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LAND RESOURCES AND DESERTIFICATION ABATEMENT

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Competition for land is increasing as demand for multiple land uses and ecosystem services rises. Food security issues, renewable energy and emerging carbon markets are creating pressures for the conversion of agricultural land to other uses, such as reforestation and biofuels. This is occurring in parallel with other growing demands from land systems for urbanization and recreation, mining, food production, and biodiversity conservation. Managing increasing competition for the supply of these services, accounting for different stakeholders' interests, requires efficient allocation of land resources.

Land use planning can be of use with regard to finding a balance among competing and sometimes contradictory uses, while promoting sustainable land use options. This brief presents evidence of land use planning, spatial planning, territorial (or regional) planning, and ecosystem-based or environmental land use planning as tools that can strengthen land governance, improve economic opportunities based on sustainable management of land resources, and develop land use options that reconcile conservation and development objectives.

Contributions of land use and spatial planning for supporting sustainable land use and management Case studies analyzed show that spatial and land use planning can contribute to sustainable land management(SLM) through:

- protecting land of agricultural significance from urban and peri-urban encroachment;
- protecting natural capital from urban and peri-urban encroachment;
- preventing or limiting exposure of saline and acid sulphate soils;
- rehabilitation, and/or avoidance of contaminated sites;
- adaptation to salinization and rising groundwater levels;
- ensuring land use reflects land capability;
- protection of the quality and quantity of ground water supply sources;
- protection of water quality and minimization of erosion through water-sensitive urban design;
- minimizing eutrophication and other pollution of surface and groundwater;

- establishing appropriate buffers between development, and coastal estuaries, and water foreshores;
- floodplain management;
- preventing or limiting vegetation clearing;
- protecting natural habitat from destruction and fragmentation;
- preservation and enhancement of ecological corridors;
- reducing car dependence by transport demand management;
- accounting for sea-level rise and increased storm surge, arising from coastal development. In areas of communal land tenure, land use planning assists in the sustainable management of rangelands, inter alia, resolving issues related to competing land uses and land tenure conflicts.

Policy messages:

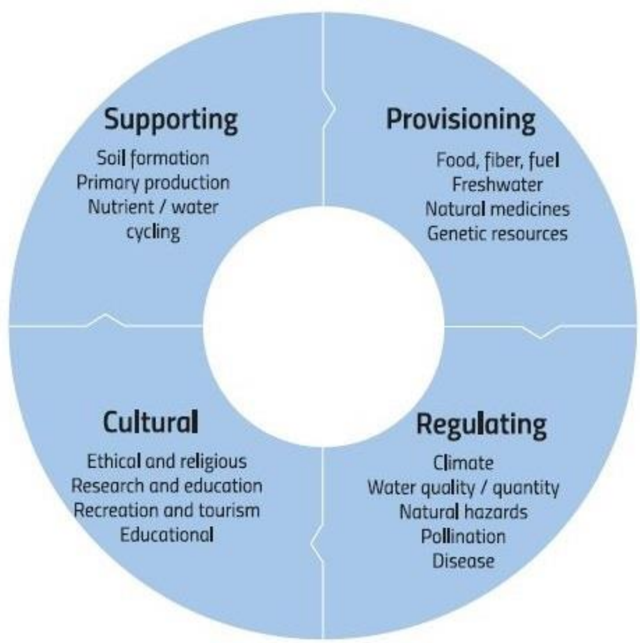
- Comprehensive land use planning is an instrument for sustainable land management, concurrently advancing sustainable development; it creates the preconditions required to achieve a type of land use that is environmentally sustainable, socially just and desirable, as well as economically sound.
- Land use planning is centered around a participatory definition of future land uses; it is, therefore, a useful approach whenever natural resources and biodiversity are to be protected and rehabilitated, and unexplored land use potential has to be identified and evaluated.
- Land-use and spatial planning can:
- reconcile land use with environmental concerns and resolve potential conflicts between sectoral interests and potential uses;
- Increase land tenure security and clarify customary land tenure of communal lands.
- Policy responses to coordinate human activities with environmental conservation - alongside suitable financial, legal and technical support - are needed to guide land use planning to support sustainable land management, and to help resolve conflicting land use demands.
- Land use planning should be approached from both land cover and land functionality perspectives, as the latteris a nexus to other transversal land issues.
- The integration of cross-sectoral policies (e.g., land use, energy and water management) into a single planning instrument at the regional level, based onan understanding of territorial dynamics, can bolster sustainable land management.
- Planning at the regional scale enables the cumulative impacts of future development on the natural capital of a region to be accounted for, and the sharing of responsibility for protection and management across a wider number of stakeholders.

Land use planning: the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future.

- Ecological land use planning;
- Integrated land use planning;
- Participatory land use planning;
- Regional land use planning;
- Rural territorial land use planning; and
- Spatial land use planning

Land use planning – a contribution to sustainable land management (SLM) Sustainable land management (SLM) encompasses the ecological, economic and socio-cultural dimensions of sustainable development; as a process, it comprises land use planning, land use design and land development. Technologies for the adoption, spread, adaptation and implementation of SLM practices rely on approaches that enable and empower people to this end; land use planning has proven to be such an approach

Land use planning, spatial planning, territorial (or regional) planning, and, more recently, ecosystem-based or environmental land use planning foster sustainable land use and management; this occurs via the acknowledgments of stakeholders, their differing objectives, and the need to strike a balance among the diverse, and often conflicting,interests of these actors. An aspiration of land use planning's to coordinate current and future societal needs, while minimizing conflicts



Above: the ecosystem services, goods and benefits provided by land.

Types of land use planning

Land use planning (LUP) has evolved from a top-down, expert-driven approach, to one of land suitability, in the 1960s and 1970s. From the 1980s onwards, this shifted towards a more integrated approach, involving planning experts, decision-makers, and ordinary citizens; an approach integrated into national institutions, as well as increasingly linked to financial planning. Moreover, the traditional concept has diversified over time, to include the appraisal of factors related to sustainability (i.e., social acceptance, economic viability, physical suitability, and environmental sustainability), as well as social impacts(i.e., access to land resources, nutritional status, health status, and education). In this way, related concepts of integrated LUP, spatial LUP, participatory LUP, participatory rural planning, territorial ecological planning, ecosystem based LUP originated from the 1980s onwards.

This transition parallels the shifting attitudes of the time regarding humankind's relationship with land. In the 1700s, land equated 'wealth'; it was later understood through the more comprehensive concept of 'commodity'; this shifted again to that of 'scarce resource'; from the 1980s onwards, it was generally viewed as a 'scarce community resource', representing both a commodity, and wealth).

Land use planning approaches: basic requirements

Land use planning approaches need to be flexible and adaptive so as to be able suit varying circumstances. In other words, "blueprint approaches" that define the steps, procedures and tools do not function, rather, LUP must be structured as a process designed according to the needs, demands, capacities, rules and institutional structures ofthe place in question.

There are two main phases to LUP and processes - ***i.e., formulation and implementation*** - each comprising arrange of activities. The formulation of a land use plan requires a broad assessment of current land uses, as well as main limitations, and opportunities for development.

This assessment requires the collection and analysis of a substantial amount of information including: biophysical information, infrastructure, population, land ownership, land tenure and legal context. Tools such as ecological and economic zoning (EEZ) of the Food and Agriculture Organization (FAO), land evaluation, and land suitability analysis are commonly applied. It is also at this stage that valuation of ecosystem services for inclusion in land use plans can be undertaken. Once the assessment is complete, a scoping study into public opinion and social impacts also needs to be carried out, via participatory planning processes

The land challenge underlying India's farm crisis

With shrinking farm sizes and lack of accurate land records, farmers find it difficult to generate enough income to provide for their households

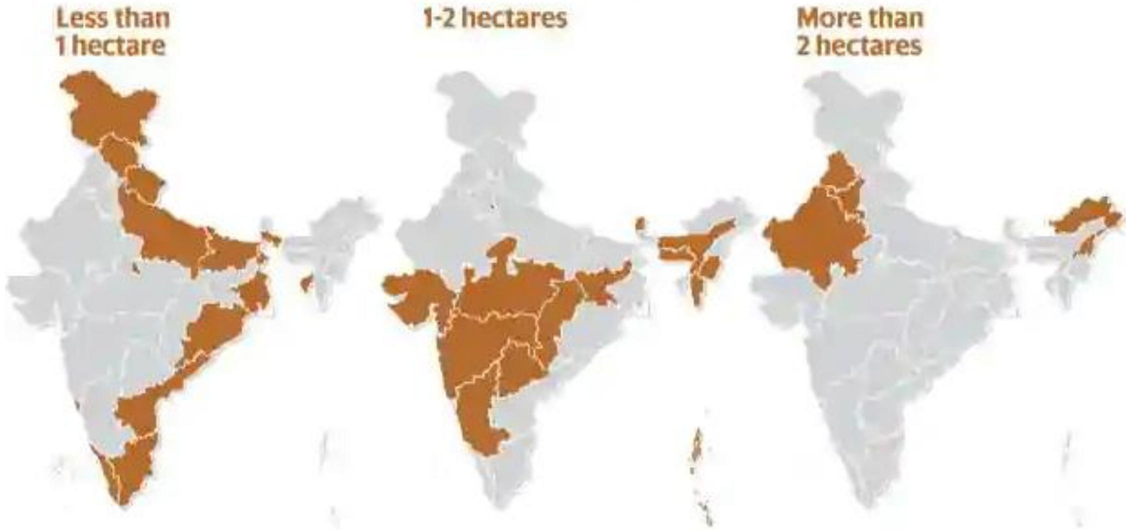
From farm subsidies to farm loan waivers, the Indian government spends crores on farmer welfare, but these efforts will be inadequate unless they can tackle an increasingly daunting barrier: lack of land. The provisional figures from the latest agriculture census reveals how land—the most critical input for agriculture—is getting more fragmented.

Since the first agriculture census, the number of farms in India has more than doubled from 71 million in 1970-71 to 145 million in 2015-16, while the average farm size more than halved from 2.28 hectares (ha) to 1.08 ha

Smaller, more numerous farms have been driven by rural population growth. Between 1970-71 and 2010-11, the number of farms increased by 194%, almost exactly in line with rural population, which increased by 189%. As pointed out in a 2011 Economic and Political Weekly research paper, this relationship is a reflection of India's inheritance pattern, which leads to farms divided between multiple heirs

Within India though, there is significant variation in farm sizes. With an average size of 5 ha, Nagaland is home to India's largest farms. Punjab and Haryana, two states known for their agricultural output, also have larger farm sizes (3.6 ha in Punjab and 2.2 ha in Haryana). However, these are exceptions. The majority of India's farms (86%) are less than 2ha. The bulk of which are located in the poorer states such as Uttar Pradesh and Bihar

In 12 Indian states, the average farm size is less than a hectare



Source: Agriculture Census, Census of India, Indira Gandhi Institute of Development Research

The Indian experience shows that small farmers are more productive than large farmers. Ramesh Chand and others show that small farmers use more inputs (such as fertilizers), use their land more intensely (planting more crops) and adopt more technology. Yet, despite this efficiency, farm incomes remain poor. It is the poor returns to farming—despite intensive efforts put in by farmers—that lie at the root of India's farm crisis, and the recent farm angst.

Given household sizes in rural India, small farms struggle to generate enough income for everyone in a household and often lack alternative sources of income.

One obvious solution to small farm sizes will be consolidating land into larger farms by enabling land leasing. However, this can be a complex and costly process, made more difficult by the lack of accurate land records. As a report by PRS Legislative Research has highlighted, land records in India are poorly maintained and do not reflect ground realities. It pointed out that, despite most states computerizing and digitizing land records, as of 2017, spatial data had only been verified in 39% of villages. This is particularly problematic for small farmers who, without accurate land records, cannot access credit or secure insurance.

India's farmers are not alone in these struggles. A 2018 study estimated that around 84% of the world's farms are less than 2 ha. While many of these small farms face the same challenges, some small farmers, such as those in China, have been more successful in securing sustainable livelihoods. This is a result of several different factors, but economists agree that improving land records, investing in research and development, providing local rural non-farm employment opportunities and building better rural infrastructure are policies that can help small farmers.

DESERTIFICATION ABATEMENT

Desertification is defined as "a type of land degradation in which a relatively dry land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife."

Loss of soil cover, mainly due to rainfall and surface runoff, is one of the biggest reasons for desertification. It is responsible for 10.98 per cent of desertification in the country. Water erosion is observed in both hot and cold desert areas, across various land covers and with varying levels of severity. The next big reason is wind erosion.

India is highly vulnerable to desertification. Desertification not only leads to loss of biodiversity but can also negatively affect food production leading to poverty, hunger, economic instability, competition for scarce land and water resources and migration. It is a form of land degradation where fertile land gradually deteriorates into a wasteland. This can be disastrous! Climatic variations and human activities such as overgrazing, deforestation, agricultural activities, overexploitation of vegetation for domestic use, bio-industrial activities are the major causes of desertification.

The main factors responsible for desertification in India are

- the extension of cultivation in marginal lands,
- inadequate soil and water conservation measures,
- intensive cropping systems and poor irrigation management and
- Overexploitation of groundwater.

India loses more and more land to desertification Recent analysis reveals that the area under desertification in India is increasing with 29.32 percent of the Total Geographic Area (TGA) of the country found to be undergoing land degradation/desertification and 23.95 percent of it is contributed by the states of Rajasthan, Maharashtra, Gujarat, Jammu & Kashmir, Karnataka, Jharkhand, Odisha, Madhya Pradesh and Telangana.

The threat of desertification increases in 26 of 29 states. Nearly 30 per cent of India is degraded or facing desertification. Of India's total geographical area of 328.72 million hectares (MHA), 96.4 MHA is under desertification. In eight states—Rajasthan, Delhi, Goa, Maharashtra, Jharkhand, Nagaland, Tripura and Himachal Pradesh—around 40 to 70 per cent of land has undergone desertification. More to it, 26 of 29 Indian states have reported an increase in the area undergoing desertification in the past 10 years.

India has witnessed an increase in the level of desertification in 26 of 29 states. More than 80 percent of the country's degraded land lies in just nine states--Rajasthan, Maharashtra, Gujarat, Jammu and Kashmir, Karnataka, Jharkhand, Odisha, Madhya Pradesh and Telangana. With 5.81 percent increase, the highest land degradation is observed in Lunglei district of Mizoram while the top three districts with the highest area under desertification or land degradation are Jaisalmer, Rajasthan, Lahaul and Spiti, Himachal Pradesh and Kargil, Jammu and Kashmir. Despite the situation, the desert development programme (DDP) has been low on priority for the government.

Karnataka's several large rivers classified as unfit for bathing According to a quarterly assessment carried out by the Karnataka State Pollution Control Board (KSPCB), several large rivers in the state fall under the C and D categories of assessment which implies that water in these rivers is not fit for drinking even after treatment. Out of the 15 rivers assessed by the pollution board, only the Kumaradhara and Nethravathi rivers were placed under category B, which means that the two rivers were fit for organised bathing. As per the report, Arkavathy and Bhadra are at the bottom of the list while Yagachi, Cauvery, Kabini and Kali have been placed under C category for the past one year.

Groundwater depletion in Kolkata results in water shortage and contamination Indiscriminate extraction of groundwater in Kolkata has not only resulted in a water shortage in the city but have also led to an increase in water contamination due to deepening of water table and instability in built structures. According to a recent study, the city faces high levels of manganese and iron content in the groundwater which can cause serious ailments. However, officials of Kolkata Municipal Corporation have dismissed allegations of water scarcity and claimed that the migrating population along with reckless use of water by citizens is impacting the supply of water.

Excess water from Punjab's reservoirs gets drained out to Pakistan Of the 2,060 million cubic metres (MCM) water released from three dam reservoirs in Punjab-- Bhakra dam on Sutlej, Pong dam on Beas and Ranjit Sagar dam on Ravi--only 30-40 percent of water is being used in the statewhile the remaining gets drained out to other Indian states, including Rajasthan, and also Pakistan through the canal network. As per the officials, the excess water is drained into Pakistan rivers to avoid a flood-like situation in Punjab during the monsoon. However, the officials have underlined the state's failure to utilise the excess water in meeting supply gap in urban areas and to recharge the depleting groundwater table.

Soil Habitat

Soil is composed of living organisms, minerals, air, water, and perform a number of key environmental, social and economic services that are vital to life. Crucial roles for soil development play different soil-forming factors like parent material, topography, climate, soil organisms and human activities. Soils are formed through the combined effect of physical, chemical and biological processes that operate over hundreds or thousands of years. Over much shorter time scales major changes can occur in the amount and nature of biological activity or hydrological conditions within soils. However, soils are under increasing threats caused by a wide range of human activities (like deforestation and environmental pollution by organic and inorganic toxic compounds). Therefore, an important aim for future soil management is to maintain ecosystem functions and biological diversity.

Diversity of Soil Organisms

Soil is one of the most diverse habitats on Earth. Soil biota includes archaea, bacteria, protists, tardigrades, rotifers, nematodes, acari (mites), collembolans (springtails), worms (enchytraeids and earthworms), macroarthropods (e.g. ants, termites, centipedes, millipedes, woodlice, etc.) and burrowing mammals. It also includes plant roots, fungi and lichens. Root exudates attract a variety of organisms that either feed directly on these secretions or graze on the microorganisms concentrated near the roots, giving this busy environment the name ‘rhizosphere’. There are also beetle larvae, flies and butterflies that use the soil as a temporary habitat to reproduce or to spend their early life stages feeding on different live and dead plant materials until they reach their maturity. All of these organisms are involved in creating and maintaining the soil structure and providing essential ecosystem services for humans (such as regulating greenhouse gas emissions or preserving water quality).

One of the main challenges that soil conservation faces today is the lack of awareness of the ecological importance of soil biodiversity.

Ecosystem Functions & Services

The combined activity of soil organisms results in ecosystem functions that sustain life on the planet. Ecosystem functions that generate benefits to society have been defined as ecosystem services. The centrality of below ground biodiversity to global sustainability is because soil organisms of different types, shapes and colors are responsible for different ecological functions that underpin the continued provision of a numbers of key soil-based ecosystem services. Soil and its biota provide these ecosystem services, for example, by contributing to the provision of food, fuel and fibre, the infiltration, storage and delivery of clean water, the regulation of nutrient cycles and atmospheric composition, and the provision of cultural values. The enormous diversity of organisms in soil, the complexity of their interactions and the multiple linkages to ecological functions have made their study particularly challenging. A useful approach to more effectively study soil functions has been to group together organisms playing similar roles in the soil into several "functional" groups. These include, for example, decomposers (those breaking down organic matter into simpler organic molecules), mineralizers (those that release nutrients from simpler organic molecules), or ecosystem engineers (those maintaining soil structure and creating channels and pores in the soil profile). The potential to manage various groups of soil organisms for a wide range of environmental, commercial and industrial applications, still remains largely unexploited.

Threats

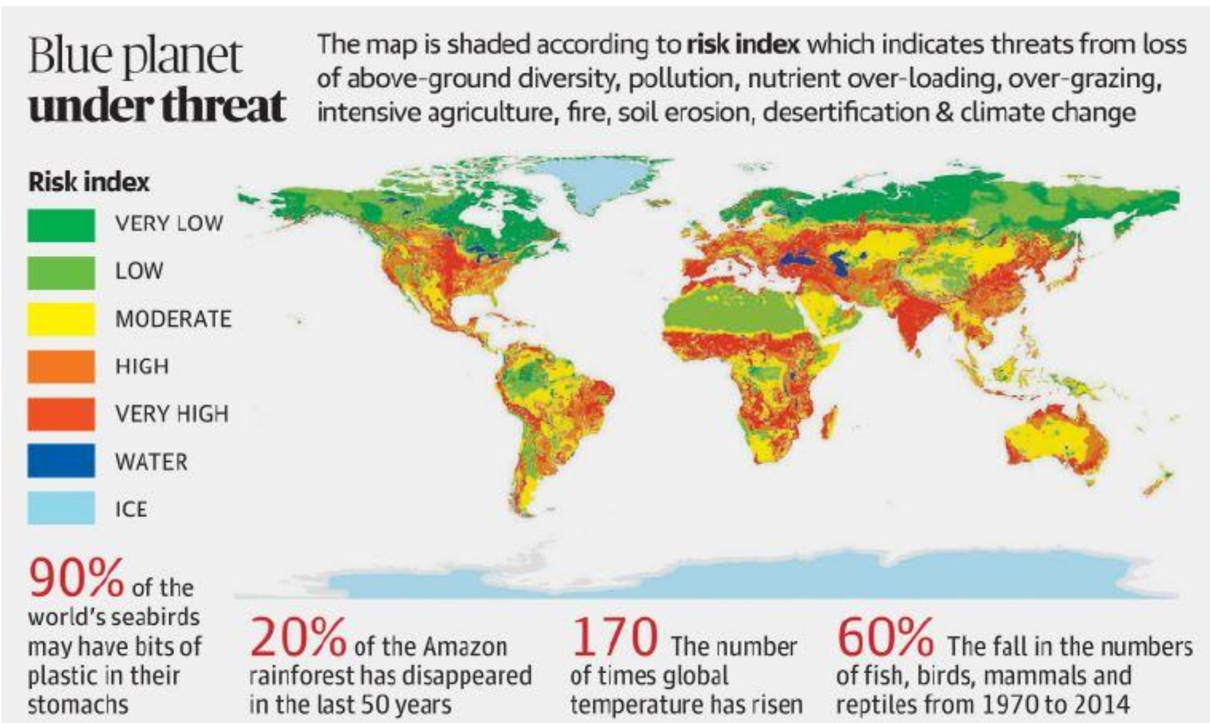
Soil organisms are sensitive to changes in land use, climate, and natural disturbance. Human soil disturbances like mining, road and building construction, tillage for agriculture, erosion, and land degradation are major threats to soil biodiversity, particularly impacting fungi and soil invertebrates. In many cases, these changes lead in irrevocable changes in soil biodiversity and soil functioning. In addition, invasive species, including invasive soil organisms, can decrease biodiversity and alter decomposition and nutrient cycling rates. Increased wildfire intensity can directly impact soil organisms, alter plant inputs, and change water infiltration capacity. Climate change may shift soil communities, and also changes how quickly soil communities decompose plant material and soil organic matter. People rely on soil for food, clean water, flood and drought mediation, and climate regulation. As we recognize both our reliance on ecosystems and our ability to alter them, it is important to understand how we negatively impact soil organisms that support us, and how we can change behavior to protect soil biodiversity and sustain our future.

The Global Soil Biodiversity Atlas is the first global overview of soil biodiversity. The Atlas was made possible through the efforts of the Global Soil Biodiversity Initiative and the European Commission Joint Research Centre. More than 150 scientists from 26 countries worked for 3 years to bring together the latest scientific knowledge.

Key findings from the Atlas:

- The planet's terrestrial ecosystems have a diversity of soil life, largely due to the variety of their soil habitats.
- Soil biodiversity is critical for human health: for plant growth and support, water and climate regulation, and erosion and disease control.

- Soil biodiversity is increasingly under threat, which results in changes in the composition of soil communities and loss of species, as well as the benefits they provide to all life.
- There is a need to celebrate these new discoveries about the life under our feet, as well as to integrate knowledge about soil biodiversity into international policies.
- Soil biodiversity is a common ground for achieving sustainability goals. Management and conservation of life in the soil is integral to governmental actions to provide healthy food, reduce greenhouse gases, lessen desertification and soil erosion, and prevent disease.
- The tremendous advances in knowledge of soil biodiversity in recent years is only the beginning. Learn more about emerging work to learn how soil biodiversity can support our communities, our planet, and our future.



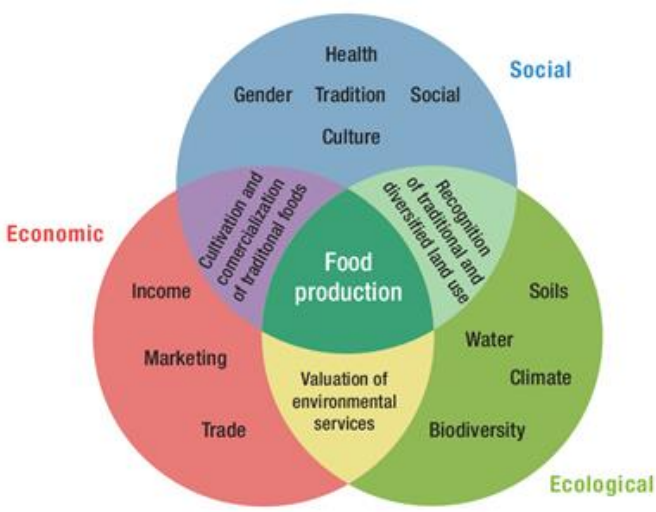
India's soil biodiversity is in grave peril, according to the Global Soil Biodiversity Atlas prepared by the World Wide Fund for Nature.

The WWF's 'risk index' for the globe — indicating threats from loss of above-ground diversity, pollution and nutrient over-loading, over-grazing, intensive agriculture, fire, soil erosion, desertification and climate change — shows India among countries whose soil biodiversity faces the highest level of risk. Coloured red on the Atlas, these include Pakistan, China, several countries in Africa and Europe, and most of North America.

- While India's per capita ecological footprint was less than 1.75 hectares/person (which is in the lowest band, among countries surveyed) its high population made it vulnerable to an ecological crisis, even if per-capita consumption remained at current levels, the WWF warned.
- To address these challenges, the WWF suggests three necessary steps: "clearly specifying a goal for biodiversity recovery; developing a set of measurable and relevant indicators of progress; and agreeing on a suite of actions that can collectively achieve the goal in the required time frame."

HILL AREA DEVELOPMENT

The hill areas are characterized by inaccessibility because of poorly developed infrastructure as it is expensive to lay roads and rail lines in the hilly terrain. Because of inaccessibility, the areas are sparsely populated and the level of economic activity is low. Investment is also difficult to come by. Education, health and housing facilities in these regions reflect their underdeveloped nature. The fragile communication links that these regions have come under strain, often getting broken at times of heavy rains, snowfall, landslides, floods, etc. Because of intrusion of outsiders with commercial intentions in these regions, defores-tation and reckless construction activities are becoming increasingly common. This is threatening the fragile eco-system of hilly areas, causing widespread soil erosion and siltation of streams. These factors have a direct effect on productivity of land and on groundwater resources which are crucial for the survival of populations in these areas.



Increasing disparity in levels of development in these areas and the rest of the country has given rise to a sense of alienation in some areas. The fact that the hilly regions of India are located along its borders, creates a sense of alienation in the people. This, in turn, often gets transformed into secessionist movements. Also, many of these areas are inhabited by tribal which makes the issue of development of hill areas even more significant.

The basic objective of the Hill Areas Development Program has been socio-economic development of the hills and the people living there in harmony with ecological development, The program implemented under the HADP have, therefore, aimed at promoting the basic life support systems with sustainable use of the natural resources of the area covered by the program.

- Intensive efforts would be necessary at the implementation level to halt the process of degradation of the hills and improve productivity of land.
- Innovative approaches to family planning and welfare to contain the population growth to sustainable levels have to be adopted.
- Afforestation program may be popularized through village Panchayats or village authorities, schools and other local organizations, groups and clubs. Private nurseries, especially, of multi-purpose trees which yield benefits like fodder leaves, edible fruits or leaves or flowers, seeds, leaves of commercial value can be encouraged.
- Use of appropriate technologies to upgrade the traditional productive systems like agricultural operations, livestock rearing, arts and crafts, household and cottage industries, etc., and to reduce drudgery of women in fetching water, fuel-wood, fodder and other demanding daily domestic chores needs to be encouraged on priority. The technologies have to be need-based, more productive, efficient, low-cost, and ecologically sustainable.
- In many hill areas, land assets are held as common or community property. In such areas, people do not make permanent investments and several other problems also originate from this. To overcome these, local communities have to evolve suitable models of land management that would invite permanent investment and ensure both optimal return sand ecological safety and development.
- In order to reduce pressure on land, quality of livestock, including goats, sheep, pigs and poultry birds has to be improved and their numbers reduced. There is an urgent need for relating livestock population to the bearing capacity of available land. Scrub animals could be systematically culled out. The livestock and cattle improvement program need to be integrated with fodder and cattle-feed development, stall feeding and scientific grazing. The land and livestock management systems have to improve rapidly.
- The productivity of pastures and grazing areas needs to be restored and enhanced. The effort should be to meet the requirements of food, fuel-wood, timber and fodder through scientific utilization of scarce hill resources on sustainable basis from the least land area.
- Development of non-conventional energy and use of non- wood-based sources of energy could be encouraged.
- Development of watersheds that can meet water requirement of the people and conserve water and soil resources of the area can be taken up for integrated development. For this,

a multi-disciplinary approach is considered most appropriate for creating conditions conducive to development of natural and human resources.

- Food security has to be ensured on top most priority. Development of horticulture, sericulture and plantation, especially cash crops having low volume, light weight, high value and long shelf-life, could play an important role in generating employment opportunities, higher incomes and ecologically sound development in hilly areas.
- Development of sericulture has good potential in hill areas. A systematic program of planting feedstock trees for silkworms on all spare patches of land can be taken up. Development of sericulture can provide employment to educated and skilled workers and generate value-adding activities and bring in foreign exchange. However, the program will call for right quality of grain, prompt payment in cash for the cocoons and primary processing activities at local levels.
- Tourism can be organized as an industry, with due care taken to avoid exploitative use of scarce local resources, especially, water and fuel-wood.
- Special care needs to be taken to ensure that hill roads are constructed as per traffic needs, scientific design and specifications suited to hill areas, so that the loose soil is contained, proper drainage system is developed and chances of landslides minimized. In such hill areas where the population density is low and the villages are small and scattered over long distances, porter or pony tracks can be built and properly maintained. Road construction should be completed in all respects without delays.
- Regeneration and development of the hill environment cannot be achieved without willing and active cooperation of the people. It will be forthcoming, only if, the benefits from improved land, water and forests resources reach directly and equitably to the people themselves.
- The hill areas prone to intense tectonic and seismic activities need to be identified.

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