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Training Resource Material

Content Module 2

The Overall Context: Understanding HWC in a Development Context

A Holistic Approach to Human-Wildlife Conflict (HWC) Mitigation in India

Imprint
Training Resource Material: A Holistic Approach to Human-Wildlife Conflict (HWC) Mitigation in India

Module HWC-01:	An Introduction to Human-Wildlife Conflict Mitigation: Taking a Holistic and Harmonious Coexistence Approach
Module HWC-02:	The Overall Context: Understanding HWC in a Development Context
Module HWC-03:	Legal, Policy, and Administrative Framework for HWC Mitigation in India
Module HWC-04:	Tools and techniques for effective and Efficient Human-Wildlife Conflict Mitigation
Module HWC-05:	Strengthening Community Engagement for Effective and Sustainable Mitigation of Human-Wildlife Conflict
Module HWC-06:	Operationalizing the Holistic and Harmonious coexistence Approach to Mitigate Human-Wildlife Conflict through Cross-sector Cooperation
Module HWC-07:	Holistic, Effective and Ethical communication on Human-Wildlife Conflict Mitigation: Taking a Harmonious Coexistence Approach
Module HWC-08:	A Primer on Developing Leadership and other Non-technical Competencies for HWC Mitigation
Module OH-01:	An introduction to the One Health Approach, Zoonotic and Other Emerging Diseases

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1. About this Module

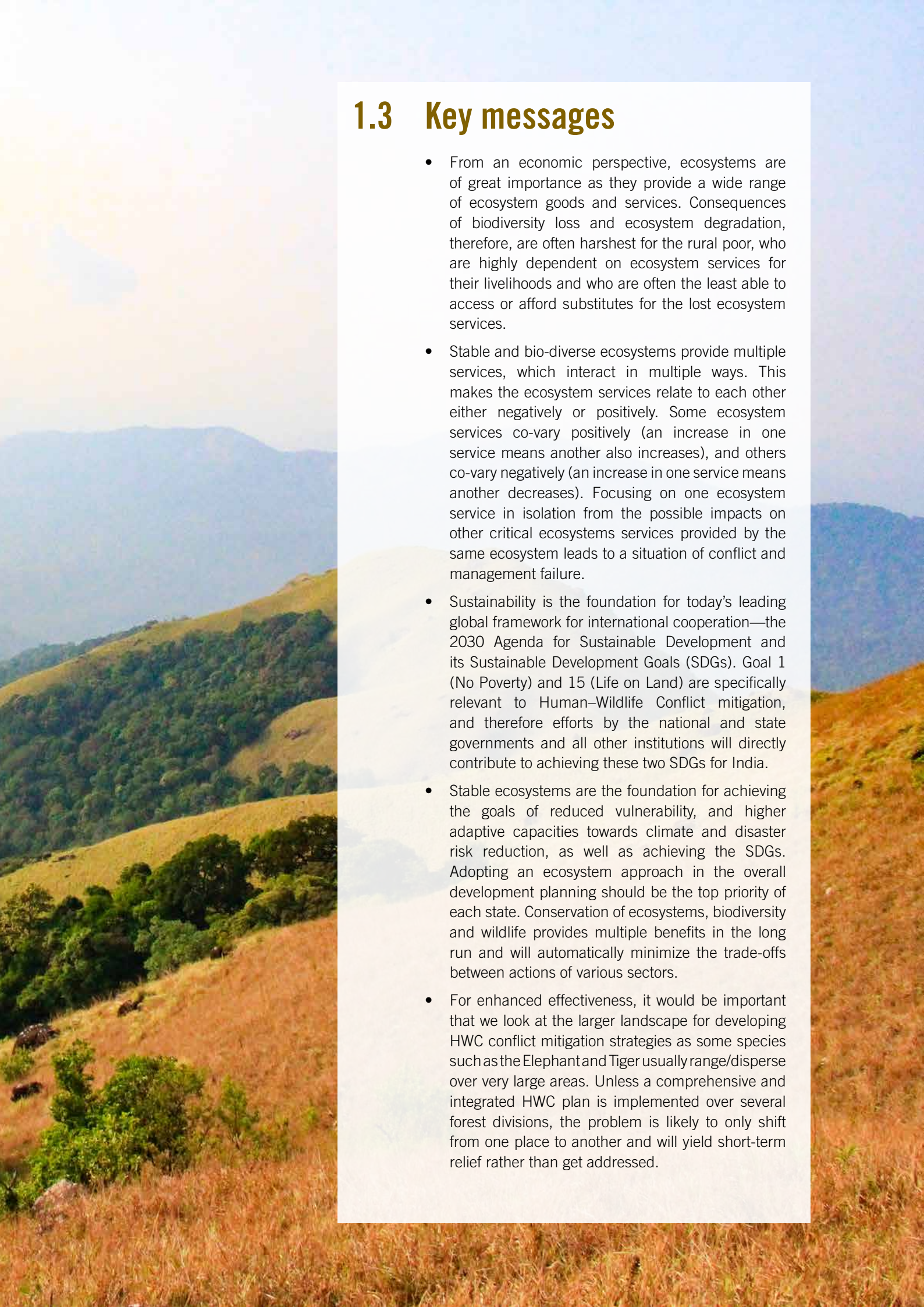
1.1 Learning outcomes:

After completing this module, the participants will be able to:

- describe human–wildlife conflict (HWC) in the overall development context,
- illustrate the landscape approach to mitigate HWC,
- describe the historical and geographical context of HWC in their respective areas,
- use the DPSIR framework (drivers, pressure, state, impact, response) in the HWC context,
- appraise the significance of corridors and connectivity for wildlife as the key HWC mitigation measure,
- appraise the existing and potential human wildlife conflict mitigation measures for their long -term effectiveness and
- appreciate the need for integrating the gender perspective into HWC mitigation plans and strategies.

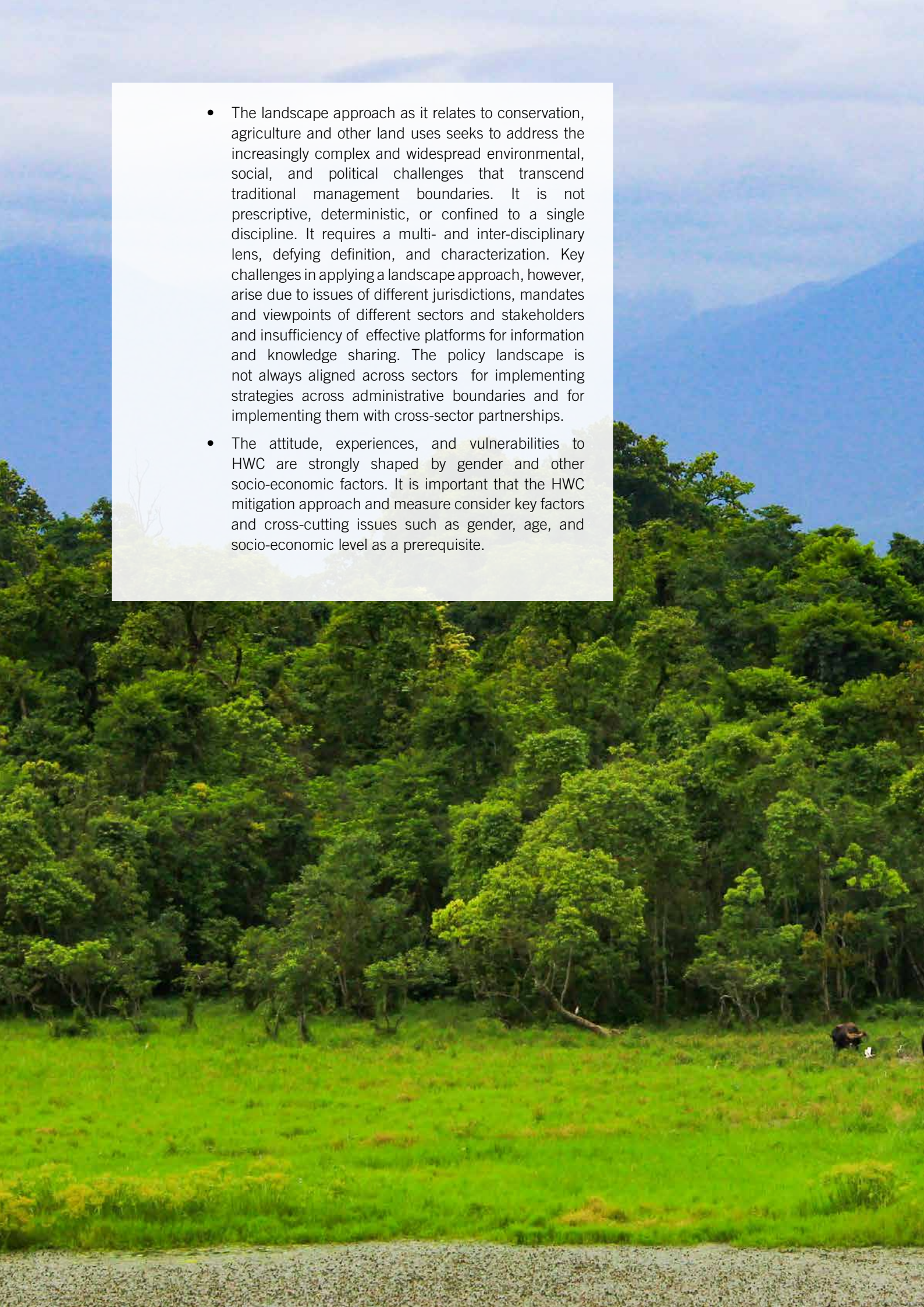
1.2 Summary

This module facilitates the participants in developing an understanding on human-wildlife conflict and its mitigation in the overall development context. The concepts and issues related to the holistic approach to HWC mitigation are presented, using DPSIR approach i.e., drivers, pressures, state, impact and response. With this module, the participants explore the relevance of corridors and landscape connectivity as one of the HWC mitigation measures while appraising the impact of land-use change on HWC. The module facilitates discussions on the relevance and significance of cross-sector cooperation in addressing the issue of HWC. The training sessions will sensitize and equip the participants in designing holistic HWC mitigation measures which also address the needs and requirements of the most vulnerable and affected sections, including the rural poor and women.



1.3 Key messages

- From an economic perspective, ecosystems are of great importance as they provide a wide range of ecosystem goods and services. Consequences of biodiversity loss and ecosystem degradation, therefore, are often harshest for the rural poor, who are highly dependent on ecosystem services for their livelihoods and who are often the least able to access or afford substitutes for the lost ecosystem services.
- Stable and bio-diverse ecosystems provide multiple services, which interact in multiple ways. This makes the ecosystem services relate to each other either negatively or positively. Some ecosystem services co-vary positively (an increase in one service means another also increases), and others co-vary negatively (an increase in one service means another decreases). Focusing on one ecosystem service in isolation from the possible impacts on other critical ecosystems services provided by the same ecosystem leads to a situation of conflict and management failure.
- Sustainability is the foundation for today's leading global framework for international cooperation—the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). Goal 1 (No Poverty) and 15 (Life on Land) are specifically relevant to Human–Wildlife Conflict mitigation, and therefore efforts by the national and state governments and all other institutions will directly contribute to achieving these two SDGs for India.
- Stable ecosystems are the foundation for achieving the goals of reduced vulnerability, and higher adaptive capacities towards climate and disaster risk reduction, as well as achieving the SDGs. Adopting an ecosystem approach in the overall development planning should be the top priority of each state. Conservation of ecosystems, biodiversity and wildlife provides multiple benefits in the long run and will automatically minimize the trade-offs between actions of various sectors.
- For enhanced effectiveness, it would be important that we look at the larger landscape for developing HWC conflict mitigation strategies as some species such as the Elephant and Tiger usually range/disperse over very large areas. Unless a comprehensive and integrated HWC plan is implemented over several forest divisions, the problem is likely to only shift from one place to another and will yield short-term relief rather than get addressed.

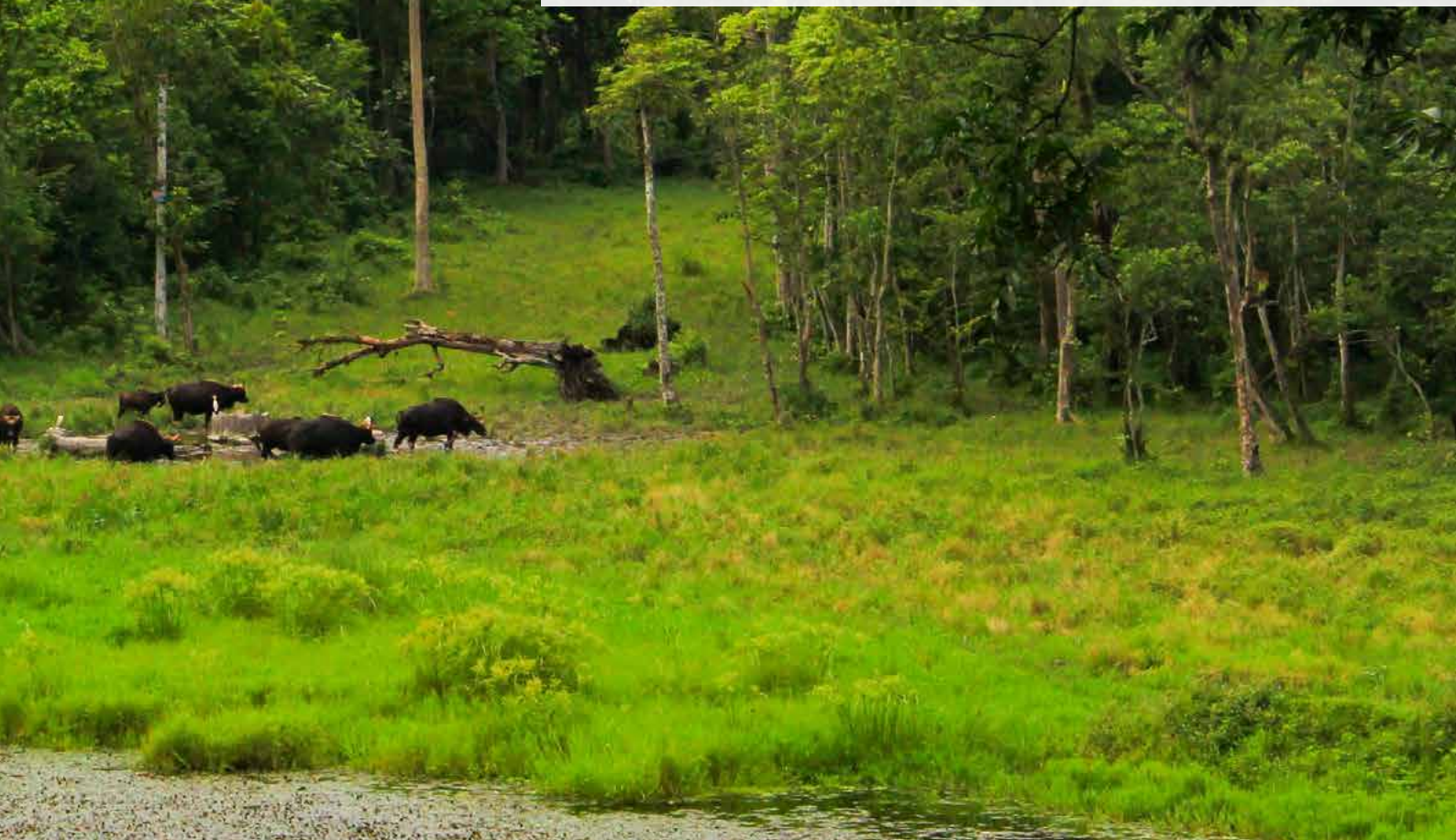


- The landscape approach as it relates to conservation, agriculture and other land uses seeks to address the increasingly complex and widespread environmental, social, and political challenges that transcend traditional management boundaries. It is not prescriptive, deterministic, or confined to a single discipline. It requires a multi- and inter-disciplinary lens, defying definition, and characterization. Key challenges in applying a landscape approach, however, arise due to issues of different jurisdictions, mandates and viewpoints of different sectors and stakeholders and insufficiency of effective platforms for information and knowledge sharing. The policy landscape is not always aligned across sectors for implementing strategies across administrative boundaries and for implementing them with cross-sector partnerships.
- The attitude, experiences, and vulnerabilities to HWC are strongly shaped by gender and other socio-economic factors. It is important that the HWC mitigation approach and measure consider key factors and cross-cutting issues such as gender, age, and socio-economic level as a prerequisite.

2. Development context

2.1 Overall development situation

From an economic perspective, ecosystems are of great importance as they provide a wide range of ecosystem goods and services. India has a large population living close to forests and with livelihoods critically linked to the forest ecosystems. There are around 1.73 lakh villages in India located in and close to forests. Although there are no official census figures for the forest-dependent population of the country, there are different estimates, from 275 million to 350–400 million. People living in these forest-fringe villages depend upon the forests for a variety of goods and services. These include edible fruits, flowers, tubers, roots and leaves for food and medicines; firewood for cooking (and some for sale in the market); material for agricultural implements, house construction and fencing; fodder (grass and branches) for livestock; grazing of livestock; and a range of marketable non-timber forest products. Moreover, a significant percentage of the country's underprivileged population happens to be living in its forested regions. It has been estimated that more than 40 per cent of the poor of the country are living in these forest-fringe villages. Apart from this, a significant percentage of India's tribal population lives in these regions.

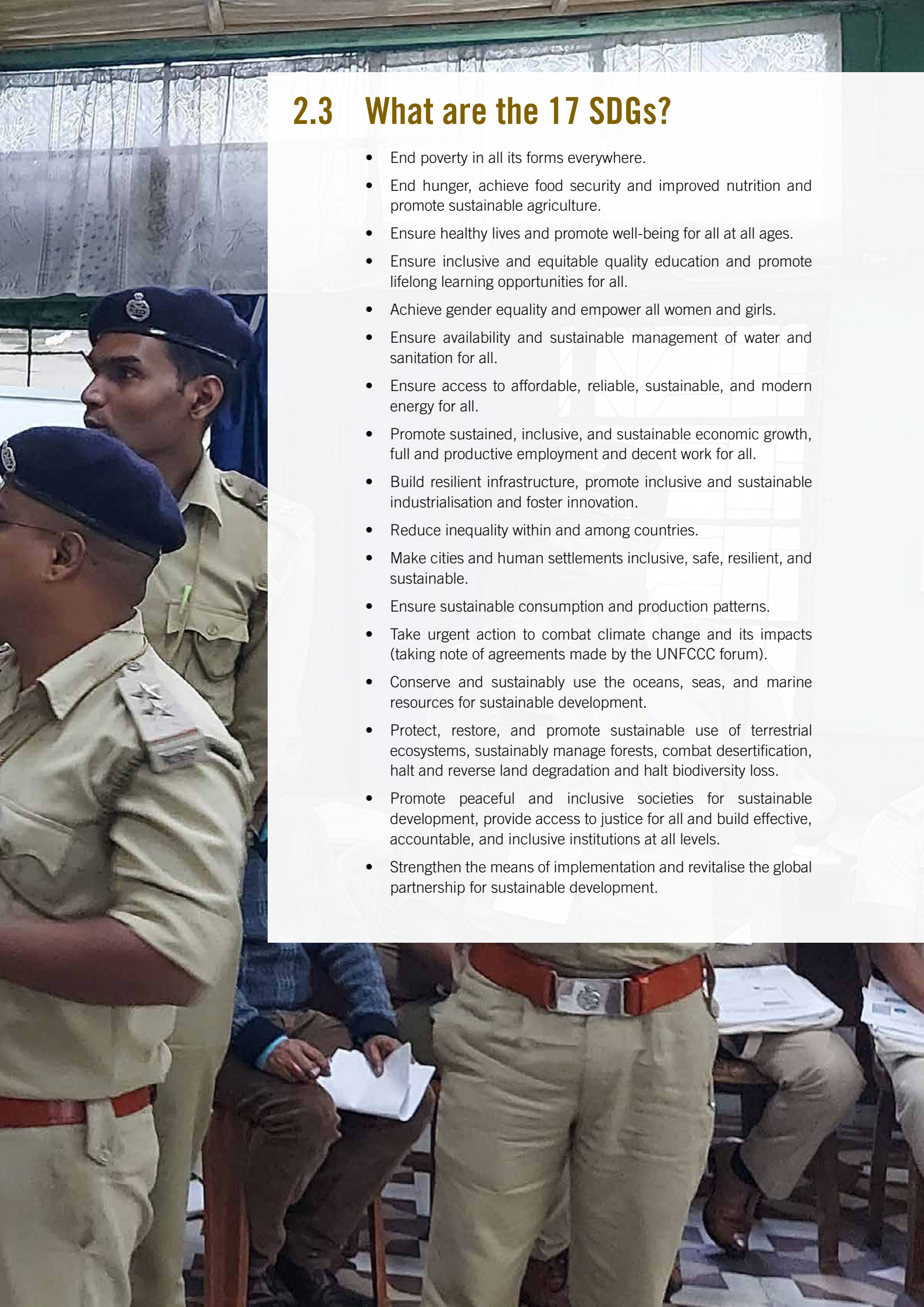


2.2 The concept of sustainable development

Sustainable development has been defined in many ways, but the most frequently quoted definition is from Our Common Future, also known as the Brundtland Report: *'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'* Sustainability is the foundation for today's leading global framework for international cooperation—the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs).

The SDGs are a new, universal set of goals, targets, and indicators that United Nations member states are expected to use to frame their agendas and political policies over the next 15 years. The SDGs follow, and expand on, the Millennium Development Goals (MDGs). The MDGs consisted of eight international development goals established after the Millennium Summit of the United Nations in 2000, following the adoption of the United Nations Millennium Declaration. The MDGs were replaced by the SDGs in 2015.

While the MDGs provided a focal point for governments on which to hinge their policies and overseas aid programmes to end poverty and improve the lives of poor people—as well as provide a rallying point for NGOs to hold them to account—they were criticised for being too narrow.



2.3 What are the 17 SDGs?

- End poverty in all its forms everywhere.
- End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- Ensure healthy lives and promote well-being for all at all ages.
- Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Achieve gender equality and empower all women and girls.
- Ensure availability and sustainable management of water and sanitation for all.
- Ensure access to affordable, reliable, sustainable, and modern energy for all.
- Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.
- Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.
- Reduce inequality within and among countries.
- Make cities and human settlements inclusive, safe, resilient, and sustainable.
- Ensure sustainable consumption and production patterns.
- Take urgent action to combat climate change and its impacts (taking note of agreements made by the UNFCCC forum).
- Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
- Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.
- Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable, and inclusive institutions at all levels.
- Strengthen the means of implementation and revitalise the global partnership for sustainable development.

Goal 1, 2 and 15 are specifically relevant to human–wildlife conflict mitigation, and therefore efforts by the national and state governments and all other institutions will directly contribute to achieving these two SDGs in India.

2.4 SDG India Index

NITI Aayog has constructed the SDG India Index spanning across 13 out of 17 SDGs (leaving out Goals 12, 13, 14 and 17). The Index tracks the progress of all the States and Union Territories (UTs) on a set of 62 National Indicators, measuring their progress on the outcomes of the interventions and schemes of the Government of India. The SDG India Index is intended to provide a holistic view on the social, economic, and environmental status of the country and its States and UTs.

The SDG India Index is an aggregate measure that can be understood and used by everyone—policymakers, businesses, civil society, and the general public. It has been designed to provide an aggregate assessment of the performance of all Indian states and the union territories, and to help leaders and change makers evaluate their performance on social, economic, and environmental parameters. It aims to measure the progress of India and its states towards the SDGs for 2030.

To measure India's performance towards SDG 15 (Life on Land), following national-level indicators have been identified that capture three out of the 12 SDG targets for 2030 outlined under this goal:

- Forest cover as a percentage of total geographical area
- Tree cover as a percentage of total geographical area
- Percentage of area covered under afforestation schemes to the total geographical area
- Percentage of degraded land over total land area
- Percentage increase in area of desertification
- Number of cases under Wildlife Protection Act (1972) per million hectares of protected area

3. HWC-safe Livelihoods

3.1 Ecosystem Services ensuring environmentally and socially sustainable livelihoods

A livelihood is a means of making a living. A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living (Chambers and Conway, 1991). In rural areas, a major determinant of livelihood security is the availability of resources—especially natural resources, which includes forest /grazing areas, land, water and livestock and other animal resources—as well as access to these resources through a conducive natural resource governance system. Access to information and knowledge on the use of natural resources, through peer learning or through inter-generational knowledge transfer, is equally crucial for livelihood security.

A livelihood is sustainable when it can with and recovers from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (Chambers and Conway, 1991).

This translates into a two-way relationship between livelihoods and the ecosystem. A livelihood is environmentally sustainable when the natural resources and ecosystem services are being utilized for livelihood activities at a rate and manner that does not pose any threats to the natural ecosystem and the ecosystem services. A livelihood is socially sustainable when it can cope with and recovers from stress and shocks, can maintain or enhance its capabilities and assets, can provide sustainable livelihood opportunities for the next generation and contributes net benefits to other livelihoods at the local and global levels and in the short and long terms (Chambers and Conway, 1991). Many authors (Chambers and Conway, 1991; UNSIDR/UNDP/IRP 2010) have emphasized the need to include the impacts of stresses and shocks or disasters and the coping capacities of human communities in the conceptual planning of livelihood sustainability and vice versa.

Therefore, environmental sustainability is related to the external impact of livelihoods on other livelihoods and natural capital, whereas social sustainability is related to their internal capacity to withstand outside pressure. Both aspects of livelihood sustainability—social and environmental—are fundamentally affected by the type, amount and sustainability of the ecosystem services.

Ecosystems services are the benefits that people obtain from ecosystems. Ecosystems provide a variety of benefits to people, including provisioning (food, fuel, fibre, water, etc.), regulating (air and water quality, climate regulation, carbon sequestration, pest and disease control, disaster risk reduction, pollination, etc.), cultural (spiritual, aesthetic and religious values, tourism, etc.), and supporting (soil nutrient balance, habitat provision, etc.) services, as described by the Millennium Ecosystem Assessment (2005). Biodiversity is the foundation of ecosystem stability and resilience, and its loss negatively affects the provision of ecosystem services by natural ecosystems. The consequences of biodiversity loss and ecosystem degradation, therefore, are often harshest for the rural poor, who are highly dependent on ecosystem services for their livelihoods and who are often the least able to access or afford substitutes for the lost ecosystem services. The Millennium Ecosystem Assessment (2005) has confirmed that biodiversity loss poses a significant barrier to meeting the needs of the world's poorest, as set out in the United Nations Millennium Development Goals. The impacts of biodiversity loss and ecosystem degradation are most severe in mountain and coastal communities, and these ecosystems are also among the most vulnerable ecosystems as far as the negative impacts of climate change are concerned.

The Millennium Ecosystem Assessment has confirmed that biodiversity loss poses a significant barrier to meeting the needs of the world's poorest, as set out in the United Nations Millennium Development Goals (now SDGs).

Figure 1: Ecosystem Services as constituents of human well-being (Source: Millennium Ecosystem Assessment (https://www.sciencedirect.com/science/article/pii/S0065250415000343#f0005))

Land use/land cover (LULC) change affects the provision of ecosystem services for humans, and habitat for wildlife. Hence, it is crucial to monitor LULC around all forested landscapes and particularly around HWC hotpots. Potential impacts of climate change on habitats and movement of key species-in-conflict, would need to be anticipated, assessed, and integrated into carrying capacity assessments that form the basis for all management interventions

3.2 HWC-safe livelihoods at HWC hotspots

While sustainable use of natural resources generally does not pose a significant ecological problem, over-extraction due to rising demands of a growing human population and insufficient regulation mechanisms causes degradation of such wildlife habitats. A degraded and disturbed wildlife habitat, in turn, decreases the carrying capacity for wildlife species, which may lead to wildlife searching for food outside of their natural habitat, resulting in HWC, in some instances, thus endangering the livelihoods.

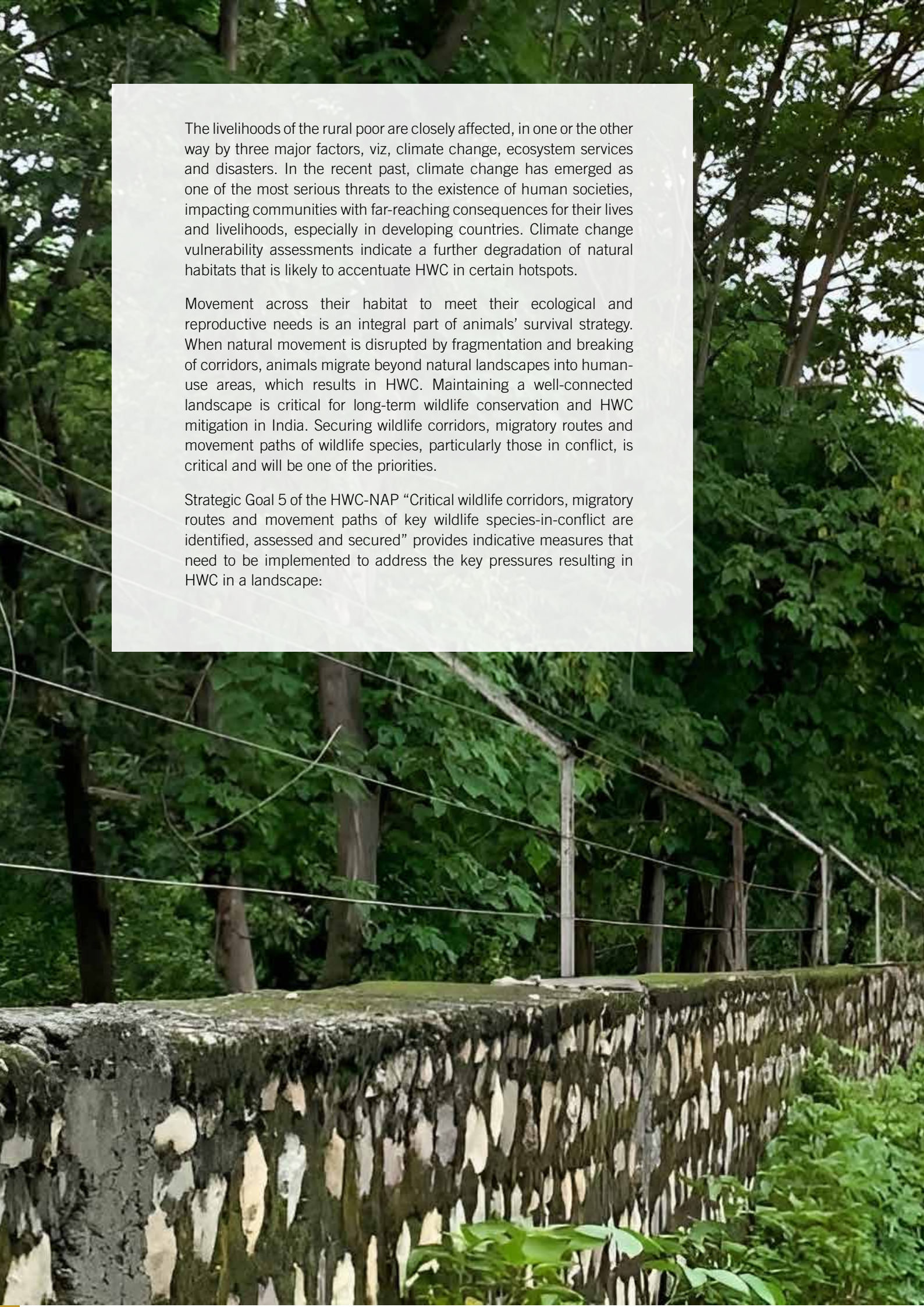
"HWC-safe livelihoods" are environmentally and socially sustainable livelihoods that are not negatively impacted by presence of wild animals in the landscape.

> Stable and bio-diverse ecosystems provide multiple services, which interact in multiple ways. This makes the ecosystem services relate to each other either negatively or positively. Some ecosystem services co-vary positively (an increase in one service means another also increases), and others co-vary negatively (an increase in one service means another decreases). Focusing on one ecosystem service in isolation from the possible impacts on other critical ecosystems services provided by the same ecosystem leads to a situation of conflict and management failure (Elmqvist et al 2011).

The most important factor to ensure HWC-safe livelihoods is maintenance of ecosystem services in a landscape, and a healthy wildlife population is one of the foundation factors to ensure provision and maintenance of ecosystem services.

Reducing the anthropogenic pressure on natural habitats, particularly in HWC hotspots, is one important way for the safety of humans and the welfare of wildlife, and to ensure HWC-safe livelihoods. HWC-safe livelihoods can be developed through:

- Education and skill improvement, which will open better employment opportunities.
- Furthermore, value addition to existing produce (farm or forest-based) will improve incomes, without increasing extraction.
- The introduction of high yield hybrid cattle is expected to minimize or eliminate (where stall-fed) grazing pressure in native wildlife habitats while ensuring higher economic returns. The Animal Husbandry department can formulate and implement special plans for improved stall-fed farm animal stock and practices, especially in the HWC hotspots.
- Alternate fuel sources such as Liquified Petroleum Gas (LPG) or kerosene, or fuel-efficient stoves, will reduce or minimize fuelwood extraction.
- The forest-dweller groups and local communities participating in JFM, having customary rights for use of natural resources as an integral part of their cultural identity, need special attention and protection. Community-based institutions, government institutions, private sector etc involved in community development (Education, Tribal, Rural, Agriculture and Animal Husbandry, MGNREGA, Health, Small-Scale and Cottage Industries, Micro-finance agencies, etc.) can be engaged cohesively by the forest departments, to bring about synergies that benefit socio-economic development of forest-dependent communities, in a manner that minimizes their dependence of forests, by simultaneously providing both better livelihood and resource alternatives.
- The Joint Forest Management (JFM) in India, initiated in 1990, has influenced the agrarian economy towards sustainable management of resources. The community institutions created in fringe-forest villages such as Village Forest Committees (VFCs), Eco Development Committees (Programme EDCs) and watershed committees can be engaged in efforts to mitigate HWC.
- Use of crops that are not preferred by the wild animals-in-conflict in that landscape
- Effective and wildlife-friendly crop guarding and crop protection measures, effective property and livestock protection measures



The livelihoods of the rural poor are closely affected, in one or the other way by three major factors, viz, climate change, ecosystem services and disasters. In the recent past, climate change has emerged as one of the most serious threats to the existence of human societies, impacting communities with far-reaching consequences for their lives and livelihoods, especially in developing countries. Climate change vulnerability assessments indicate a further degradation of natural habitats that is likely to accentuate HWC in certain hotspots.

Movement across their habitat to meet their ecological and reproductive needs is an integral part of animals' survival strategy. When natural movement is disrupted by fragmentation and breaking of corridors, animals migrate beyond natural landscapes into human-use areas, which results in HWC. Maintaining a well-connected landscape is critical for long-term wildlife conservation and HWC mitigation in India. Securing wildlife corridors, migratory routes and movement paths of wildlife species, particularly those in conflict, is critical and will be one of the priorities.

Strategic Goal 5 of the HWC-NAP "Critical wildlife corridors, migratory routes and movement paths of key wildlife species-in-conflict are identified, assessed and secured" provides indicative measures that need to be implemented to address the key pressures resulting in HWC in a landscape:

3.3 Maximizing synergies between sectors and minimising trade-offs to ensure HWC - safe livelihoods at HWC hotspots

Though the objective of all conservation, development and livelihood generation activities, including climate change adaptation and mitigation, and disaster risk reduction is to reduce the vulnerability of the local communities, some measures may unintentionally leave people even more vulnerable than before, by accentuating the risk to human-wildlife conflict, thus endangering their livelihoods and overall well-being. It is important to identify such possibilities and minimise these trade-offs and enhance the synergies.

The HWC-NAP of India has an important **Indicator**, under its Goal 2 "All development activities are sensitive to potential human wildlife conflicts"- **Number of new conflict hotspots as a result of development projects** that seeks to monitor any such possible trade-off, where a development measure many inadvertently accentuate the risk of HWC in an area, resulting to increased vulnerability of the people.

The challenge, however, lies in identifying the activities and strategies that may be mutually beneficial (synergies) or may diminish the efforts of the other sectors (trade-offs) in a particular context. It may not be possible to develop a global equation on the synergies between different sectoral strategies as the linkages may be highly context specific. However, an attempt is made in the following section to provide a general framework and indicative activities where synergies and trade-offs many exist, using which officers from different areas can conduct a similar analysis delineating the type of relationship that exists between various elements as a starting tool to further assess the synergies and trade-offs in their area.

- Trade-offs can be seen when development activities may increase the vulnerability of communities to HWC, via long-term negative impacts on the wildlife corridors, or lead to degradation of natural ecosystems.
- Similarly, some livelihood interventions can unintentionally leave people even more vulnerable than before to the impacts of HWC. For example, development of rural infrastructure, such as roads, railways tracks, large building complexes, tourism facilities etc may block the movement path of long-ranging species such as elephants and tigers or reduce the natural habitat for species like leopard, rhesus macaque, leading to a situation of increased wild animal movement in 'now' human-dominated landscape.
- Similarly, unless effective waste management measures are deployed, tourism facilities including ecotourism and community-based tourism near natural habitats may attract more wild species that may either get attracted to the food waste, or the water or fruit trees planted around such facilities, or even some carnivores may get attracted to the dogs feeding on food waste. This may leave the local community around such tourism facilities even more vulnerable.
- Use of new crop varieties that may be palatable or a favourite food for them, may attract wild animals-in-conflict
- Use of water harvesting or water conservation structures that are not wild animal-proof

Stable ecosystems are the foundation for achieving the goals of reduced vulnerability, and higher adaptive capacities towards climate and disaster risk reduction, as well as achieving the SDGs. Adopting an ecosystem approach in the overall development planning should be top priority of each state. Conservation of ecosystems, biodiversity and wildlife provides multiple benefits in the long run and will automatically minimize the trade-offs between actions of various sectors.

To find a balance and to look forward to 'harmonious co-existence' it seems relevant to find solutions keeping in mind that the issues of human–wildlife conflict arise due to conflicting needs from the same landscape and therefore the solution also lies in taking a landscape approach while formulating solutions for mitigating human–wildlife conflict.

4. Taking a landscape approach to addressing HWC

4.1 What is a landscape?

A landscape is a heterogeneous land area that is often hierarchically structured. Forman and Godron (1986) defined 'landscape' as a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout. Turner and Gardner (2001) defined 'landscape' as an area that is spatially heterogeneous in at least one factor of interest.

From an ecological perspective, a landscape is a mosaic of interacting ecosystems (at any scale), an area spatially heterogeneous in at least one factor of interest Spatially, landscapes form the lived and experienced environment of humans, which enables them as individuals as well as society to fulfil physical and psychological needs.

Landscapes have a variety of functions as resources. They are living, working, recreation and identification space for humans, habitat for animals and plants, as well as a spatial expression of the cultural heritage. In addition, they contribute to value creation.

Landscapes are dynamic structures of action and are constantly evolving due to natural factors and human use and design.' From a wildlife perspective, 'landscape' can be defined as an area of land containing a mosaic of habitat patches, often within which a particular 'focal' or 'target' habitat patch is embedded. These habitat patches can only be defined relative to a particular organism's perception and scaling of the environment.

The required landscape size would differ among organisms. A landscape may be envisioned as a geographical area that represents the distribution range of a population of species. For instance, an elephant landscape could be a 10000 sq. km. network of Protected Areas and non-forest areas over which a population of elephants are distributed. For an endemic frog, a landscape could be a network of streams and headwaters in Western Ghats where the particular species is found. Hence, the definition of landscape is functional. For freshwater services of Perennial North Indian rivers, the entire Himalayan Range and forested areas within it could be considered as one landscape. For conservation purposes, landscapes are often associated with particular species populations or protected area systems: Tiger landscapes, Elephant landscapes, the Terai Arc landscape, the Central Highland landscape, etc.

Structure of landscape

The structure of a landscape is defined by a spatial pattern consisting of two components: composition and configuration. The composition of a landscape is defined by the spatial elements that are distinguished on the map and that are believed to be relevant to the landscape function under consideration. The composition represents the non-spatial aspect of a landscape, since only the number of landscape elements are considered, not their spatial configuration. The configuration of a landscape is defined by the spatial character, arrangement, and context of the elements. The configuration represents the spatial aspect of a landscape. Together the two components define the spatial pattern or heterogeneity of a landscape. The basic structure of a landscape is a patch, which is a homogenous area. The size of a landscape depends on research or management objectives, and it varies with the perception of organisms.

- A wildlife landscape may be determined as a large area containing continuous wildlife habitats, delimited by a human-dominated landscape. On the other hand, a landscape defined by a geological formation, such as the Terai Arc Landscape, may be a mosaic of settled and wildlife areas. Patches and landscapes are not isolated entities, but they are embedded in local, regional, and global contexts.
- A landscape is an open system, with flows across landscape-patch boundaries and interacts among landscape-patches. Various ecosystems, such as forests, swamps, and lakes, may be found in one landscape, and landscapes may be divided into landscape units (patches) with intact wildlife habitats (forests, wetlands, grasslands, deserts, etc.) as well as landscape units dominated by human use (agriculture/built-up areas).
- In the context of HWC, the 'factors of interest' are the 'human-use areas' (agricultural lands, settlements, industrialized land, infrastructure, etc.) and 'wildlife habitats' (forests, wetlands, coastal areas, grasslands, etc.). Wildlife habitats are areas of land that provide resources such as food, cover, water and environmental conditions (such as precipitation and soil) that affect the occupancy of individuals or populations of species, allowing those species to survive and to reproduce.
- Landscape features are visible landforms that make up a landscape. They may be natural in origin, such as hills, rivers, lakes, meadows, and forests, or they may be human-made, such as canals, settlements, infrastructure, and agricultural areas.

Major components of landscapes

Landscapes are considered as integrated systems, composed of different components that form different layers:

- The upperpart of the landscape is the atmosphere, visible as 'the sky.' This layer forms also determines the climate of the region.
- Above (and partly below) the earth's surface, a layer is found that harbours life (the biosphere), including animals and vegetation (phytosphere) as well as humans and their associated creations (settlements, agriculture, infrastructure, etc.).
- The geomorphology determines largely the form of a landscape (geosphere or geomorphosphere) but also partly its characteristics (hydrology, climate, etc.).
- The upper earth layer is composed of soil (clay, silt, sand, loam) or rocks. The soil is referred to as the pedosphere, and it is crucial for vegetation, agriculture, and other forms of land cover. Soil is the weathered product of the geological layers below, or it originates from the decomposition of organic material. It may be overlain by sedimented material.
- The lowest layer is formed by the rock underground (lithosphere), which is the basis of a landscape. It is strongly related to the geomorphology and partly determines the soil.

These components/layers represent separate aspects, but there is usually a strong relation and interaction between different layers.

Types of Landscapes

The landscapes managed through a landscape approach are usually delimited by geophysical barriers, by boundaries of social or stakeholder incentives or by government restrictions and administrative borders.

Landscapes can be of the following types:

- Coastal landscapes
- Forested landscapes
- Deserts
- Wetlands
- Taiga
- Tundra
- Shrublands
- Cultural landscapes
- Grasslands and savanna

For the purpose of the management of species, it is convenient to define landscapes on basis of the distribution of key species. It is evident that the scale of the landscape depends on the species. For large animals, such as the ones that cause HWC, larger landscapes are defined than for smaller species.

Examples of Indian wildlife landscapes are the various defined landscapes occupied by Elephants and Tigers. One of them is the Central Indian Tiger Landscape. This landscape has a network of Tiger reserves linked with forest patches or corridors. The corridors are the critical areas as these are outside the protected areas. Likewise, the Odisha Elephant Landscape is a priority landscape for Elephants with increasing HWC.

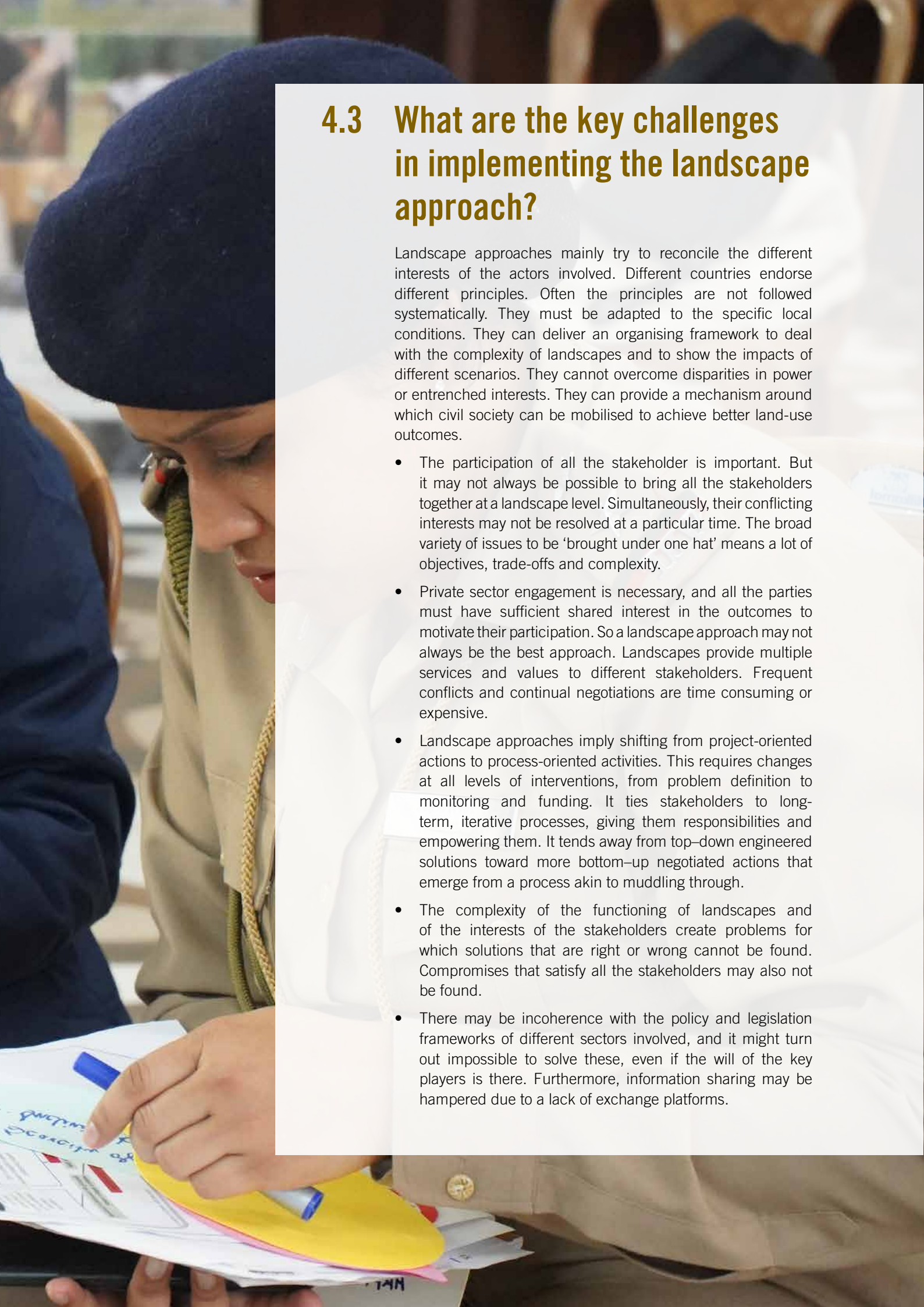
Throughout the seasons, wildlife species use a landscape for their different needs, such as feeding, drinking, and breeding. The strategy of some species to adapt to fluctuating resource availability or climate conditions is to migrate seasonally within landscapes. Because species associate, we can use certain species as indicators of certain landscapes. This may be useful for management purposes. In India, we distinguish, for example, Elephant landscapes such as the Odisha Elephant Landscape and the Nilgiri Landscape, as well as Tiger landscapes, such as the Sundarbans and the Satpuda-Maikal Tiger Landscape, in central India.

4.2 Why take a landscape approach?

As wildlife areas in India today are becoming islands within human-use areas, the spatial extent of a landscape can be the entire forest patch in each area, which is surrounded by human-use areas, irrespective of its size. As this would, in many cases, stretch across multiple administrative jurisdictions, a more manageable spatial unit would be a forest division, which is generally the unit at which 'working plans' are developed. This administrative unit is significant because HWC mitigation plans can be included in the working plans of forest divisions, making them operationally efficient.

> However, for enhanced effectiveness, it would be important that managers also look at the larger landscapes for developing HWC conflict mitigation strategies, as some species such as the Elephant and Tiger range/disperse over very large areas. Unless a comprehensive and integrated HWC plan is implemented over several forest divisions, the problem is likely to only shift from one place to another and will yield short-term relief rather than get addressed.

Therefore, HWC can be addressed effectively and sustainably only when an actionable HWC mitigation plan is developed for the relevant landscape across the boundaries of forest divisions and other administrative boundaries. For example, Elephants can have home ranges of over 600 km^2 (Baskaran et al 1995), and there are reports of Tigers dispersing nearly 65 km (Carter et al 2015) and even 650 km (Joshi et al 2013), while the extent of a forest division might range between 70 km^2 and 50 km^2 (which are much smaller than the areas mentioned for Elephant/Tiger dispersal). So spatial scales for HWC management action plans should not be limited to forest divisions if we wish to address the issue of HWC.



4.3 What are the key challenges in implementing the landscape approach?

Landscape approaches mainly try to reconcile the different interests of the actors involved. Different countries endorse different principles. Often the principles are not followed systematically. They must be adapted to the specific local conditions. They can deliver an organising framework to deal with the complexity of landscapes and to show the impacts of different scenarios. They cannot overcome disparities in power or entrenched interests. They can provide a mechanism around which civil society can be mobilised to achieve better land-use outcomes.

- The participation of all the stakeholder is important. But it may not always be possible to bring all the stakeholders together at a landscape level. Simultaneously, their conflicting interests may not be resolved at a particular time. The broad variety of issues to be 'brought under one hat' means a lot of objectives, trade-offs and complexity.
- Private sector engagement is necessary, and all the parties must have sufficient shared interest in the outcomes to motivate their participation. So a landscape approach may not always be the best approach. Landscapes provide multiple services and values to different stakeholders. Frequent conflicts and continual negotiations are time consuming or expensive.
- Landscape approaches imply shifting from project-oriented actions to process-oriented activities. This requires changes at all levels of interventions, from problem definition to monitoring and funding. It ties stakeholders to long-term, iterative processes, giving them responsibilities and empowering them. It tends away from top–down engineered solutions toward more bottom–up negotiated actions that emerge from a process akin to muddling through.
- The complexity of the functioning of landscapes and of the interests of the stakeholders create problems for which solutions that are right or wrong cannot be found. Compromises that satisfy all the stakeholders may also not be found.
- There may be incoherence with the policy and legislation frameworks of different sectors involved, and it might turn out impossible to solve these, even if the will of the key players is there. Furthermore, information sharing may be hampered due to a lack of exchange platforms.

5. A quick analysis of human-wildlife conflict using a landscape approach

5.1 An overview of landscape-level drivers and land-use change

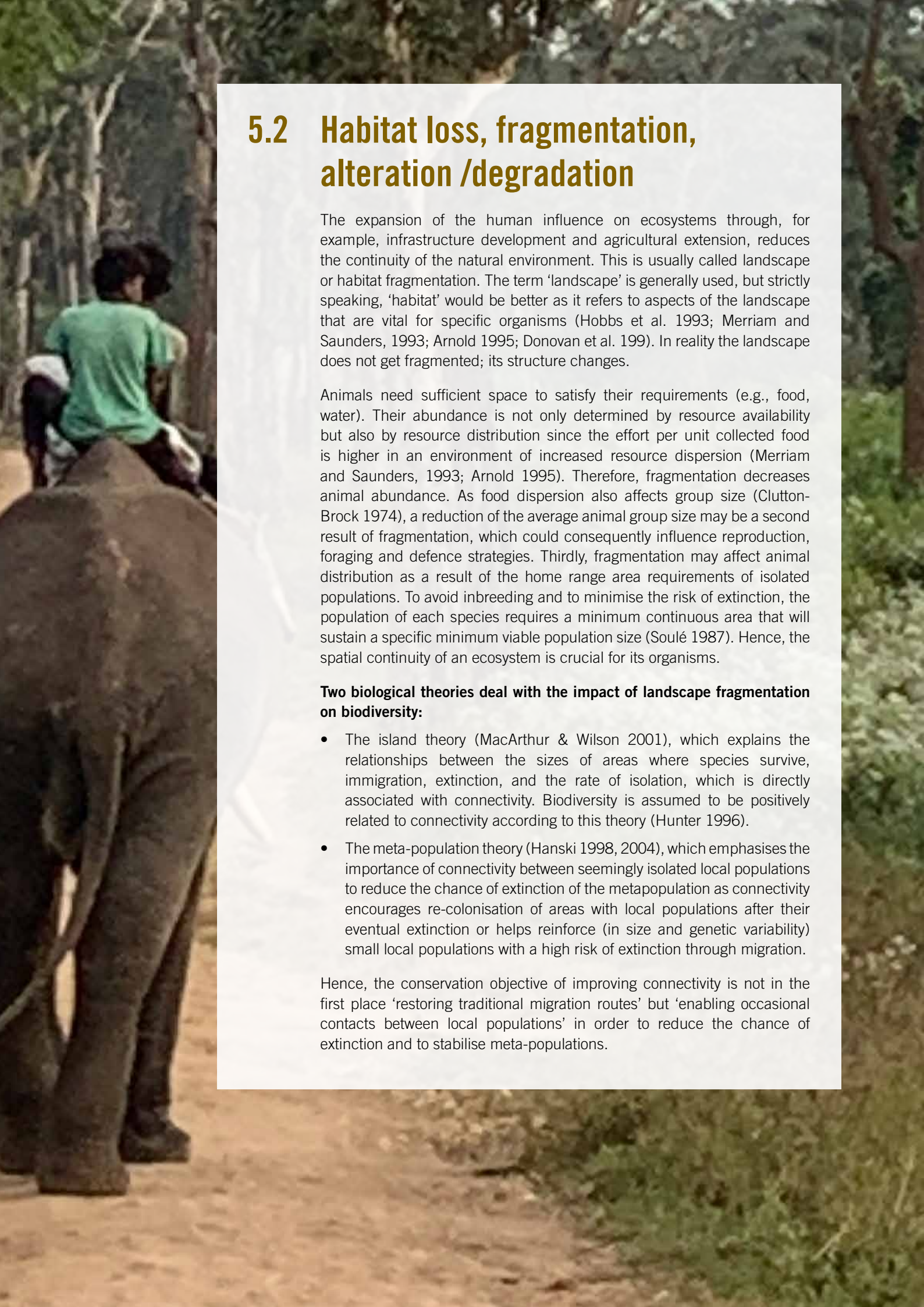
The use of land and resources by humans impacts wildlife habitats and consequently increases the risk of HWC due to the reduction of resources for the wildlife and the disturbances created within the habitats. Humans use wildlife-dominated landscapes, extracting resources such as NTFP and creating pastures for grazing cattle. This does not only result in conflict inside wildlife areas—the habitat degradation caused may force wild animals to disperse more into human-use areas in search of alternative resources.

When present in landscapes, humans are generally an important factor in determining the shape of these landscapes. In some cases, humans have modified landscapes largely to suit their needs. Such changes of landscapes involve the modification of ecosystems and thus wildlife habitats. These modifications, however, do not lead necessarily to areas that are unsuitable to all wildlife species, and some wildlife may still find significant resources in these areas and roam in them. In such cases, the humans and wildlife are close together, and this may result in a risk of HWC. An example here is the Leopard, which can survive in rural and even urban areas, preying principally on small and medium-sized domestic animals. Rarely it preys on humans, particularly women and children.

The management of landscapes is determined by the administrative regions covered, by the protection status of the land defined in the conservation legislation, by the land ownership and by the land-user rights. However, customary, and religious rules may also play a role in determining the nature of landscape management. Normally, oriented by regulatory land-use frameworks, different stakeholders may claim parts of the landscape for their activities, which may result in temporary or permanent land modifications. As a result, landscapes have both natural patches and patches dominated by human modification, including agricultural areas, transport infrastructure, settlements, mines, forest plantations and dams.

Addressing the drivers and pressures of HWC requires an integrated approach to natural resource management and land-use planning. This approach is based on the following:

- Considering the land-use regulatory frameworks
- Understanding of the relations between wildlife and habitats
- Understanding the socio-economic requirements of the local human communities in relation to the landscape
- Understanding of environmental and socio-economic risks and impacts of land-use options
- A rational decision-making process that involves stakeholders in land-use planning.



5.2 Habitat loss, fragmentation, alteration /degradation

The expansion of the human influence on ecosystems through, for example, infrastructure development and agricultural extension, reduces the continuity of the natural environment. This is usually called landscape or habitat fragmentation. The term 'landscape' is generally used, but strictly speaking, 'habitat' would be better as it refers to aspects of the landscape that are vital for specific organisms (Hobbs et al. 1993; Merriam and Saunders, 1993; Arnold 1995; Donovan et al. 199). In reality the landscape does not get fragmented; its structure changes.

Animals need sufficient space to satisfy their requirements (e.g., food, water). Their abundance is not only determined by resource availability but also by resource distribution since the effort per unit collected food is higher in an environment of increased resource dispersion (Merriam and Saunders, 1993; Arnold 1995). Therefore, fragmentation decreases animal abundance. As food dispersion also affects group size (Clutton-Brock 1974), a reduction of the average animal group size may be a second result of fragmentation, which could consequently influence reproduction, foraging and defence strategies. Thirdly, fragmentation may affect animal distribution as a result of the home range area requirements of isolated populations. To avoid inbreeding and to minimise the risk of extinction, the population of each species requires a minimum continuous area that will sustain a specific minimum viable population size (Soulé 1987). Hence, the spatial continuity of an ecosystem is crucial for its organisms.

Two biological theories deal with the impact of landscape fragmentation on biodiversity:

- The island theory (MacArthur & Wilson 2001), which explains the relationships between the sizes of areas where species survive, immigration, extinction, and the rate of isolation, which is directly associated with connectivity. Biodiversity is assumed to be positively related to connectivity according to this theory (Hunter 1996).
- The meta-population theory (Hanski 1998, 2004), which emphasises the importance of connectivity between seemingly isolated local populations to reduce the chance of extinction of the metapopulation as connectivity encourages re-colonisation of areas with local populations after their eventual extinction or helps reinforce (in size and genetic variability) small local populations with a high risk of extinction through migration.

Hence, the conservation objective of improving connectivity is not in the first place 'restoring traditional migration routes' but 'enabling occasional contacts between local populations' in order to reduce the chance of extinction and to stabilise meta-populations.

The requirements in terms of habitat and home range area of species are rather complex. These requirements relate more or less to the size of the animal as resource dependence and availability (during all seasons) for a species and the members of its social unit are an important determining factor of carrying capacity. This means that larger animals are more vulnerable to fragmentation than are smaller animals and that species such as the Elephant, Tiger, Leopard, and deer are more vulnerable to fragmentation than are smaller animals. In addition, carnivores, which occupy a higher trophic level, need relatively large areas compared with herbivores, and therefore they are more vulnerable to fragmentation. Animals with a more gregarious lifestyle are also more vulnerable to fragmentation unless they can adapt their social structure. Furthermore, the dispersion of food resources, water and other crucial habitat elements may have a specific influence on the vulnerability of species to fragmentation.

Since forests and other natural habitats, are critical for the survival of most wildlife, their loss, degradation, and fragmentation are one of the primary drivers of HWC, as has been noted for Elephants (AsERSM, 2006). As wildlife habitats becomes more and more fragmented and wildlife is confined into smaller pockets of habitats, humans and wildlife are increasingly coming into contact, resulting in higher extents of conflict with each other (Lamarque et al. 2009). In the Kakum Conservation Area, in Ghana, reduction of forests by about half since the 1970s has led to Elephant densities reaching about 0.6/km^2 which is higher than in most other West African forests, thereby resulting in increased crop-raiding activities (Barnes et al. 2003).

Securing corridors becomes critical in light of the predicted impacts that climate change may have on natural habitats. The resulting impediments to animal movements through the habitat matrix may lead to enhancement of HWC. In this context, the guidelines issued by WII- MoEFCC (WII, 2016) provide for possible solutions, including creation of underpasses, overpasses, etc., that can be adopted by the infrastructure development agencies. This will apply when creation of such structures in the habitats becomes inevitable, to prevent fragmentation. Undertaking all infrastructure in the shortest possible time, is a critical requirement for projects in forest habitats, and must be monitored and ensured at highest level.

Habitat degradation (historic and recent) is a major driver of HWC. Terrestrial herbivores, even Elephants, feed on the lower vegetation levels below the canopy and hardly or not on full grown trees. Therefore, large herbivores may still be adversely impacted as the extent of land under grass, herbs, shrubs, and tree saplings are reduced by land use including livestock grazing, fuel wood collection, etc. Due to food shortages, these herbivores may start roaming into cultivated areas in search for food. Similarly, when the numbers of herbivores, which are prey species of large carnivores, decline due to the poor quality of a habitat, predators may turn to preying on domestic livestock as alternative food items, thus causing conflict. The same may occur when prey species decline due to poaching.

5.3 Climate change as a driver of HWC

The main characteristics of climate change include rising temperatures, changes in rainfall patterns, melting of glaciers and sea ice, sea-level rises and an increased intensity or frequency of extreme events. These changes in physical processes have impacts on biological and socioeconomic factors, such as shifts in crop-growing seasons, food production and food security, changes in disease vectors, shifting boundaries of forests and other ecosystems and extreme events such as flooding, droughts and landslides.

According to the fifth report of the IPCC, in recent decades, climate change has caused impacts on natural and human systems on all continents and across the oceans.

- In many regions, changing precipitation or melting snow and ice is altering hydrological systems, affecting water resources in terms of quantity and quality.
- Many terrestrial, freshwater, and marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundance, and species interactions in response to ongoing climate change.
- Climate change has negatively affected yields of wheat, maize, rice, soybean, and other crops in many regions and in the global aggregate.
- There has been increased heat-related mortality and decreased cold-related mortality of humans and wildlife in some regions as a result of warming.

Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including a decrease in low-temperature extremes, an increase in high-temperature extremes, an increase in extreme events, high sea levels and an increase in the number of heavy precipitation events in several regions, as well as an increased irregularity of seasonal rainfall patterns.

Box 1: Case example- Climate Change and Human-Bear Conflict in Sikkim (Source: Jamwal, 2018)

Climate change exacerbates human–wildlife conflicts in Sikkim

Climate-induced changes have directly or indirectly impacted the habitat and distribution limits of wild animals. With flowering and fruiting being affected by the changing climate, the availability of food inside the forests for wildlife has changed over time. This is directly correlated with an increased number of incidences of wildlife straying into villages, leading to increased human–wildlife conflict.

In an article published in Mammalian Biology, the rise in human–bear conflicts has been linked with the rising temperature in the Himalayan region and the delay in snowfall. An increase in temperature and delayed precipitation means a shorter hibernation period for the Black Bear and more searching for food. The paper also records a dramatic increase in the numbers of direct encounter incidents involving Himalayan Black Bears and stray incidents involving Leopards. This species eats acorns and nuts of the previous year, and if the production of such nuts decreases due to unusual weather events, the bears wander around for other foods.

The state government's 2012 report notes that in the last two decades (1991–2000 and 2001–2010), the number of rainy days and the annual rainfall at the Tadong meteorological station have decreased at rates of 0.72 days per year and 17.77 mm per year, respectively. Further, the rate of increase of the mean minimum temperature between the decades 1991–2000 and 2001–2010 is 0.81°C per decade, or 0.08°C per year. Erratic rainfall is also a major concern.

In Luncha Kameru village, Sumbuk block, in South Sikkim, where Peafowl have become a menace, as they destroy rice and corn crops, every morning a group of farmers carries grains to the forest to feed the Peafowl. Villagers around the Kitam Bird Sanctuary are doing something similar. They planted fruit-bearing trees inside the sanctuary. They are also growing maize, millets, tubers, etc. inside the forest so that wild animals do not attack their crops. In addition to this, farmers around the Kitam sanctuary have drawn up a plan to fence the boundary of the protected area. In 2013–2014, the wildlife division had installed solar hybrid electric fence along the 3 km boundary of the sanctuary. The plan is to build an additional 3–4 km long barbed wire fence along the remaining boundary of the sanctuary. A bio-fence, a thick mesh of multiple plants, is also part of the project.

Interestingly, the villagers are using corporate social responsibility funds of the Axis Bank Foundation and labour funds from the Mahatma Gandhi National Rural Employment Guarantee Act to support their fencing project. They also plan to switch to crops such as coffee and turmeric, which are not attacked by wild animals. Dairy, cottage industries (pickle making, local wines, etc.) and village tourism are also being promoted in villages around the Kitam sanctuary. In Talkharka village, near India-Bhutan border, WWF-India has trained villagers in bee keeping. Thirteen households have got beehive boxes from which honey would be extracted every month and sold for Rs 1,000 (USD 14.28) a litre. Households have also been provided chicken coops to reduce wildlife attacks on poultry. Farmers and non-profit organisations believe these initiatives may help find a long-term solution to human-wildlife conflict in the state.

5.4 Blockage in Wildlife migration

Animals require space to move around for several reasons, such as finding food, avoiding competition, and finding partners for reproduction. In many species young animals leave their parents' territory to reduce competition, but adult animals may also move away in response to environmental changes (e.g., climate change, human influence). Dispersion of young animals is of particular importance for maintenance of genetic variation in populations and for re-colonisation of abandoned areas. Three types of animal movement are often discerned:

01. Daily movements within an animal's home range, which may be related to feeding, the use of shelters, territory maintenance or reproduction.
02. Seasonal migration, which relates to seasonal fluctuations in resource availability, which in turn often determines the reproduction cycle.
03. Dispersal, which involves animals leaving their current home range in search of new areas for food and reproductive partners.

Box 2: The strategic goal in HWC-NAP of India dedicated to securing wildlife corridors

Strategic Goal 5:
Critical wildlife corridors, migratory routes and movement paths of key wildlife species-in-conflict are identified, assessed and secured.

Movement across their habitat to meet their ecological and reproductive needs is an integral part of animals' survival strategy. When natural movement is disrupted by fragmentation and breaking of corridors, animals migrate beyond natural landscapes into human-use areas, which results in HWC. Maintaining a well-connected landscape is critical for long-term wildlife conservation and HWC mitigation in India. Securing wildlife corridors, migratory routes and movement paths of wildlife species, particularly those in conflict, is critical and will be one of the priorities.

Corridors will need to be identified for key long-ranging species, in addition to recognized ones, assessed and mapped on a GIS platform to understand their ecological role, and their specific role and relevance to HWC mitigation. Further, threats to the long-term viability of these corridors will be identified. Accordingly, management plans, including a system and mechanism for regular monitoring and reporting of corridors, are established for these corridors, and will be developed and integrated into HWC-SAP, and other similar documents of the states, taking a landscape approach.

In areas where regular movement of large mammals through non-forest areas leads to conflict, instruments such as Memoranda of Understanding (MoU) with the concerned landowners/communities, purchase of land by forest department in critical bottleneck areas, land swaps, establishment of Community and Conservation Reserves, heritage sites etc., will be explored to secure wildlife passage. Additional appropriate legal provisions can also be explored in this regards.

Securing corridors becomes critical in light of the predicted impacts that climate change may have on natural habitats. The resulting impediments to animal movements through the habitat matrix may lead to enhancement of HWCs. In this context, the guidelines issued by WII- MoEFCC (WII, 2016)[2] provide for possible solutions, including creation of underpasses, overpasses, etc., that can be adopted by the infrastructure development agencies. This will apply when creation of such structures in the habitats becomes inevitable, to prevent fragmentation. Undertaking all infrastructure in the shortest possible time, is a critical requirement for projects in forest habitats, and must be monitored and ensured at highest level.

Table 6: Desired results and achievements under Strategic Goal 5

Goal	Desired Results & Achievements	Responsible Institutions
Goal 5: Critical wildlife corridors, migratory routes, and movement paths of key wildlife species-in-conflict are identified, assessed and secured	Critical corridors for key long-ranging wildlife species are identified, assessed, prioritised and mapped on a GIS-based platform linked to the national database	MoEFCC, SFDs
	A system and mechanism for regular monitoring and reporting of corridors is established	SFDs
	Use of innovative instruments to secure corridors are discussed and operationalized	SFDs
	Use of eco-friendly measures for mitigation of linear infrastructure projects to be implemented.	SFDS

5.5 Invasive species and HWC

Reduction in native food plants due to an increase in cover of invasive non-palatable plant species has been stated as one of the reasons for wild herbivores to enter human-dominated landscapes, in search of food. Management of prioritized invasive species by 2020 is a national target. The HWC-NAP of India states "Invasive species management will be taken up as an important facet of the HWC mitigation strategy and would be allocated the required attention and resources, for assessment and action for eradication thereof. Impact assessment and invasive species risk assessment models would be developed to support the implementation process and also to prioritise the sites for invasive species management. Regular monitoring of invasive species would be done, preferably with the support and engagement of local communities and other stakeholders, including Community PRTs."

The area under invasive alien species such as *Desmodium trifliatumum*, *Cardiospermum halicacabum*, *Ipomea carnea* and *Argemone mexicana* in Pabitora Wildlife Sanctuary is increasing rapidly. These species are competing with native fodder species, leading to increasing numbers of crop-raiding incidents involving the Rhinoceros. Similarly, an increase in the *Lantana camara* cover has resulted in decreased habitat use by Elephants in the dry deciduous forest of Mudumalai Tiger Reserve.

Some plants are sown in between palm oil and rubber plantations to ensure soil does not lose its moisture and fertility. Some of these plants, such as *Mucuna bracteata* and *Pueraria phaseoloides*, have become highly invasive in natural forests.

"Area covered by invasive species in HWC hotspots (O)" is one of the key indicators to monitor the progress under the HWC-NAP

Box 3: The strategic goal in HWC-NAP of India focusing on eradication of invasive species

Table 9: Desired results and achievements under Strategic Goal 8

Goal	Desired Results & Achievements	Responsible Institutions
Goal 8: Efficient and effective response teams are developed in each forest division and protected area at the HWC hotspots in India.	Forest divisions establish, by notification, a three-tiered system (division, range and village/ward-level) of response teams with dedicated staff and funds	SFDs
	Competencies-based training is provided to all three levels of response teams, by the state training Institutions, and other accredited institutions in the state, using participatory and hands-on training methods, in a systematic and regular fashion, together with key relevant departments	SFDs
	The SLCC, landscape-level HWC Mitigation multi-stakeholder forum and DLCCs facilitate the involvement and contribution of related departments, in the district and local-level for establishment of RRTs and Community PRTs	SFDs
	Number of incidents of human death, injury and crop/property damage are reduced due to enhanced efficiency and effectiveness of response teams	SFDs

Strategic Goal 9:
Wildlife habitat within protected areas and forests is restored

To understand the dynamics of the ecosystems, a systematic ecosystem analysis for all HWC hotspots would need to be carried out forming the basis for restoration planning. Of specific relevance would be to map the degradation levels and water availability over time in HWC hotspots. Research institutions can be roped in by the forest departments, where possible, to apply population dynamics models for changing ecosystems, and development of a decision system on these findings for habitat restoration activities within PAs around HWC hotspots.

In cases where vegetation and water augmentation will be used as an instrument for ecosystem restoration, regular monitoring of ecological changes would be done to understand the long-term implications of such measures. The management recommendation ensuing from such analysis would be incorporated into existing Management Plans for PAs, Working Plans for territorial forest divisions, and HWC-MAPs to ensure systematic implementation.

Reduction in native food plants due to an increase in cover of invasive non-palatable plant species has been stated as one of the reasons for wild herbivores to enter human-dominated landscapes, in search of food. Management of prioritized invasive species by 2020 is a national target[5 6], Invasive species management will be taken up as an important facet of the HWC mitigation strategy and would be allocated the required attention and resources, for assessment and action for eradication thereof.

Impact assessment and invasive species risk assessment models would be developed to support the implementation process and also to prioritise the sites for invasive species management.

Regular monitoring of invasive species would be done, preferably with the support and engagement of local communities and other stakeholders, including Community PRTs.

Table 10: Desired results and achievements under Strategic Goal 9

Goal	Desired Results & Achievements	Responsible Institutions
Goal 9: Wildlife habitat within protected areas and forests is restored	Protected Area Management Plans and Territorial Working Plans are adapted to integrate scientific assessment and analysis of roles and impact of different habitat elements on population sizes, structures, fertility rates, etc., of key species-in-conflict	MoEFCC, SFDs
	Ecological restoration measures are identified and implemented in each protected area, and other wildlife habitats including prioritized corridors	SFDs
	Ecological integrity in and around protected areas is restored by reducing the influence of invasive species	SFDs

Box 4: Case Example- Invasive plant species and human-wildlife conflict in Nilgiris (Source: Wilson et al, 2014)Climate Change

Recent reports from the fringes of Nilgiris Biosphere Reserve, in the Western Ghats, have shown that there is a sharp increase in the number of human–wildlife negative interactions. The banana plantations of the eastern slopes of the Nilgiri plateau, in Tamil Nadu, are being raided by Asiatic Elephants frequently (Wilson et al 2014).

This recent activity is the result of rapidly spreading invasive plant species such as Prosopis juliflora and Lantana camara, which seem to have extreme weather endurance, quite better than that of their indigenous counterparts. Lantana, native to South America, came to India in the 19th century as an ornamental plant to occupy real estate in the botanical gardens. Because of the pretty flowers it became popular as a hedge plant to circumscribe gardens. On the other hand, Prosopis seeds were sprayed aerially in the 1960s as the plant was considered a great source of firewood. In drought-stricken Tamil Nadu it was immensely useful especially for the underprivileged. As the need for firewood diminished, the plant took root and its sturdy nature helped it to spread in a far more robust manner, especially in the prevailing drought conditions, compared with indigenous plant varieties.

Traces of Prosopis juliflora were found in dung samples of Elephants that reportedly died of starvation at the state's Mudumalai Tiger Reserve, near the Thengumarahada area. The dung of many animals that consume Prosopis acts as a distributor as well as a seed bank, enabling the plant to spread far and wide. In the upper reaches of the Nilgiris, the invasive plants have caused losses for residents while also bringing them into conflict with the wildlife. Invasive species such as the Scotch Broom, Yellow Cassia, Wattle and so on have eaten up most of the shola forest patches in the land of the Toda communities. The thickets that the invasive grasses have formed have become suitable for predators to prey upon the livestock.

A very important learning from this case study is that human–wildlife interactions and biological invasions may appear as distinct problems but, in many occasions, a reduction in the availability of native food plants due to an increase in the invasive plant species cover has been stated as one of the reasons for the straying out of wild herbivores in search of food. Since the starved herbivores come out of the forests for food they are also being followed by carnivores, which can be dangerous to both livestock and human life. In this case, cross sector coordination is the key to mitigate the consequences, and schemes such as E-Parihara, of the Karnataka Forest Department, should be encouraged, for quick actions on ex-gratia.

5.6 Land use change for wildlife and their habitats

Land use is defined as the sequence of operations carried out with the purpose of obtaining goods and services from the land, can be characterized by the actual goods and services obtained as well as by the management interventions undertaken by the land users. Land use systems are the combination of specified land uses (or production systems) practised on a given land unit that can be geo-referenced. Hence, land use systems are determined by both socio-economic as well as bio-physical factors. Some modes of land-use, such as agriculture, human settlement and mining may have an obvious impact on the landscape characteristics. The influence of other forms of land-use has a less visible impact on landscape, e.g., livestock grazing, the exploitation of wood and non-wood products. What is land-use change?

Land use change is a process by which human activities transform the natural landscape, with regard to how land has been used historically, usually emphasizing the functional role of land for economic activities.

Land use changes are often nonlinear and might trigger feedbacks to the system, stress living conditions, and increase the vulnerability of people and natural systems to the climate change and disaster risks (see relevant sections in this module). Therefore, any land use change needs to be assessed and monitored carefully, and simulated predictions made with certain assumptions, to ensure sustainable conditions for both humans as well as wildlife.

Human land-use patterns are usually primarily determined by human needs and not by habitat requirements of wildlife. Therefore, the conversion of wildlife habitat by human development causes wildlife habitat fragmentation, which may result in restriction of wildlife migration and resource limitation.

Drivers of habitat fragmentation and degradation are:

- Unsustainable forest use
- Invasive species
- Migration (e.g., Indo-Pak war)
- Interventions in water catchments
- Pollution
- Agriculture
- Livestock grazing causing habitat degradation and resource competition with Wildlife
- Encroachment
- Urbanisation
- Infrastructure development (roads, railway, dams, etc.)

5.7 Unplanned mass tourism

The impacts of excessive tourism are a global problem. Tourism often is the only available source of income for people living in or around Protected Areas. Eco-tourism should be developed cautiously to avoid destruction of the landscapes visited and a decrease of even extinction of wildlife populations.

Unplanned mass tourism may have to following negative impacts:

- The local infrastructure is overused (water, food) and excessive quantities of waste are generated.
- Habitats are destroyed.
- Breeding places of nature are impacted.
- The local culture is neglected.
- Social structures are destroyed.
- Excessive infrastructure (hotels, roads, airstrips, marinas, etc.) is developed.
- Poor people often do not benefit; their basis of living even may be destroyed.
- The costs of living become too high for the local population due to increasing prices of goods.
- Natural resources are overused (over-fishing, depletion of water resources).

6. Integrated natural resource management and land-use planning

The management of landscapes is determined by the administrative regions covered, by the protection status of the land defined in conservation legislation, by land ownership and by land user rights. However, customary, and religious rules may also play a role in determining landscape management. Usually, oriented by these regulatory land-use frameworks, different stakeholders may claim parts of the landscape for their activities, which may result in temporary or permanent land modifications. As a result, landscapes combine natural patches as well as patches dominated by human modification, including agricultural areas, transport infrastructure, settlements, mines, forest plantations and dams.

The foregoing sections explained how human land-use patterns increase the risk of HWC. The reduction of this risk requires an integrated approach for natural resource management and land-use planning.

This approach is based on the following:

- considering the land-use regulatory frameworks,
- understanding the relationship between wildlife and habitats,
- understanding the socio-economic needs of humans in relation to the landscape,
- understanding environmental and socio-economic risks and impacts of land-use options and
- a rational decision-making process involving stakeholders related to land-use planning.

7. Joint HWC mitigation planning at national, state and division-level: proposed institutional mechanism in HWC-NAP to ensure that HWC mitigation concerns are integrated in overall development planning

HWC Management Action Plans (HWC-MAPs), taking into consideration the respective landscapes are being developed in each division or cluster of divisions in India, in line with the recommendations of the National Wildlife Action Plan of India (NWAP, 2017-2031). A common framework for developing the HWC-MAP is provided in Supplementary Framework to the HWC-NAP on Developing Division-level HWC Management Action Plans. The priority areas for developing HWC-MAPs are the districts that have high levels of HWC. The HWC-MAPs of divisions will be aligned to a landscape-level plan that will be the key instrument to operationalize inter-division strategies and measures.

A cross-department working group at district level is planned and is expected to be linked to the district-level coordination committees (DLCCs), and will be a key platform to work towards managing land-use change and bringing about synergies between goals of different departments, and facilitating inter-agency coordination for HWC mitigation during emergency situations. Under this forum, landscape-level knowledge sharing events and citizen science programmes can be organized, in collaboration with university/ institutional partners. This will consolidate and broadcast the learnings and new experiences on HWC and its mitigation measures in the landscape. The learnings and proceedings of all such events can be used later for revision of the HWC-MAPs, and to provide feedback up to the HWC-SAPs.

A crucial requirement is for each HWC-MAP getting integrated into district and block development plans. SFDs would be facilitating this integration into relevant plans and processes at the district and block level. DLCCs would be the key institution to facilitate such integration, together with intensive efforts from

the SFDs on organizing consultation meetings, workshops and joint trainings with the rural development and Panchayati Raj institutions at relevant levels (Strategic goal 22, HWC-NAP).

To ensure an enabling environment in the country for integration of HWC mitigation concerns in the overall development planning, the HWC-NAP makes provisions to ensure that key stakeholders from different sectors and domains would be engaged, via the National HWC Mitigation Forum, and other means, to create an alliance or network of different experts and institutions with diverse perspectives, competencies and resources to address complex challenges posed by HWC effectively. This will ensure collaborative efforts from a wide array of partners such as government departments and agencies such as rural development and Panchayati Raj institutions, disaster management departments and agencies, police, civil defence, home guards, private sector (tea and coffee plantations), railways and highways department, educational institutions, wildlife conservation and development NGOs, as well as farmers' cooperatives and agricultural research institutions.

Ways to ensure cross-sector cooperation include using a participatory and inclusive approach by SFDs in planning and implementing mitigation measures; efficient information sharing across key departments; joint training courses for officers from key relevant departments; and taking a landscape approach to plan and implement mitigation measures. To ensure cross-sector cooperation, a higher commitment would be invested from the forest departments to ensure inter-departmental collaboration.

Innovative financial solutions need to be developed and piloted to mobilize resources for HWC mitigation measures, including engaging infrastructure and mining companies to provide CSR funds for mitigation measures in the HWC hotspots, they work in.

Private sector companies are to be supported to develop and adopt innovative technologies, strategies, and approaches to foster wildlife-friendly production, processing and marketing. This is to be especially focussed in case of tourism, plantation, agriculture and industry sectors, where a landscape approach would be essential to avoid habitat fragmentation. Donor agencies are to be facilitated and encouraged to address HWC in their programmes, either as direct interventions, or by adopting safeguards to avoid escalation of HWC in their intervention areas. Civil society organisations, especially conservation NGOs and animal welfare organizations, are to be encouraged and facilitated to take a more prominent role in HWC-related research. They are encouraged via HWC-NAP to extend their cooperation in of innovative mitigation methods and supporting the implementation of the interventions in a participatory manner, to ensure sustainability and effectiveness. There are specific national and global targets testing under SDGs and Biodiversity Post-2020 targets of the Convention on Biological Diversity (CBD), climate change targets and initiatives, interventions of Smart Cities initiatives, Swachh Bharat Abhiyan, where convergence with the goals and indicators of the HWC-NAP is to be explored and facilitated. Convergence with Reducing Emissions from Deforestation and forest Degradation (REDD++) is to be specifically facilitated to further strengthen the Strategic Priority A. Possibility of joint working and sharing of financial resources is to be explored with these schemes and programmes.

8. Case studies

8.1 Landscape approach in the Central Highlands Tiger Landscape

Background

The conservation of Tigers has been a high priority for both the Indian and global conservation authorities. In 1973, Project Tiger was launched by the Indian Government with the establishment of nine special Tiger reserves, and the number of reserves has been increased since then. The National Tiger Conservation Authority was established in December 2005 following a recommendation of the Tiger Task Force, constituted by the Prime Minister of India for reorganizing the management of Project Tiger. The National Tiger Conservation Authority (NTCA) has been set up under the chairmanship of the Minister for Environment & Forests.

In 2000, WWF, along with its conservation partners and the scientific community, drafted a vision for conserving Tigers in the wild. Based on this concept, seven priority Tiger landscapes were selected globally. At a workshop held in Anyer (Indonesia), the Satpuda-Maikal Landscape (SML) was recognized as being of global importance for conservation of Tigers. Soon after, in July 2004, WWF-India initiated a programme called 'Tiger Conservation, through the Management of Protected Areas and Corridors in Satpuda-Maikal Landscape'.

The following challenges are the main concerns for preserving Tiger habitats in this landscape:

- encroachment on forest lands,
- poaching of predator and prey species,
- human–wildlife conflicts,
- unregulated and illegal cattle grazing,
- frequent forest fires,
- unsustainable harvesting of non-timber forest products (NTFPs) such as medicinal plants, honey, and other products.

Rationale

The project aims at securing the connectivity in the network of PAs in SML in order to maintain the meta-population of tigers in this area. The programme's conceptual model is based on the following types of interventions:

- reduction of human–wildlife conflicts related to habitats and resources by providing alternative sustainable livelihoods and through community participation in the corridor areas;
- support for law enforcement and protection in the corridor areas; and
- increased collaboration between the government agencies and other stakeholders of the different states.

Towards achieving the aforementioned goal, the priorities of the programme are 'to enhance protection and management of key Tiger population along with their habitats in PAs and priority linkages', to be achieved through long-term measures that can be sustained and supported by governments, local communities and other stakeholders. Considering the vastness of this area, the diversity of issues and availability of resources, the first phases of the programme mainly focused on the Kanha-Phen-Achanakmar corridor and the Pench-Seoni-Kanha corridor.

The programme addresses the threats posed to Tigers and their habitats in the landscape through the following:

- A model for corridor management for Tiger conservation aiming at the reduction of Tiger–human conflicts related to habitats and resources
- Supporting forest divisions and wildlife sanctuaries in Tiger corridors in the Central Indian Tiger Conservation Landscape
- A shared Tiger conservation vision, in order to mainstream Tiger conservation measures in state and regional policies and management.

Stakeholders

The programme seeks to partner with other stakeholders in the landscape, such as the state forest department, other government agencies, local NGOs, communities, and like-minded individuals for propagation and mainstreaming of the landscape approach. WWF often plays the role of the coordinating or facilitating agency, and it implements programme components directly in order to demonstrate best practices and build upon a bank of knowledge.

The following stakeholders participate in this initiative: state forest departments; district councils; village development committees' forest management committees; tourist lodges and operators; TRAFFIC; State Forest Research Institute, Jabalpur; Veterinary College, Jabalpur and Nagpur; Wildlife Institute of India; Foundation for Ecological Security; Nature Club Bilaspur; the Wildlife and We Protection Foundation; Wildlife Trust of India; Pradan; Udyogini; BAIF; Rotaract and Rotary clubs; Madhya Pradesh Agro; the district administration; and the local press.

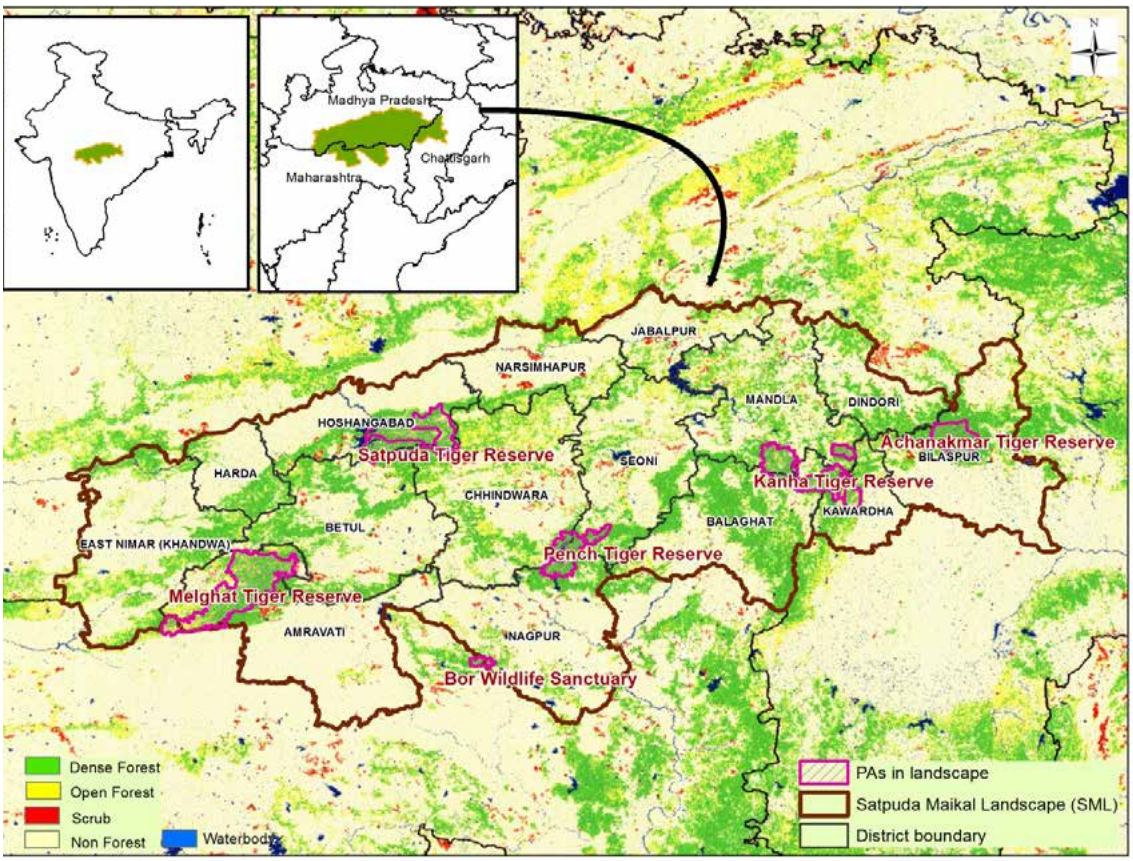


Figure 2: The Satpuda - Maikal Landscape (source: WWF India report)

8.2 Community Resource Management Areas, Ghana

The CREMA model is a community-based natural resource management model aiming at sharing the costs and benefits of applied in Ghana for buffer zones of PAs and wildlife corridors that have no legal protection status. CREMA are established around PAs, and some corridors have been covered by CREMA to maintain connectivity between PAs in Ghana and neighbouring countries for species such as the Elephant and Chimpanzee. A description of the model is derived from a publication of the Royal Society.

The Community Resource Management Area (CREMA) mechanism

The CREMA mechanism is an innovative natural resource management and landscape-level planning tool for community initiatives. It was developed by Ghana's Wildlife Division, an arm of the Forestry Commission, together with its partners, to support community resource management in off-reserve (un-gazetted) lands. CREMAs fill a critical gap by giving communities the right to manage and benefit economically from their natural resources. While Ghana's constitution vests ownership of the land in the Stool or Skin (the traditional or customary leadership structures that preside over a particular ethnic group, clan or tribe and the associated land and resources), it gives the government the right to manage the naturally occurring resources for economic gain. This has resulted in a series of perverse incentives that, over the decades, have tended to drive 'illegal' resource use and degradation or deforestation of the forest resources. The CREMA represents a profound policy shift by permitting communities, landowners, and land users an opportunity to govern and manage forest and wildlife resources within the boundaries of the CREMA and to benefit financially or in kind.

In Ghana, the CREMA process has followed a nearly 20-year evolution from an intellectual concept to an approved pilot initiative and finally to an authorized mechanism, which

is now seeking full legal backing from the parliament. As originally conceived, the CREMA approach provided a mechanism by which the Wildlife Division could transfer authority and responsibilities for wildlife to rural communities. It denoted a geographically defined area endowed with sufficient resources where the people had organized themselves for the purpose of sustainable management of their natural resources. The aim was to encourage local people to integrate wildlife management into their farming and land management systems as a legitimate land-use option. The CREMA concept officially emerged from the 1994 Forest and Wildlife Policy, but it took the better part of a decade for communities to put it into action.

The CREMA structure and process

CREMA development is not a rapid process, typically taking at least 3–5 years until inauguration. Successful community-based management is an adaptive process [26] that requires patience and a sustained commitment from all stakeholders as community consensus-building and decision-making do not happen overnight and can be fraught with complexities. One of the greatest strengths, however, of the mechanism is that it is founded upon traditional or local beliefs and value systems, while being couched within a democratic decision-making and governance process. For example, many CREMA boundaries are drawn according to traditional area boundaries, and CREMA by-laws often incorporate or derive from local norms or traditional systems of forest and wildlife management.

All functional CREMAs come under a two-tiered governance structure, an approved constitution and rules and regulations. They enjoy backing in the form of local government by-laws as well as the power to engage their own staff and the authority to generate revenue from natural resource management. In addition, CREMAs must have defined boundaries that are agreed upon by all stakeholder communities and the traditional leadership, upon which a long-term vision, goals, management plans, activities and regulations are agreed. As such, CREMAs represent a strong community structure that facilitates landscape planning, democratic decision-making, community-based governance, and local design of benefit-sharing agreements for all stakeholders. A CREMA is officially inaugurated when the ministry is sufficiently satisfied and issues an official certificate of devolution of rights over natural resource management to the local CREMA institution.

The CREMA development process usually begins with an initial assessment and consultation period in which an external stakeholder (NGO) or a government agency (Wildlife Division) works with community leaders to assess whether the site is a potential CREMA or not. Critical determinants include the community structure and level of organization, land tenure regimes in the target area, existing land-use practices, and current uses of natural resources by the community(s) that may form part of the CREMA. If the results bode well for CREMA development, then the community leaders and traditional authorities must agree to engage in the CREMA process.

This is typically followed by several detailed studies including a socio-economic and ethnographic survey, a biological survey, an ethno-biological survey and an assessment (including mapping) of land uses, habitats and natural resource management systems. Widespread sensitization follows, culminating in the initiation of the process to build the CREMA.

The first step is to develop the CREMA management structure. Initially, this involves the creation of a community resource management committee (CRMC) in each CREMA community or in a cluster of communities. Committees typically consist of 5–13 men and women who are nominated or elected during a village-wide meeting and who adequately represent the various sub-groups within the village. The role of the CRMC is to help envision the goals and objectives of the CREMA, to implement activities and to serve as the main liaison between the CREMA Executive Committee (CEC) and the individual community. Eventually, CRMC representatives and traditional leaders come together to draft a constitution. A constitution in the CREMA context is a social contract that sets out the organizational structure, defines the ‘community’ and its purpose and sets the basic rules and regulations that all will abide by. Following consultations with all the communities that make up the CREMA and with the Wildlife Division (Forestry Commission), the constitution is vetted and ratified at a final meeting with CRMC representatives and traditional leaders. Representatives from the community committees are subsequently elected to serve on the CEC, in addition to other co-opted resource persons. The CEC

is the over-arching management body that directs and oversees CREMA operations and decision-making.

The next step is to define the CREMA boundary to determine the area within which the constitution is enforceable. This boundary, which defines the 'community,' should be clearly marked as it will ultimately be backed by District Assembly by-laws. During this time, the CEC and the CRMC also engage in land-use planning, develop a strategy and a set of activities (management plan) for the CREMA and define an appropriate benefit-sharing arrangement for revenue that will be generated. These deliberations eventually culminate in the enactment of more detailed CREMA rules and regulations.

All CREMA stakeholders must agree upon a benefit-sharing arrangement that reflects their values, expectations, and needs. Benefits usually include financial as well as non-financial resources, including payments at the individual or household level, access to information or agronomic resources, community development projects and scholarship funds. When CREMAs begin to generate revenue, transparent financial management is crucial. Multiple signatories on a local bank account, frequent overseeing, and auditing of accounts by the CEC and a third-party entity, and investment in trust funds, managed by a third party, are just some of the ways in which existing CREMAs have worked to foster financial transparency and accountability.

The final step before official recognition (inauguration) is for the CEC, traditional authorities, the Wildlife Division, and the District Assembly to review all the CREMA rules and regulations in the context of other national laws and District Assembly by-laws. The CREMA rules are then drafted as district by-laws and eventually presented for debate and ratification before the General Assembly of the District Assembly.

The final step is the inauguration of the CREMA and the issuance of a certificate of devolution by the presiding minister, who gives the CEC the authority to manage its natural resources. This is not, however, the end of the process but rather a shift from development to daily operations.

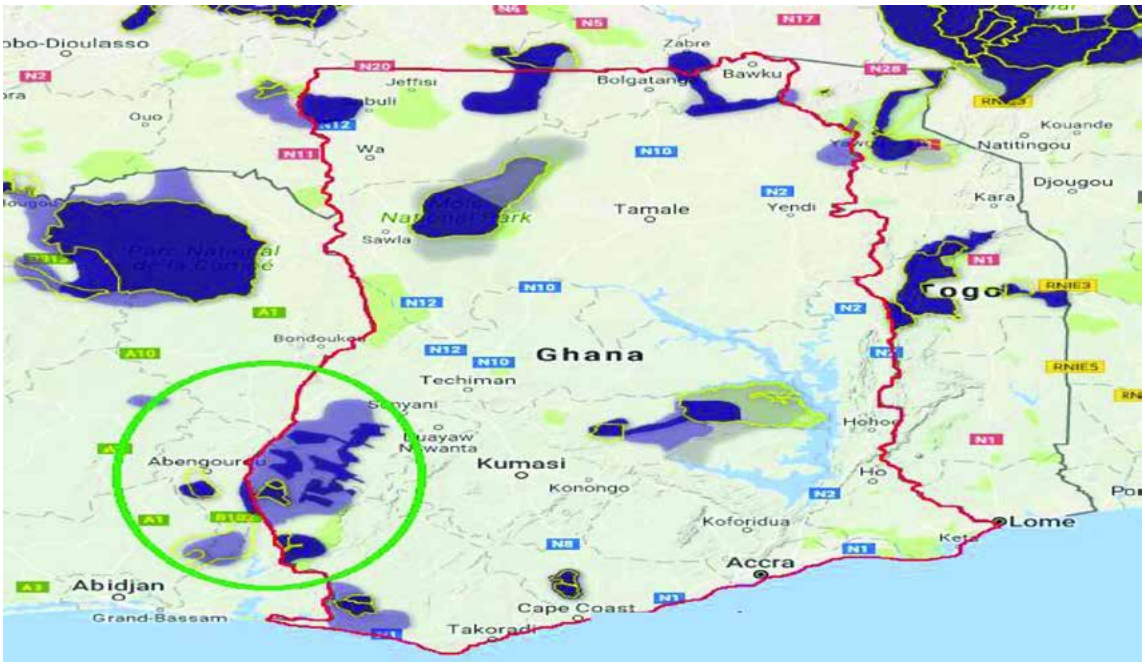


Figure 3: Elephant populations in Ghana and neighbouring countries (dark blue) (source: Asare, R.A., Kyei A., & Mason, J.J. 2013)

9. Reflections

Stable ecosystems are the foundation for achieving the goals of reduced vulnerability, and higher adaptive capacities towards climate and disaster risk reduction. In the mountain ecosystems, the role of biodiversity and ecosystem services is further critical due to high dependence of communities on natural resources for livelihoods. **Adopting an ecosystem approach in the overall development** planning should be top priority for the region. Conservation of ecosystems and biodiversity provide multiple benefits in the long run, and will automatically minimize the trade-offs between actions of various sectors. A World Bank study also suggests that adopting 'no regrets' measures, such as planting mangroves to stabilize coastal land and climate-proofing key investments, can go a long way towards reducing vulnerability.

The most appropriate way could be to use disaster management structures as the entry point for climate change management strategies. However, in India climate change and disaster issues already have separate institutional structures, therefore the best possible way is the **establish formal cross-sectoral linkages**. State Climate Change Action Plan must integrate disaster risk reduction at programme and implementation level; similarly, Disaster Management Plans should fully capture climate change vulnerability and adapt disaster management planning accordingly. Agriculture, environment, and food security departments must be represented in the disaster risk management committees (state, district, and village); Risk reduction/climate change adaptation focal points/teams should be appointed within forestry, agriculture, power, horticulture, energy, and rural development departments, and their capacity built. The development plans at Village/ district levels must integrate climate change and disaster risk.

Sectoral studies on assessing the combined vulnerability and cumulative risk due to climate change and disasters, and **identifying sector-specific synergies and trade-offs** and their long-term impact on the local ecology ad economy are immediately needed in the region. This will not only help each sector in identify climate related disaster risk to their activities but will also facilitate the state governments in prioritizing mitigation action in the sectors that are worst affected and/or affecting disaster risk in the state.

It is important that the **education and trainings of relevant stakeholders** include this concept, so that a strong support system is created that ensure the success of various government interventions. The school and college curriculum must include climate change and disaster risk reduction as an integrated concept in the subject of environmental/ ecological sciences. Climate change trainings must have disaster risk reduction as an integrated concept, and vice versa. The GIZ project in the North East already an integrated training programme to be delivered to administration, scientists, students, media professional, NGOs, private sectors etc.

It is high time to invest in **Infrastructure, human capacity, and information networks at International, National and Regional levels,** which are required for efficient vulnerability and risk assessment, early warning and preparedness planning in the region and also timely rehabilitation and reconstruction work.

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