "energy-gathering families of India were responsible for deforestation as then all trees should have disappeared by now". The poor only collected twigs and branches. The "biggest threat to forests is because of commercialisation of firewood—growing use in urban areas".

Agarwal asked this question again in the late 1990s. He found that his earlier assessment was confirmed by developments over the two decades. By then there was no apparent firewood crisis, even though all evidence suggested that biomass use for cooking continued across India. He analysed data from the National Council of Applied Economic Research (NCAER), which showed that the firewood demand in urban areas had dipped because of the switchover to commercial fuels like LPG and kerosene. Subsidies had made these two fuels cheaper than even firewood for urban areas.

The NCAER survey, published in 1995—the last such country wide assessment of cooking fuel consumption—compared its data with the results of the previous survey done in 1978-79. It found that in 1992-93 the total household energy use in rural India was 153.4 million tonnes of coal replacement—coal replacement being the amount of coal that would be needed to replace 1 tonne of firewood. Of this, 30 per cent energy came from firewood twigs and another 32 per cent from firewood logs. But this better quality log was not coming from forest. The survey found that between the two decades, the percentage of households collecting firewood from forests had halved. Instead, firewood was coming from farms and other lands. On analysing data from other studies, Agarwal found that the other firewood crisis had been averted because people were using exotic invasive weeds like *Prosopis juliflora* trees for tree plantation. People were not dependent on forests for firewood and, therefore, large-scale forest destruction (as predicted in the 1970s and 1980s) had not happened. The 2011 State of Forest Report, published by the Forest Survey of India, corroborates this. It estimates that in 2010 the total fuelwood used was 216 million tonnes. Of this, only 60 million tonnes, or 27 per cent, came from forests. The rest came from private or wasteland. "All

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this evidence points out that people have averted the ecological crisis through a rational response of community and individual action. But very little is studied or understood of what people have done and at what cost," Agarwal wrote in 1999. Since then even fewer studies have been done on the firewood demand for household energy use.

In India, Census 2011 shows that 75 per cent of rural households continue to use biomass and dung to cook, as against 21 per cent of urban India households. In the last two decades, between 1993-94 and 2009-10, when urban India moved to LPG (from 30 per cent to 64 per cent), rural India, at 76 per cent, remained where it was, cooking on highly inefficient and polluting *chulha*—cookstove for poor women who collect sticks, twigs and leaves to cook meals.

Sadly, the international community today is equating the survival emissions of the poor with the luxury emissions of those who drive to work and live in air-conditioned comfort. The 2010 *Global Burden of Disease Study* established that indoor air pollution from cookstoves is a primary cause of disease and death in South Asia.

The bulk of what is defined as renewable comes from biomass burning, from the very stoves of poor families. The poorest, therefore, provide the world the perfect opportunity to leapfrog—they can move from using renewable energy, currently polluting, to other renewable energy sources that are healthy for them and for the world. We need cooking devices that can be sold, distributed, need to find approaches that move the poorest to clean sources of cooking fuel.

It is clear that the discourse on environment and development must be reframed so that it is built on the premise that sustainable growth and development is not possible if it is not equitable.

Q & A

Why will environment management not work if it does not address the poor?

The involvement of local communities in environmental management is a pre-requisite for sustainable development. It is also important that this environmentalism of the poor—building bottom up, based on the principles of equity and human need—must influence the world. But most importantly, we must re-articulate that the environmental challenge is not technocratic but political. We cannot neuter politics of access, justice and rights, and still hope to fix environmental problems.

Can you give an example where solutions have not worked, as the poor was not kept in mind?

Consider air pollution in cities. Estimates show that only 15 per cent of people living in Delhi commute by car. Can these cities combat air pollution, given that more and more people will drive? Is it possible to plan for the remaining 80-85 per cent?

Clearly, it is not possible. Our research has pointed out that unless we reinvent mobility at a scale not seen before, we cannot have clean air. A few years ago, in a landmark judgement, the Delhi High Court had ruled that roads need to be planned taking into account "equity of use"—those who use more, should get more space. Today, the bulk of our cities' population walks, cycles or takes a bus. It does so because it is poor. Therefore, unless the strategy to combat air pollution moves from fixing the tail-pipe emissions of each car to planning for affordable and inclusive mobility, we will not get clean air. Solutions must work for the poor, for them to work for the rich.

OTHER PUBLICATIONS BY THE AUTHOR

- *Why I should be tolerant? On environment and environmentalism in the 21st century*, Centre for Science and Environment (CSE)
- *Capitan America, US climate goals: a reckoning* (Co-author: Chandra Bhushan), CSE
- *Excreta Matters: Seventh State of Environment Report*, CSE
- *Paryavaran Ki Rajneeti* (Hindi), CSE
- *Reclaiming Nature-Environmental Justice and Ecological Restoration* (With James K Boyce and Elizabeth A Stanton); Anthem Press, London
- *Making Water Everybody's Business: Policy and Practice of Water Harvesting* (With Anil Agarwal), CSE
- *Poles Apart: State of Global Environmental Negotiations*, CSE

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FIELD TRIP #1

The Apatani Valley

The Apatanis weave a unique economy around a fragile ecosystem

VIKAS CHOUDHARY / CSE

SURROUNDED BY wooded hills in Lower Subansiri district of Arunachal Pradesh is the small Apatani valley, covering 26 square kilometres. The Apatani heartland can be accessed easily as there is a road leading right up to it. *Jhum* or burn and slash cultivation is predominant in this region but not in Apatani valley. Embedded in hills that rise up to 2,400 metres, this oblong valley is home to arguably the most intensively managed wet-rice cultivation in the world. Apatanis have access to relatively small tracts of forests and hills. Stacked into a small area, the community manages space by designing compact homesteads.

Apatanis have a unique forest management system. They demarcate their forests: there are private bamboo forests, private mixed forests, clan forests, common forests and sacred groves. The private forests and the clan mixed forests are often dominated by the oak species *Castanopsis indica*. They also have the blue pine species *Pinus wallichiana*. Wood is the only source of fuel and energy here. The forest land is limited and keeping the forests intact requires constant work. The seedlings and saplings are tended and replanted at the first sight of open space, keeping the basic idea of sylviculture in mind. The saplings from the deeper forests are transplanted into private groves in the months of February or March. Apatanis do not promote monoculture. The

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fruit-bearing species like cherry, peach, pear and a bitter tasting subspecies of apple are also grown here.

Little input, high output

The homesteads are built from bamboo and pinewood. Many bamboo varieties grow wild in the hills surrounding the valley. However, in their private groves, the Apatanis grow *bije* (*Phyllostachys bambusoides*). Also known as Apatani bamboo, *bije* is literally the pillar of the Apatani society. It's a medium-sized, straight-stemmed plant that stands up well to the region's frosty winters. A study by R C Sundriyal and his colleagues at the G B Pant Institute of Himalayan Environment and Development shows that *bije* grown in the private groves provides for 90 per cent of the Apatanis' bamboo demands. An absolutely new Apatani house requires 2,500-3,000 bamboo culms and people in the valley require 391,400 bamboo culms for construction purposes, every year. The analysis also reckons that 472,204 bamboo culms are used for fencing every year, while 112,681 culms are used for making different products in rural settlements in the Apatani valley. These numbers initially appear staggering, especially because the valley's population is just 40,000. But the community has never needed to buy any of these resources from the market. The country fares badly in comparison, importing wood in millions of tonnes. A lot can be learnt from them.

Energy-efficient ecosystem

Apatanis grow more than six varieties of rice. The rice fields are meticulously terraced land irrigated by canals that draw water from streams in the valley. Water levels are controlled in plots—with gradients as tiny as a few centimetres—via bamboo tubes. Irrigating the flatter plain lands is more arduous: each drop of water has to be pulled as far as possible over an ever-decreasing gradient, through manually dug canals with bamboo scaffoldings. The canal walls are held together by plant varieties, such as *Eleusine coracana*, which bind the soil and also provide end-season leafy vegetables.

Every inch of the canal bund is used intensively. This demands maintenance. People get down to it right after the rice is harvested. The community collectively maintains canals till the feeder points; individuals tend them near their fields.

The intensively used soil needs extra nutrients and the Apatani has it all worked out almost magically. Huge volumes of biomass from the mixed-oak forest on mountain tops are the source of nutrients at one end. At the other, houses with piggeries supply recycled waste. The two create a graded system of soil fertility, with nutrient-rich plots closer to the village and nutrient-poor ones consigned to the middle of the fields. Apatanis also turn their agricultural fields into fishponds. Fish culture—usually that of the common carp—in plots closer to the village synchronises well with the late-ripening rice variety. The ponds are managed as meticulously as the irrigation canals. It is a tricky business: too much water in a plot and the standing crop would be destroyed; too little and the fish won't survive. The balance is crucial. The fish seeds are introduced when the water is rich in nutrients. Also, the fish must share nutrients in the water with the paddy: so, fish seedling numbers have to be carefully calculated.

The energy efficiency of the Apatani agroecosystem is 60 to 80 joules per joule of input. Green Revolution agriculture fares dismally in comparison: it gives less than a joule for every joule of input. The valley's energy input-output ratio is also considerably higher than that of other traditional mountain systems in the region.

Change is here

Today, many aspects of Apatani life are showing signs of transformation. Some Apatani educated youngsters are migrating out to Itanagar, the capital of Arunachal Pradesh, and even further, in pursuit of jobs. The fields and groves are left unattended making it the biggest challenge before the Apatani society.

The bamboo hay roofs are giving way to fire resistant tin roofs. Horticulture is preferred more. But forests need to be cleared for horticulture, resulting in the decrease of the runoff from the mountains, increase in erosion and reduction in the nutrient flow to the fields affecting agriculture.

WHAT TO DO

- Visit the rice fields where water levels are controlled by bamboo tubes
- Compare the energy output efficiency of Apatani agroecosystem with that of modern agriculture
- Observe the usage of bamboo in the daily lives of Apatanis
- Make a note of the changes this mountain ecosystem is going through and analyse the factors that threaten its sustainability

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AN URBAN NIGHTMARE

Our cities are polluted and congested, and the authorities seem unable to cope. Will they become healthy abodes again?

VIKAS CHOUDHARY / CSE

India has been witnessing an explosive urbanisation, and today urban areas are regions meant only for us—*Homo sapiens*. Indian cities are in a rut. Urban population explosion, needs of modern comfort and aspirational pressure have turned them into unmanageable monsters. The government's development policies are largely governed by the dictum that "India lives in its villages".

Rapid urbanisation is a typical developing nation syndrome and India is no exception. A glance at Census 2011 shows that almost a third of the country's population (377.2 million) resides in its cities. According to the World Urbanisation Prospects report released by United Nations (UN) in 2014, the share of urban population in India was 32 per cent, which was way behind China's 54 per cent. As against developed countries, which urbanised at a gradual pace, developing countries are urbanising faster.

The urban ecology largely focuses on improving conditions of people living together with scant attention to the damages being done to the environment. The cities are in a perpetual state of developmental chaos; laying of cables, drainage lines, roads, additional lanes, flyovers, demolition of good habitable houses to construct malls, business centres or multi-storey apartments are the infrastructural pangs cities have to bear. Today's urban environment is not a natural environment. It is an artificial environment created by humans. The high density of population and rapid industrialisation have polluted the urban environment to a great extent. The polluted water around us and the air that we inhale tell us how ill-equipped we are when it comes to managing our resources.

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How does our air get polluted?

Air pollution in urban areas is the result of a complex mix of anthropogenic (emissions from vehicles, industries, waste burning and crop burning) and natural sources like road dust. Primary air pollutants like soot, lead, asbestos, oxides of carbon and nitrogen, sulphur dioxide (SO_2), methane, benzene are released directly from a source, like our cars, into the air while secondary air pollutants are ozone and sulphur trioxide.

According to the World Health Organization (WHO), air pollution is the fifth largest killer in India. Among the world's 20 most polluted cities in the world, 13 are in India (see 'State of Cities', *p*24). India is in the group of countries that have the highest particulate matter (PM) levels. Its cities have the highest levels of PM10 and PM2.5 (particles with diameters of 10 and 2.5 microns), and a high concentration of carcinogenic substances, such as SO_2 and nitrogen dioxide (NO_2). This puts the urban people at an additional risk of respiratory diseases and other health problems. States experiencing high premature mortalities are Maharashtra, Delhi, West Bengal, Bihar, Andhra Pradesh, Tamil Nadu, Gujarat, Karnataka, Madhya Pradesh, Odisha and Rajasthan.

Vehicles pollute air throughout their life. With more vehicles being added to the road, the pollutants in the air are exponentially increasing. According to the Ministry of Road Transport and Highways (MORTH), a total of 182.45 million vehicles were registered in India in 2013. According to a study by the Centre for Science and Environment (CSE) in June 2016, Delhi alone has more than 8.9 million registered vehicles. Another 570,000 personal and passenger vehicles enter the national capital every day. Moreover, around 23 per cent of the cars registered in Delhi use diesel as fuel. Diesel cars emit 7.5 times more particulate matter than the petrol versions and produce more toxic NO_2.

Besides, our cities are expanding and are in the thick of construction activities. Dust deposits at the construction sites have taken a toll on the air quality. Silica is the most harmful pollutant released during construction activities. It escapes human body's filter mechanism and reduces lung capacity, making people vulnerable to all kinds of infections. Unpaved roads and the non-greened shoulders of roads also add to the burden of dust emission. In November 2016, when Delhi and the National Capital Region (NCR) were in the grip of heavy smog, the National Green Tribunal (NGT) banned all construction work in Delhi and NCR for a week's time.

Air pollution rears its head at the onset of winter when heavy fog envelopes cities, reducing visibility and causing physical discomfort. In a polluted city like Delhi, fog becomes smog—a deadly mix of pollutants. While firecrackers during Diwali and burning of crops in neighbouring areas worsen the quality of air that is already polluted, meteorological conditions make the air thick and stagnant, thereby trapping the pollution close to the ground. In the northern parts of the country during the agricultural-clearing season (late October and November), burning of agricultural biomass residue is widely practised to remove the paddy stalk and prepare the field for wheat cultivation. Punjab alone burns 18 million tonnes of paddy straw during this period, and contributes 12-60 per cent of the particulate matter concentrations that chokes Delhi.

Polluted rivers and vanishing wetlands

Water pollution is fast emerging as another critical issue in India. According to the Central Pollution Control Board (CPCB), the discharge of untreated sewage is the single most important source of water pollution in India. Today, urban India is soaking up water, polluting rivers and drowning in its own excreta. The sewage invariably goes into streams, ponds, lakes and rivers, polluting the water system and putting at risk the health of people to whom this water is supplied. India generates a massive 38,000 million litres of sewage every day. The government has the capacity to treat only 12,000 million tonnes—or, less than one third of the muck. The 35 metropolitan cities of the country produce 15,644 million litres of sewage daily (see 'State of Cities, Sewage generation/ treatment', *p*26). And most of our rivers today carry this load of excreta and industrial effluents.

We are slowly killing our rivers. In the hills, we dam them—drawing water for electricity

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STATE OF CITIES

Air pollution is now a chronic problem in small cities

Metropolitan cities are not the only ones that bear the brunt of air pollutions. The scenario is equally scary in small cities across India

AIR POLLUTION LEVELS EXCEED THE PRESCRIBED STANDARDS IN 85% CITIES

City	Cause of pollution	Pollution level	PM10 level in µg/m3
Agra	Vehicles and industries	Critical*	182
Allahabad	Vehicles and industries	Critical	250
Amritsar	Information not available	Critical	187
Bengaluru (BBMP)[1]	Vehicles and industries	Critical	140
Bhopal	Vehicles and industries	Critical	156
Delhi (DMC)[2]	Natural dust, vehicles and industries	Critical	215
Faridabad	Vehicles and industries	Critical	197
Ghaziabad	Vehicles and industries	Critical	246
Gwalior	Vehicles and industries	Critical	148
Hyderabad (GH)[3]	Vehicles and industries	Critical	98
Indore	Vehicles and industries	Critical	144
Jaipur	Vehicles and industries	Critical	154
Jodhpur	Natural dust, vehicles and industries	Critical	189
Kanpur	Vehicles and industries	Critical	199
Kolkata	Natural dust, vehicles and industries	Critical	107
Kota	Natural dust, vehicles and industries	Critical	128
Lucknow	Vehicles and industries	Critical	175
Ludhiana	Vehicles and industries	Critical	152
Meerut	Vehicles and industries	Critical	154
Mumbai	Vehicles and industries	Critical	95
Nagpur	Vehicles and industries	Critical	93
Navi Mumbai	Vehicles and industries	Critical	151
Pune	Vehicles and industries	Critical	92
Raipur	Vehicles and industries	Critical	329
Ranchi	Vehicles and industries	Critical	197
Varanasi	Vehicles and industries	Critical	139
Ahmedabad	Vehicles and industries	High**	85
Aurangabad	Vehicles and industries	High	85
Jabalpur	Vehicles and industries	High	69
Surat	Vehicles and industries	High	89
Vadodara	Vehicles and industries	High	87
Vishakhapatnam (GVMC)[4]	Vehicles and industries	High	64
Chennai	Information not available	Moderate***	59
Coimbatore	Vehicles and industries	Moderate	48
Madurai	Information not available	Moderate	45
Howrah	Vehicles and industries	Data not received	–
Patna	Vehicles and industries	Data not received	–
Srinagar	Natural dust, vehicles and industries	Station not operational	–

As per 2011 Census, India has 46 million-plus population cities in 16 states and one Union Territory

Cities falling under Critical pollution level (*) and High pollution level (**) are not meeting the National Ambient Air Quality Standards (NAAQS) PM_{10}, which is 60 µg/m³; Locations falling under Moderate pollution level (***) are meeting the standards as of now but are likely to exceed the standards in future if pollution is not controlled; 1: Bruhat Bengaluru Mahanagara Palike; 2: Delhi Municipal Corporation; 3: Greater Hyderabad; 4: Greater Visakhapatnam Municipal Corporation
Source: Ministry of Environment and Forests and Climate Change, Lok Sabha, July 28, 2015

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generation and irrigation. Once the river hits the plains, it becomes a dumping ground. It's a double trouble for the river and a misfortune for those who live along it. Large stretches of key rivers have become so polluted that they are not even safe for bathing. Today, 275 of the 445 rivers in the country are polluted. It was 121 in 2009. The UN has declared the Ganga one of the fastest shrinking and most threatened rivers in the world. According to the Government of India sources, 2.9 billion litres of raw sewage is discharged into the Ganga every day. More than half the length of the Ganga is now considered unfit by CPCB.

Indian cities have traditionally been managed by storm water drains, which offer the twin benefits of drainage and rainwater harvesting. There are countless instances where a city's drain, or *nullah*, was actually a river. Buddha Nullah in Ludhiana is referred to as a drain because it is that—full of stench and filth. But not so long ago, it was referred to as *darya* (river)—then it was a clean freshwater stream. Its form and name have changed in just one generation. When floods drowned Mumbai in 2005, it was found that a drain called Mithi, was clogged and marred by encroachments. This "drain", which originates near the city, is actually a river.

A study published in the *Journal of Environmental Protection* in 2011 shows that the country lost 50 per cent of the lakes and wetlands, spanning 911,992 ha, in the last century. Considered as liquid treasures of a country, wetlands are not only home to unique flora and fauna but play an important role in the ecological security. Srinagar witnessed high casualty during the 2014 floods because of encroachment of wetlands and channels (see 'Case study #4', *p*28).

Spilling waste

Waste is a by-product of living. Waste is being generated at a faster rate than urbanisation. In our haste to get rid of wastes, we have created garbage mountains, and while the quantum of waste that is being generated is increasing, our capacities to collect, transport, dispose and reuse garbage is going down. Studies show that India's waste has more than doubled in the past 25 years. In 2008, India produced 48 million tonnes of solid waste. As per the latest CPCB report in 2016, India produced some 52 million tonnes of waste each year or roughly 0.144 million tonnes per day. As a result, cities are drowning in piles of refuse, adding to public health challenges. Waste has also contaminated groundwater and sub-soil water besides putting out toxic emissions and dust into the atmosphere.

According to CPCB estimates, over 90 per cent of Indian cities with a functional collection system dispose of their waste in landfills. Though landfills are the cheapest modes of disposal, the cost of the land and its sheer availability is not accounted for. The Department of Economic Affairs' position paper on solid waste management projects that by 2017, India would produce 260 million tonnes of waste annually, needing over 140,000 ha of landfills.

To find an answer to the increasing waste, technologies, such as converting waste to energy, have caught policymakers' imagination. The problem is not to find the right technology for waste processing, but to integrate technology with a system of household level segregation, collection and transportation of waste, and all this in ways that are both affordable and manageable by city local bodies. Waste has to be segregated at the source. Segregation at source should therefore be the priority for effective solid waste management in India.

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STATE OF CITIES

Sewage generation / treatment

India is one of the world's fastest urbanising countries, and its urban population is increasing at a very fast pace. This is a cause of worry for a country which is already struggling with sewage management. Only 37% of sewage generated in Class I and II cities is treated. The widening gap between sewage generation and the capacity to treat is going to be a tough challenge.

STATUS OF SEWAGE GENERATION AND TREATMENT CAPACITY OF URBAN POPULATION OF INDIA

State	Urban population	Sewage generation in urban areas in MLD*
Andaman & Nicobar Islands	135,533	20
Andhra Pradesh	28,353,745	4,196
Arunachal Pradesh	313,446	46
Assam	4,388,756	650
Bihar	11,729,609	1,736
Chandigarh	1,025,682	152
Chhattisgarh	5,936,538	879
Dadra & Nagar Haveli	159,829	24
Daman & Diu	182,580	27
Goa	906,309	134
Gujarat	25,712,811	3,805
Haryana	8,821,588	1,306
Himachal Pradesh	688,704	102
Jammu & Kashmir	3,414,106	505
Jharkhand	7,929,292	1,174
Karnataka	23,578,175	3,490
Kerala	15,932,171	2,358
Lakshadweep	50,308	7
Madhya Pradesh	20,059,666	2,969
Maharashtra	50,827,531	7,522
Manipur	822,132	122
Meghalaya	595,036	88
Mizoram	561,977	83
Nagaland	573,741	85
NCT Of Delhi**	16,333,916	3,838
Odisha	6,996,124	1,035
Puducherry	850,123	126
Punjab	10,387,436	1,537
Rajasthan	17,080,776	2,528
Sikkim	151,726	22
Tamil Nadu	34,949,729	5,173
Tripura	960,981	142
Uttar Pradesh	44,470,455	6582
Uttarakhand	30,91,169	457
West Bengal	29,134,060	4,312
Total	**377,105,760**	**57,233**

*Source: State of India's Environment 2016, CSE - Down To Earth; *Million Litres per Day; National Capital Territory of Delhi*

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RELEVANCE

Rapid urbanisation is the cause of increasing urban floods

CASE STUDY #3

Chennai Floods

Unplanned urbanisation can lead to catastrophic disasters, bringing to fore the constant tussle between nature and human encroachments

ON DECEMBER 1, 2015 houses on the ground floor in Jafferkhanpet, a neighbourhood in southern Chennai, started to inundate because of torrential rains gradually engulfing 80 per cent of the city under four metres of water. The situation continued for the next 72 hours, killing over 500 and destroying infrastructure worth ₹500 crore. On December 1, Chennai received 300 mm rainfall, making it the wettest December day ever recorded in the city. The normal rainfall for Chennai in December is 191 mm. The India Meteorological Department (IMD) in mid-October issued a forecast that predicted 11-12 per cent above normal rains in the southern states with a probability of about 90 per cent.

ARUN SHARMA

Enough reasons for disaster

A 2014 analysis by the Indian Institute of Science, Bengaluru, shows that the rate of urbanisation in Chennai has increased by 20 times in the past four decades—and the city has expanded at the cost of destroying the city's natural flood sinks, such as marshlands and river channels. The concrete jungles obstruct and encroach upon the natural flow of waterbodies and create pockets that trap water, which increases the flood intensity. Concerned citizens groups have moved courts several times to save the wetlands. In September 2015, the Madras High Court ordered all the authorities concerned to remove encroachments from the marsh of Pallikaranai lake. Laws, such as the Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007, have not been able to save the wetlands in the city, say experts.

The existing rules and regulations are not strong enough to protect the urban lakes. This is the reason the three rivers in Chennai—the Cooum, Adyar and the Kosathalaiyar—are highly encroached upon. The city has four sewage treatment plants, but the treated water that flows through natural channels often gets mixed with untreated wastewater from colonies and industries on the way. The sewage generated by the people gets mixed with the water runoff and clogs the natural channels and storm water drains. Even the city's numerous water bodies and marshlands that should have acted as sponges are either encroached upon or over polluted.

The management of untreated sewage and solid waste should be done on a war footing to avoid choking of drains. Strong regulations should be implemented to stop encroachment of the wetlands and water channels.

LESSONS

- **Urban floods can happen due to unplanned urbanisation as it hardly leaves space for natural flow of water**
- **Encroachment of wetlands and other small water bodies does not let water to be absorbed; results in flooding**
- **Improper sewage treatment results in the clogging of storm water drains which lose their capacity to carry extra load of water**

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RELEVANCE

Wetlands and lakes are necessary to prevent floods

CASE STUDY #4

Kashmir: Caught Unawares

Srinagar, famous for its traditional ponds and tanks, makes way for commercial complexes and parks, resulting in environmental degradation

THE RAINS began in jammu and Kashmir (J&K) on the morning of September 3, 2014. On the night of September 4, the Doodh Ganga, a tributary of the Jhelum flowing through Srinagar, breached its embankment following a cloudburst in its catchment area. On September 5, the water level in the Tawi and Chenab rivers in Jammu rose dramatically. Flood control bunds were washed away, bridges collapsed and agricultural land got submerged. Rains continued to lash the region in the next few days triggering landslides that disrupted highways and snapped power lines. On the night of September 5, the Jhelum too breached its embankment at Padshahi Bagh.

In September 2014, rainfall in Srinagar crossed its 10-year-high mark—151.9 mm of rainfall in September 1992—within 24 hours. This year, the city received 156.7 mm of rainfall on September 5 alone. The average monthly rainfall for Srinagar is 56.4 mm. The India Meteorological Department recorded more than 500 mm of rainfall in the first week of September. The two distinct water channels flowing through the city—the Jhelum and the flood channel, an artificial outlet created in 1904 to drain out excess water from the Jhelum in case of flood—had merged into a big, brown lake. Several localities in Civil Lines remained submerged under two metres of water.

REUTERS

In flood-ravaged Jammu and Kashmir, the streets of the state's summer capital, Srinagar, resembled surging streams. The drainage channels of the city were blocked. The links connecting the lakes have been cut off due to unplanned urbanisation and encroachment. As a result, the lakes have lost their capacity to absorb water the way they used to a century ago. Wetlands and lakes act as sponges during floods. Apart from natural ponds and lakes, the Kashmir valley has other types of wetlands, such as rivers, streams, riverine wetlands, human-made ponds and tanks. Dal Lake in Srinagar, one of the world's largest natural lakes, covered an area of 7,500 ha in 1,200 AD. The lake area almost reduced to one-third in the 1980s and has further reduced to one-sixth of its original size in the recent past. It has lost almost 12 metres of depth. Srinagar's natural drainage system has collapsed, making it prone to urban floods. According to a report by the Department of Environment and Remote Sensing, there are 1,230 lakes and water bodies in the state—150 in Jammu, 415 in Kashmir and 665 in Ladakh. Dal Lake, Anchar Lake, Manasbal Lake and Wular Lake are some of the larger wetlands in the region which are today threatened by urbanisation.

Kashmir floods should be an eye opener for other cities that are in the race for urbanisation.

LESSONS

- **Wetlands are unique ecosystems and play an important role in the hydrology of an area**
- **Conservation of waterbodies must be an essential component of urban planning**
- **Construction of flood water drains is as important as laying of roads and other infrastructure while expanding a city**
- **Low-lying areas should be used as drainage basins and not for construction**

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TANMAY TATHAGAT

Principal at Environmental Design Solutions, Delhi

LECTURE #2

Small steps towards green buildings will result in a giant leap towards sustainable cities

THE INDIAN economy has grown rapidly over the past decade and is expected to sustain this growth over the next few decades. The country's building sector is growing in tandem with the economy. In fact, the total built-up area is expected to swell five times of its current size by 2030. Such rapid growth will further increase our demand for energy, water, minerals and other natural resources, exacerbating environmental problems.

The building construction industry consumes 40 per cent of the materials entering the global economy, and accounts for 40-50 per cent of the greenhouse gas (GHG) emissions and agents of acid rain. Their impact on the environment would be even higher if one considers the GHG emitted during the production of cement, bricks, steel, glass and other construction materials. Such concerns underscore the need to create sustainable buildings and cities worldwide.

But making buildings truly sustainable and green in India remains a major challenge. One of the major problems is that our design industry and developers ape the Western design and comfort ideals, ignoring the fact that their climate and lifestyle are drastically different from those of India.

Besides, our policy-making bodies at the Centre are yet to understand the significance of energy efficiency in the building sector. Tough standards are wrongly seen as impediments to growth and the industry, and most policies tend to opt for voluntary compliances or less stringent standards. In the absence of mandatory standards for green and energy-efficient buildings, most municipalities do not have a uniform and practical energy code, especially for passive and solar designs. Those who have the code in place do not have effective infrastructure for its enforcement and administration. There are also no clear guidelines for state and municipal bodies for developing and implementing uniform building energy efficiency programmes and policies.

International experience shows that mandatory and uniformly implemented codes and standards are the only way to achieve a substantial impact of energy-efficiency measure. Though the Energy Conservation Building Code (ECBC) is being implemented in India, it is moderately stringent. The country needs a dynamic building energy policy with long-term goals that can shape the future of the sector.

A zero net-energy building target could be a major leap in this direction. This will spur innovation for sustainable and super -efficient buildings.

Fostering an ethic for integrated design should be the most important part of the strategy. A building's energy-efficiency, its ability to generate renewable energy and its architectural design and construction can be integrated to achieve the goal of sustainability. But such integration is not commonly practised. Many of the solutions for energy-efficiency and green buildings tend to be product-driven. Such solutions could address individual concerns in a project, but they do not provide an integrated and comprehensive solution. Most design and construction firms do not have in-house resources to integrate sustainable designs. On the other hand, projects, which do invest in high performance building design, often fail to get the desired results because of poor construction, inadequate commissioning and poor physical integration.

Architecture must also respond to climate and culture. New commercial buildings must be designed for day lighting and limiting solar heat gain. Residential buildings must be sensitive to the local climate,

TO IMPROVE THE quality of life and environment in cities, several countries are setting targets of net-zero energy, water, or even carbon, for their communities

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and should have appropriate orientation for shading, insulation, sun protection and cooling through cross ventilation. Addressing these concerns at the concept stage through passive design requires conscious efforts and no incremental cost. The additional cost involved in measures like insulation, better glazing and window frames usually gets offset by lower energy use, with a payback period of less than five years.

Simulation for energy performance of buildings is a powerful tool that architects, engineers and developers can use to analyse how the form, size, orientation and type of building affect the overall energy consumption of a building. Of course, this analysis is approximate and only as good as the inputs provided, but energy modelling is a tool now extensively used and provides accurate results. For instance, glass plays an important role in a building's overall energy consumption. But its excessive use causes glare and overheating, while too little glazing may reduce daylight available inside the building.

To improve the quality of life and environment in cities, many countries are focusing on reducing the environmental impact of construction to the minimum possible, and are moving towards a goal of net zero or nearly-zero energy buildings (NZEB). In fact, targets of net-zero energy, water, or even carbon, have been set for many communities. For example, NZEBs have integrated renewable energy systems that produce as much energy as the building requires throughout the year. Such buildings are likely to draw energy during the peak periods from the grid, and give back excess energy produced when their energy demand is low. These buildings harness all potential advantages from the site, surroundings and are designed for the climate. The decisions about building form, orientation, shading and ventilation, taken during the early design stage have the most significant impact on the energy consumption of the building.

Q & A

What can be done to make people adopt green measures?

The government must address the issues that deter people from adopting green measures, and put in place a strategy to encourage the mass appeal of these measures. Consider this. India has one of the highest electricity tariffs for commercial buildings and the cost of energy-efficient technologies and renewable energy systems has reduced over the years. Yet, their start up costs continue to deter people from adopting the products and technologies. A bigger market for them as well as a policy environment providing incentives for development, implementation and import of such products and technologies are a must for energy-efficient buildings to be mainstreamed.

What deters developers from adopting green measures?

Developers tend to under-invest in green measures because they do not gain from the investment made in energy-efficient buildings, and thus pass on the cost of inefficiency to the buyer and the environment. The current high cost of borrowing money can be a strong impediment to incremental funding in efficiency, which would be offset by future savings in energy costs.

Could you suggest some smart natural ways to make our homes a cosy place?

Use natural ventilations like windows or *jaali*s to let in the breeze. Use desert cooler during hot and dry months of the year, and AC only during the hot and humid months. Shade your windows irrespective of the direction it faces. If it faces west, shade a bit extra because the house is already hot by afternoon. Shading should be done using light material, lightly connected to the wall around the window. Instead of curtains and blinds, an adjustable shade will help whenever the sun is troubling you.

OTHER PUBLICATION BY THE AUTHOR

- *Calibrated Simulation Models of a Passive Building* ; Arizona State University

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FIELD TRIP #2

Sunset over Udaisagar

Udaisagar Lake is under immense pressure and could die in the near future due to anthropogenic activities

COURTESY: JHEEL SANRAKSHAN SAMITI

UDAIPUR, THE historic capital of Rajasthan's storied Mewar region, is known as the Venice of the East for its lakes. Maharana Udai Singh II founded Udaipur in 1559 and built a chain of lakes to make the rainfall-deficient city self-sustainable in water supply. Being the last in the chain of lakes, Udaisagar is fed by the overflow from upper lakes, such as Pichola and Fatehsagar. Several seasonal streams also flow down the catchment hills, spanning 47,900 ha, to replenish Udaisagar. But over the past three decades, the catchments of Udaisagar and other lakes have degraded. Tej Razdan, convenor of the Jheel Sanrakshan Samiti (JSS), an Udaipur-based non-profit, says that according to the data available with his organisation, 10-15 per cent of the total catchment area has been encroached upon in the past decade. In the same period, 15 per cent of forest cover has been lost. Moreover, he adds, the waterbodies atop the Aravalli hills that feed these lakes have been choked with marble slurry deposited after marble mining. A number of national and state highways also pass over the catchment hills. All this is affecting the water flow from upper lakes, reducing the water level of Udaisagar, says Lakshmi Lal Sharma, retired lake expert from the Maharana Pratap University of Agriculture and Technology in Udaipur. Reduced rainfall in recent years has compounded the situation, Sharma adds. The lake is also being threatened by increasing pollution, says Pradeep Kumar Singh, professor at the university. The Ahar, a tributary of the river Berach, is the lake's major source

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WIKIMEDIA COMMONS

WHAT TO DO

- Study the Wetland Rules of 2010, and find out how the Rules can help revive Lake Udaisagar
- Identify polluting industries near the lake and the volume and kind of effluents pumped into the lake
- Find out how the highways passing over the catchment of the lake affect its water levels

of water. But more than water, the Ahar brings domestic and industrial waste into the lake as it passes through Udaipur city. Hindustan Zinc Limited located in the vicinity of Udaisagar, extracts the lake water and releases untreated effluents into it. The biological oxygen demand, a parameter used by scientists to understand the pollution level of the lake, reaches as high as 65 mg per litre which is almost 20 times the permissible limit. The reduced amount of water in the lake has taken away its self-cleansing power, says Sharma, adding that the lake is majorly eutrophicated. The polluted water is highly acidic and affects the groundwater of the neighbouring villages in a diameter of 21 km. But revival of the lake seems distant. There is an island in the middle of Udaisagar where rampant construction is happening and even the Supreme Court has given the go-ahead.

An ugly concrete structure

Till a few years ago, farmers lived on the island and farmed on it. In 2008, Vardhan Enterprises, a Mumbai-based developer, purchased most of its land to construct a five-star hotel on it. JSS in 2010 moved Rajasthan High Court against this construction. The high court slapped a fine of ₹1 crore on the developer and asked it to demolish the structure. In 2014, the developer moved the Supreme Court against the high court ruling, saying the construction site was not a "true island". It was "an island-like area" formed by siltation and the project in no way fiddled with the ecology of the lake. The Supreme Court agreed and the developer resumed construction. The project stopped only after the local residents staged protests.

The Wetland Rules of 2010 is responsible for such a fate of the country's lakes and wetlands. Under the Rules, a wetland and its drainage or catchment area need to be notified by the Centre. Since water is a state subject, the first step of this notification starts with the state government identifying them. If the state fails to identify the wetland or its catchment, then the wetland might be easily killed. This is exactly what has happened in the case of Udaisagar lake, which is in dire need of help for its survival.

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TERMS

Agrosylvopastoral
Under this subdivision of agroforestry, crops, trees and pasture/animals are grown simultaneously on the same piece of land.

Biomass
The total quantity or weight of living matter in a given area or volume. India is a biomass based economy.

BOD
Biological oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.

Biodiversity Hot spot
A biogeographic region with significant levels of biodiversity that is under threat from humans. The Western Ghats is one of the biodiversity hot spot in India.

Cloudburst
An extreme amount of precipitation in a short period of time, sometimes accompanied by hail and thunder. It is capable of creating flood conditions.

Drip irrigation
A form of irrigation that saves water by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the roots, through a network of pipes. It is an economical way of irrigation in water scarce areas.

Eutrophication
The process of a dense growth of plants in a lake or waterbody, often caused by chemical runoff from surrounding farm lands. This depletes the water of oxygen, thereby affecting the aquatic life.

Invasive species
It is a plant, fungus or animal species that is not native to a specific location. *Prosopis julifera* is an exotic invasive weed.

Sustainable practice
Practice that maintains a condition without harming the environment. An example is the practice of reduce, reuse and recycle.

Sylviculture
Growing and cultivation of trees. Indian farmers practice a mix of agriculture, animal care and sylviculture.

Watershed
An area of land that catches rain and snow and drains or seeps into a marsh, stream, river, lake or groundwater.

Wetland
An area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem.

TASKS

- Write an essay describing an Indian village as a unique ecosystem. Explain the problems the ecosystem has been burdened with.
- Explain the causes of urban flooding. Write the preventive measures that can be taken to reduce the scale of such floods.
- Write an essay on the importance of wetlands.
- How does eutrophication affect aquatic life? Explain.
- Explain the reasons responsible for drying of an urban lake.
- How did farmers in Kadwanchi village overcome the drought problem and what changes did it bring in their lives?
- Describe the state of air pollution in India.
- Why are rivers in India in a poor state? Explain.
- What are the hurdles India has to overcome to turn cities into smart cities?

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