



Rural settlement: The epicenter of sustainability in environmentally challenged India

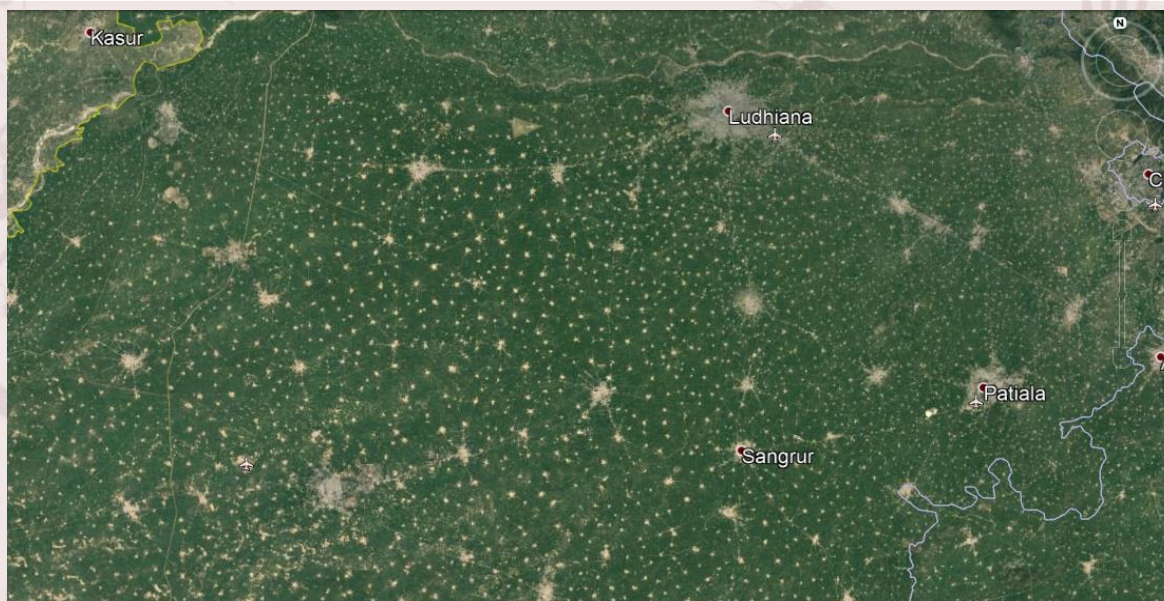
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A countryside...a village...a place of tranquility for many of the urban dwellers. Certainly, the greenery, cultivated field, openness, and mosaic of land parcels tend to mesmerize us. The scenery is even digitally eye-catching in Google earth if you zoom in on the human inhabited areas in India except for the big cities. The settlement studded traditional landscape in rural India often resembles “Starry Night” and is a real-life example of how entangled we are with our environment. The mosaic landscape with vast agricultural fields, water bodies, settlements, road networks along with the sporadic presence of natural forests represents diverse activities, interaction, development as well as destruction.

For any heterogeneous landscape, villages are the key components of the habitat and settlement network sitting at the core of multiple functions like agricultural activities, natural resource extraction, ecological functions, and socio-cultural practices closely tied with the landscape. In tropical countries, Like India, nearly 68.8% of people (Census of India, 2011) are living in villages and are directly connected with the multifaceted dynamics of human-nature interaction

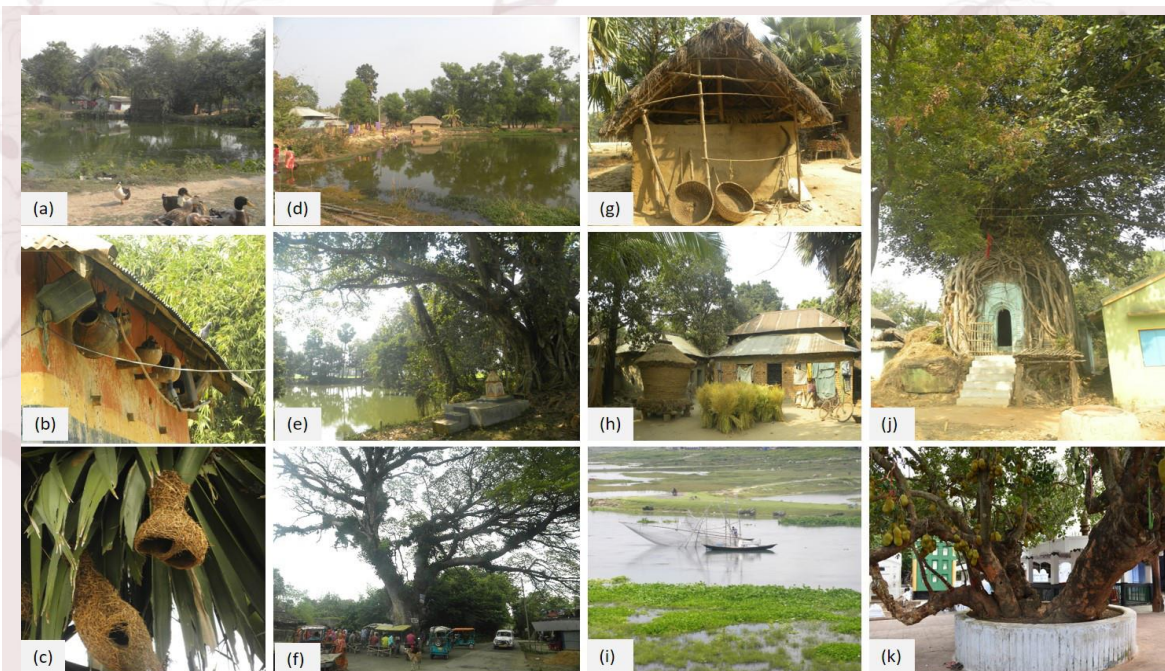


The settlement studded landscape of northern India (Image source: Google Earth, eye altitude 100miles.)

in a low-key mode often not visually discernible but strongly felt. Till the onset of the industrial era, village life was truly revolving around natural dynamics. Industrial advancement completely maneuvered human society towards never-ending demand for earthly possessions and a new level of comfort which subsequently channeled towards uncontrolled natural resource extraction as well as intense landscape modification. Globally, a large volume of the literature suggests how commerce and consumerist economy stimulate deforestation, agricultural intensification, uncontrolled resource extraction, and change in socio-cultural perspective towards nature (Tschardt et al. 2012; Cuaresma et al. 2017; Rasmussen et al. 2018).

Human Settlement: a part of biodiversity

In tropical countries like India, the rural landscape holds the key to biodiversity apart from the apparent grandeur of mountains, rivers, forests, and deserts, the physical components of the ecosystem. Rural landscape with different land-use practices viz., agricultural land with varieties of crops, agroforestry plantations, water bodies, grazing lands with all kinds of human activities (livelihood maintenance, social-religious-cultural practices, etc.) offers sufficient space for multiple organisms to survive and interact. Look around the agricultural field, it is the farmers' choice to allow other plants to grow or faunal members to stay along with crops depending on the availability of the soil nutrients and water, benefits in pest control, and space requirement. Similarly, a plantation drive cannot afford to allow other species to grow other than the desired one due to a high stake in terms of economic return. In this background, the settlement stands apart from our attention. Here settlement means a typical representation of rural houses (ranging from 10 – 60) with varied spatial extent and accessories (viz, home



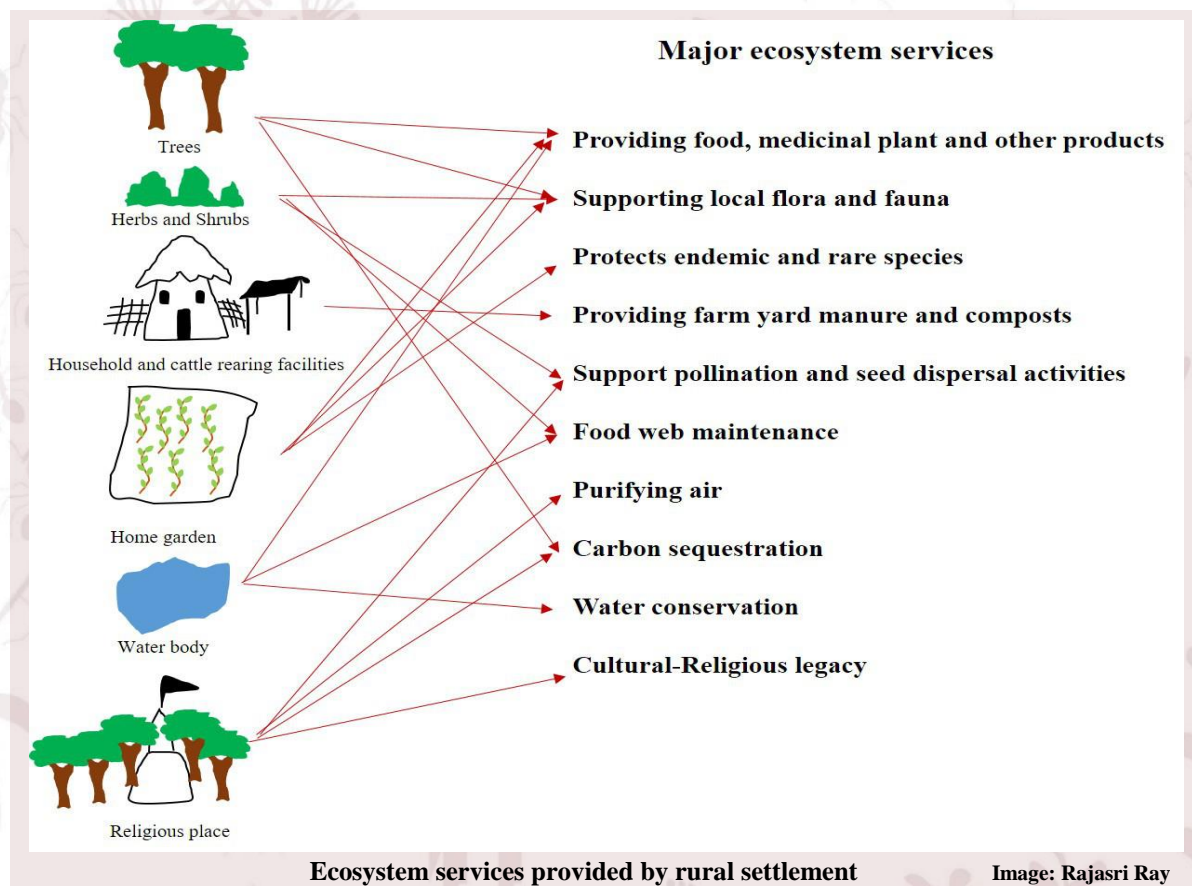
Functionality at the village life. It has different forms, (a) – (c) supporting diversity; (d) – (f) multiple land use forms; (g) – (i) livelihood options and (j) – (k) religious-cultural legacy

Image: Rajasri Ray

garden, cattle sheds, common lands like worship places, water bodies, fallow land, village road, etc.). All these accessory places are usually with some basic vegetation like common fruit trees (mango, jamun, litchi, sapota, banana), shade trees (banyan, pipal, neem, gulmohar), aquatic plants (lotus, lilies, water hyacinth, Azolla), roadside and fallow land trees (tal, date palm, eucalyptus, acacia, bamboo) and common herbs and shrubs depending on area and climate.

This basic plant assemblage in the settlement area provides support for local fauna viz, insect and bird populations, rodents, fishes and other life forms visible and invisible both. Moreover, a good number of household and professional items used to be extracted from natural resources, namely, house building materials (wood, soil, straw), daily needs (containers, furniture, cooking utensils), agricultural implements, medicinal plants, which in a way determine resource availability in the landscape. The list will be extended if we consider household (food habits, clothing, medicine, cleaning, and sanitation) and community practices (social, cultural, and religious rituals, traditional and local artistry, architecture) altogether.

Settlement influences a plethora of ecosystem services combining both tangible and non-tangible ones. However, it is difficult to assess this operating mechanism separately from rural livelihood as every nuance changes, evolution even destruction is attached with day-to-day decision making.



Human intervention and ecological functionality in rural landscape

Anthropogenic intervention shaping the landscape in multiple ways from the early phases of the evolution of the human race, and landscape modification intensified with the origin of agriculture (Ray and Ray 2018). In India, green revolutions in the 60s'-70s' not only emphasized the enhanced crop production but also replaced the inherent traditional sustainable practices. As a result, agriculture with its' current practices like eradication of weeds, application of chemical fertilizers and pesticides, heavy use of machinery, and unregulated use of irrigated water is oriented towards maximization of productivity but at the cost of surrounding ecosystems' health. Similarly, other human mediated spatially explicit areas are waterbodies, plantation plots, etc. which offer less room for multiple life assemblages once anthropocentric demand intensifies.

In terms of biodiversity, the existence of diverse life forms and the plethora of services in a rural landscape is strongly related to how well they interact with each other and with nature. The different life-sustaining functions performed by organisms are the basis of functional diversity in the landscape. A functionally diverse landscape means multiple types of functions viz., self-and cross-pollinations, wind, animal, and mechanical mode of seed dispersals, different nutrient acquisition strategies, diverse growth patterns even competition, cohabitation, adaptation, and destruction at different scales. The web of activities makes a landscape stable, resilient, and productive simultaneously, exemplary of a sustainable system. Human is an integral part of this web not only as a viewer but actively involved as modifiers, creators and destructors. Be it agricultural modification, plantation establishment, settlement establishment or expansion, and development of amenities, the landscape is under continuous modification along with human civilization.



Landscape homogenization at different level.

(a) – (d) agricultural land in seasons and its preparation; (e) – (f) plantation and (g) – (h) aquaculture

Globally, it is an accepted fact that a functionally diverse system is the prerequisite for the productive landscape (Diaz et al. 2007, Wood et al. 2015). Both consumerist and sustainable viewpoints are supported by the idea as it ensures diverse products as well as instills stability

to the system. Human intervention in functional diversity is an active area of research and studies have been conducted in varieties of landscape structures (viz. grassland, agricultural land, sacred groves, plantation, etc.). These studies have pointed out how human activities make functional systems rich, sometimes redundant (the assemblage of members with similar working style) or homogeneous (wider presence of few selected members).

Thinking of the “starry night” like rural landscape in India, where settlement dotted the plains, each of them seems like a functional unit in the background of vast agricultural lands. Moreover, a cluster of settlements in an area collectively contributes to maintaining biodiversity and ecosystem services. The rationale behind the statement lies in the fact that the majority of the rural landscape is under homogenization at different magnitudes. The homogenization process stems from the monoculture of crops (vast paddy/wheat/maize field, fruit orchards, vegetable farms) and plantation drive, both commercial and social (eucalyptus, acacia, or roadside leguminous members), removal of unwanted plants, bushes, and extreme modification of soil ecosystems. The scenario is no different for water bodies or wetlands due to their commercial potential for fisheries and other economic products which prompt stakeholders to create an artificial conducive environment for selected species. Apart from stakeholders’ conscious choice, different operating mechanisms, like application of chemical fertilizers, pesticides, weedicide, external food resources (for fish), etc., also contribute towards homogenization. These activities also act as a selection pressure for floral and faunal assemblage, sieving the members for survival in the landscape. In this nearly homogenized backdrop, settlement acts as a relief where the consequences of the homogenizing activities are felt less severe. A small but significant portion of biodiversity exists in the home garden, community meeting place, sacred groves, village ponds, non-perennial water bodies, pasture lands, even in the surroundings of the deserted house. This small but important part of the natural world offers heterogeneity in species composition and functional traits which becomes an integral part of the functionality in the rural landscape.



**An uprooted tree means many homeless lives (image not in scale)
Image: Rajasri Ray**

Challenges related to settlement and landscape functionality

Though it sounds exciting, there are multiple challenges while implementing the concept of the functionality of the settlement. Apart from agriculture, settlement dwellers have multiple other interactions with the environment, the magnitude of which often fluctuates with the season, socio-cultural calendar, and demographic profile. Examples can be drawn from the seasonal fruit harvesting, festival, and household requirements which are mostly low to moderate level demands and replenished in course of time. The scenario becomes complex when larger plans are implemented with conspicuous spatial extent namely, road development, construction of

public amenities, renovation of religious places. These works employ a bigger workforce, demands a longer span of activities, generates debris, and near-permanent changes in the environment. Often the toll is on the environment and ecosystem which looks negligible but collectively irreplaceable. Cutting a huge old banyan or pipal tree for road extension or construction of public amenities, may not have much impact on human life but it is unbearable damage to countless other life forms who are directly or indirectly attached to it. Uncontrolled and unplanned weeding along the roadways and other places in the name of cleanliness destroying the probable shelters for insects, butterflies, soil micro-organisms, and increasing soil erosion potential. Similarly, renovation of the old places often emphasizes architectural details barring environmental compatibility, which results in a big temple/mosque/church at the cost of existing open land/grove. Apart from these visually identifiable structures, changes are also evident in ecosystem components like soil and water due to poor waste management practices and unplanned sanitation systems. Waste generation in the rural settlement is undoubtedly lesser in quantity and variation than its urban counterpart but quite alarming when pulled together. Common practices like unplanned dumping of the household waste in open place and water bodies, mixing of organic and inorganic waste, excessive plastic disposal is widely observed irrespective of geographic locations. On a similar note, sanitation is a grave concern although countrywide program like Nirmal Bharat Abhiyan has been introduced in a full swing to abolish the open defecation practices. However, environmentally suitable treatment of liquid and solid waste at home and village level is still a distant goal in many parts of the country (Sengupta and Bhatia 2021).

The magnitude of the physical changes as mentioned above is deeply entrenched in stakeholders' perception of their surroundings. Growing up amidst the environment, the rural stakeholders are aware of its existence value but contemporary lifestyle patterns and consumerist economy eclipsed that awareness. As a result, products from ecosystem services supporting livelihood get relatively more attention than non-tangible benefits which are ignored due to their apparent invisibility or spontaneous availability. The expansion of road networks and telecommunication systems revolutionized rural life throughout India. The constant interaction with the urban centers, out-migration for work, infiltration of urban lifestyle concept and exposure to diverse livelihood options tend to shift rural society from its locally activated modus operandi to be a part of the national or global network, consequently, the innate sustainability of the rural landscape is heavily compromised. The gross negligence towards active natural dynamics in the rural landscape slowly disintegrates the strength of the ecosystem to replenish and stabilize the natural world.

Reviving the sustainability in the rural landscape

India mostly lives in rural landscape. The rural area occupies ~75% of the country (with 6 lakhs villages, Census of India 2011), in comparison to 0.2% of the urbanscape (Cities with population over 1 million) (Revi et al. 2011) and 21.54% of forest area including 5.02% of the protected areas (WII database 2019). Therefore, to maintain the environmental and ecosystem health of the country the sustainability practices in rural livelihood must be encouraged. Rural settlements are more challenging than the other land use forms as human involvement is direct

and action is stochastic. Multiple stakeholders imply multiple and variable challenges at different scales ranging from local to regional. In this context, village development plans play a major role. Schemes like Indira Awaas Yojana (IAY), Nirmal Bharat Abhiyan (NBA), National Rural Drinking Water Program (NRDWP) have recommended sustainable eco-friendly practices in housing, sanitation, and drinking water provisions to efficiently deal with environmental degradation and judicious use of natural resources in the rural settlement area (Table 1) (UNDP 2012).

NRDWP	NBA	IAY
Renewable energy based system for water transportation (solar, wind or hydrams)	Green home protocol – i) 100% latrine coverage ii) Kitchen solid waste should be composted iii) Grey water channeled to household activities iv) Segregation of inorganic solid waste	Natural materials should be preferred for construction purpose Recycling of the waste products
Rainwater harvesting		Environment friendly construction process
Recycling or treatment of waste water	Gram panchayat protocol – i) Ecosan toilets in public places ii) inorganic waste collection and disposal from homes iii) Central treatment facility for liquid waste iv) Maintenance of basic cleanliness in the village	Environment friendly building design with – rain water harvesting, ecosan toilets, passive solar architecture elements etc.
Shifting to gravity flow system		

Table 1. Rural development schemes with sustainable eco-friendly recommendations (adopted from UNDP 2012)

In addition to these efforts, there are countless local traditional practices still prevalent across communities which need to be encouraged or revitalized (e.g. Garsadi tradition among Santhal community, Dongs in Assam among the Bodos, Virdha in Gujarat by the Maldhari for safe drinking water; house construction practices among Santhal, Oraon, Gond, Toda, Gujjar and Bakharwal communities) (Priyadarshini and Abhilash 2019). In general, the effort deserves participation at the grass-root level, strong community bonding, careful planning for adopting newer technology or facilities for household or community improvement, maintenance of green cover with sufficient diversity, promoting further research towards human-nature interaction by integrated disciplines like anthropology, sociology, political science, economics, environment, and ecology.

Settlement is an integral part of the rural landscape, therefore, an important component of biodiversity and ecosystem services. Both morphologically and characteristically it is different from typical land use land cover perception of the rural landscape so is in function. The contribution of the settlement to landscape functionality is often disproportionately high in comparison to major land-use formats, although quantitative data is very sketchy. The changes in the settlement are faster than the surrounding landscape, therefore, influence functionality at a pace that may doom the future of biodiversity further. To avoid the unavoidable, we have to aggressively promote sustainable lifestyle concepts with a priority on environmental health.

Scenic greenery would be futile unless there is ‘true green’ embedded in its daily activities and advancement.

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