IHCAP Indian Himalayas Climate Adaptation Programme

SCIENCE BRIEF:

ECOSYSTEM-BASED ADAPTATION: AN INTEGRATED RESPONSE TO CLIMATE CHANGE IN THE INDIAN HIMALAYAN REGION

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

About IHCAP

The Indian Himalayas Climate Adaptation Programme (IHCAP) is a project under the Global Programme Climate Change and Environment (GPCCE) of the Swiss Agency for Development and Cooperation (SDC), and is being implemented in partnership with the Department of Science and Technology (DST), Government of India. IHCAP is supporting the implementation of the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) as a knowledge and technical partner. The overall goal of IHCAP is to strengthen the resilience of vulnerable communities in the Himalayas and to enhance and connect the knowledge and capacities of research institutions, communities and decision-makers.

Published by IHCAP

Authors: Juan Antonio Ballesteros Canovas, Divya Mohan, Markus Stoffel, Mustafa Ali Khan, Janine Kuriger, Shirish Sinha

Copyediting: Shimpy Khurana

Photo Credits: Prashanth Vishwanathan/IHCAP

This science brief is available in the electronic form at:
http://www.ihcap.in/resources.html

SCIENCE BRIEF:
ECOSYSTEM-BASED ADAPTATION: AN INTEGRATED RESPONSE TO CLIMATE CHANGE IN THE INDIAN HIMALAYAN REGION

INTRODUCTION

An ecosystem is a system formed by living organisms interacting with their surrounding physical environment[1]. Mountain ecosystems are significant as they provide services that support agricultural production, water security and livelihoods. Rivers originating from the mountains and fed by glaciers and snowmelt are crucial for ensuring water flows downstream, especially in the lean season. Mountains are also storehouses of groundwater that emerges as springs, especially in the mid hills. These springs are the freshwater source for the communities living in the region. Many mountain ecosystems host biodiversity hotspots with a wide range of floral and faunal species. In addition, natural resources in the mountains are vital in providing livelihoods to the communities in the region. However, climate change and other human activities are causing degradation of the mountain ecosystems in the Indian Himalayan Region (IHR). As a consequence, provisioning of multiple and essential ecosystem services[2] is being impacted. As human wellbeing depends directly on these ecosystem services, reliable and suitable adaptation measures are essential to increase resilience of communities to climate change related impacts.

Ecosystem-based Adaptation (EbA) is defined as "the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change" (Secretariat of the Convention on Biological Diversity, 2009). EbA is based on the rationale that healthy ecosystems can help to improve the resilience of people to both climatic and non-climatic threats by assuring essential ecosystem services. EbA involves a wide range of ecosystem management, conservation and restoration activities. It considers the needs and the multiple social, economic and cultural co-benefits for local communities. This approach helps to improve ecosystem functioning and to secure the provisioning of ecosystem services. EbA is considered an efficient, sustainable and low-cost approach to improve resilience of societies and reduce their vulnerability against the negative effects of climate change. For example, constructing check dams to control floods in mountain regions is highly cost-intensive. Alternatively, if degraded forests and wastelands are restored, it would not only provide benefits in terms of flood control, but would also involve lesser financial resources. Additionally, it would provide co-benefits to the ecosystem and the communities such as increased biodiversity. This is an example of a no-regret and a win-win option providing benefits even in the case of uncertainties related to climate change.

Appropriately designed ecosystem management initiatives can also contribute to climate change mitigation by reducing emissions from ecosystem loss and degradation and enhancing carbon storage. The characteristic feature of EbA is the inclusion of communities and the use of participatory approaches which results in a win-win situation for both communities and ecosystems (Figure 1). EbA integrates available scientific knowledge, promotes the gathering of new knowledge, and combines it with local and traditional knowledge.

Knowledge on the extent of impacts of climate change on ecosystems and on the required solutions to address climate risks is limited in IHR. **This science brief emphasizes on the need for adopting an EbA approach to enhance the resilience of communities dependent on natural resources towards climate change.** It draws on the lessons from studies conducted under the Indian Himalayas Climate Adaptation Programme (IHCAP), a project of the Swiss Agency for Development and Cooperation to assess vulnerability of biodiversity and ecosystems in Kullu district of Himachal Pradesh (HP) (IHCAP, 2016).

---

[1]Article 2 of the Convention on Biological Diversity defines ecosystem as a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.
[2]The benefits obtained from ecosystems are termed ecosystem services. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.

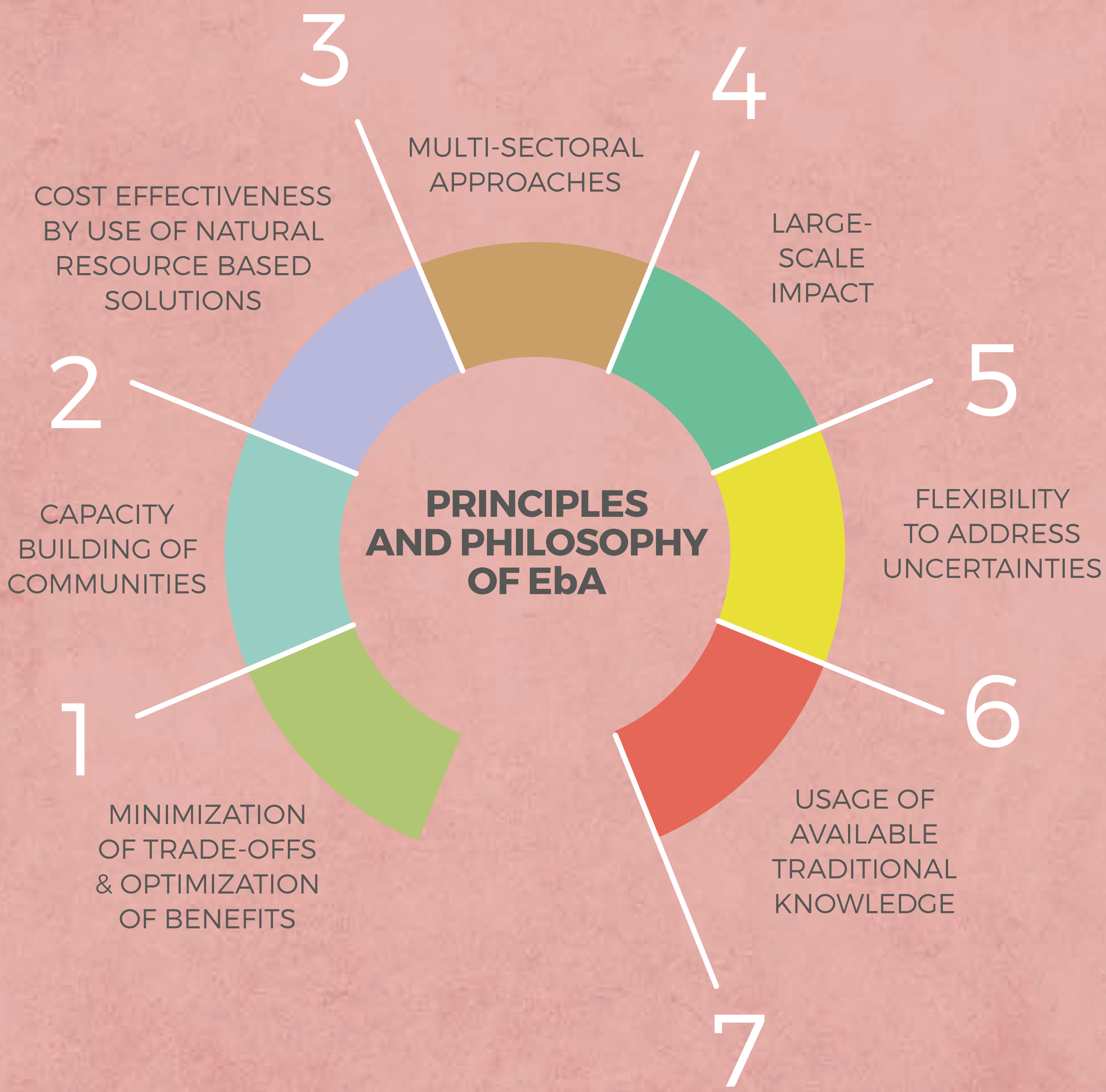
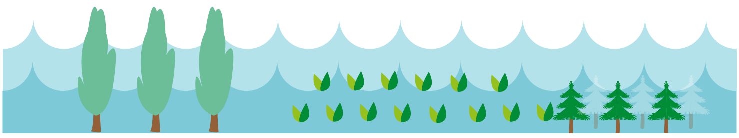


Figure 1 *Principles and philosophy of EbA. Source: Andrade et al., 2011.*

IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY AND ECOSYSTEMS IN KULLU DISTRICT

In mountain ecosystems, increasing temperatures have a direct impact on the cryosphere, which in turn, affects the runoff, and the risk of disasters such as floods and the occurrence of dry conditions. In IHR, millions of people depend on mountain ecosystems and their services, but these ecosystems are at risk due to changes in climate conditions (Estrella et al., 2013). In Kullu district, interviews conducted with local residents suggest that the weather is getting warmer (70 percent of all respondents) (Samant et al., 2016a). Similarly, 67 percent of the respondents confirm that the onset of the summer season and of the monsoon has advanced during the last ten years, whereas the winter season has become shorter and warmer. An assessment of temperature for Kullu district during 1981-2010 shows an increase of almost 1°C during spring season (IHCAP, 2016). These changes in climatic conditions modify nutrient cycles and the habitats of flora and fauna in the region. Stream flow patterns are affected, and as people depend directly on water resources, their activities too might become more concentrated in the bottom parts of the river valleys. This in turn increases their exposure to floods or extreme flood-related disasters which are more likely in the valleys as compared to the mountain and hill slopes (Randhawa et al., 2016). Hydroelectricity production could also be affected by changes in streamflow patterns and by the increase in climate-related extreme events. On the other hand, drier conditions increase the risk of forest fires. These changes in the ecosystem subsequently affect the livelihoods of dependent communities.



Analyses done under IHCAP highlights that biodiversity in Kullu district is under pressure as a result of anthropogenic factors and changing climatic conditions. The biodiversity assessments carried out in the Parvati and Upper Beas valleys indicate that from the 415 existing economically important plant species, more than 200 species are either vulnerable[3] or near threatened[4] and 25 species are critically endangered[5] (Samant et al., 2016b). A large number of these species are used as medicinal plants and fodder (Figure 2). Forests in the area are experiencing significant changes and pressure due to the strong dependence of communities on natural ecosystem and its goods and services. Generally, forest areas located close to population centres are much more vulnerable than those located far away. Changes in climatic conditions appear to be the most important reason for the major variations in the ecosystem structure. This is indicated by the observed altitudinal shift of species such as Himalayan Birch (*Betula utilis*), West Himalayan Fir (*Abies pindrow*), Himalayan Poplar (*Populus ciliate*), Indian Horse Chestnut (*Aesculus indica*), or Himalayan Pine (*Pinus wallichiana*) in Kullu district (Samant et al., 2016b). The community perception analyses also indicates a declining level of diversity of some of the agricultural, horticultural and vegetable crops which could be related to a change in diversification of agriculture, a change in lifestyle, and an altitudinal shift of high-value cash crops. The identified signs of change are associated with the rise in temperature, delayed rainfall, pest, diseases and decreasing intensity of snowfall (Samant et al., 2016a).

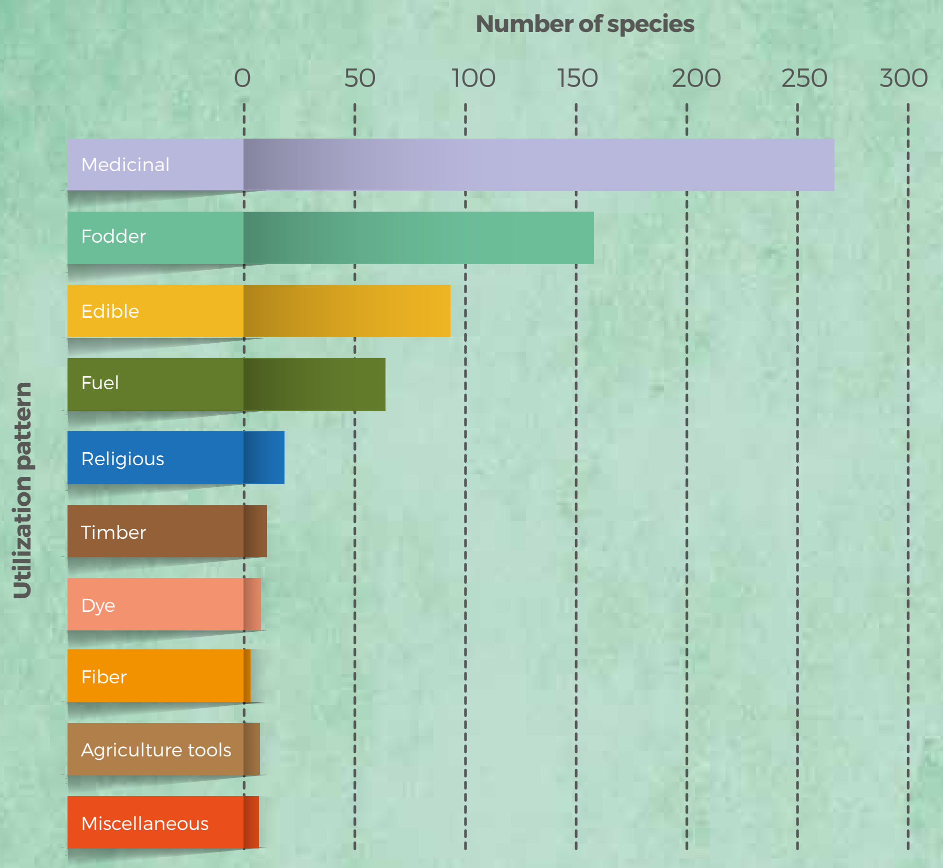


Figure 2 *Utilization of economically important species in the Parvati Valley.*
Source: IHCAP, 2016

[3]IUCN defines a species as Vulnerable when it is considered to be facing a high risk of extinction in the wild.
[4]IUCN defines a species as Near Threatened when it does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
[5]IUCN defines a species as Critically Endangered when it is considered to be facing an extremely high risk of extinction.
For more information see: http://www.iucnredlist.org/static/categories_criteria_3_1

Farmers sow wheat in their terrace farms in Galincha village in the Great Himalayan National Park (GHNP), Kullu district, Himachal Pradesh. Like these farmers, most people living in the eco-zone of GHNP depend largely on the natural resources and ecosystem services provided by the forest. However, anthropogenic pressures together with changes in climatic conditions including weather extremes are having an impact on biodiversity reserves in GHNP, and in turn, on the livelihoods of people that depend on them.

2

APPLYING EbA CONCEPT IN KULLU DISTRICT

A wide range of ecosystem-based adaptation strategies and interventions can be applied given the vulnerabilities being faced by the ecosystem and the communities in Kullu. An example of an EbA concept can be to focus on increasing the resilience of forests and its dependent communities by sustainable management of specific species such as medicinal plants. Forests are crucial for sustaining the ecosystem services in a region such as the Kullu district where 35 percent of the total land area is under forest cover (IHCAP, 2016).

The Great Himalayan National Park (GHNP), along with the Sainj Wildlife Sanctuary, Tirthan Wildlife Sanctuary and an eco-zone, cover a total of 1,171 km^2 of protected area (Table 1) in Kullu (GHNP, 2017). This protected area occupies 21.3 percent of the total geographical area of the district (FSI, 2015). Due to its significance in terms of biodiversity conservation, GHNP was given the UNESCO World Heritage Site status in 2014. The rich biodiversity of GHNP includes 832 floral and 386 faunal species. Thirty-four of the 47 medicinal plants categorized as threatened in HP are found in GHNP. Being a rich repository of biodiversity, the park provides a diverse range of ecosystem goods and services to the region.

Table 1: Land area and demographic details of protected area of GHNP

S. No.	Name of Protected Area	Area (Sq. Km)	Population/ Villages
1	Great Himalayan National Park	754.4	0
2	Sainj Wildlife Sanctuary	90.0	3 villages
3	Tirthan Wildlife Sanctuary	61.0	0
4	Eco-Zone	265.6	160 villages, 2,300 households
	Total	1,171.0	

Source: GHNP, 2017

The eco-zone, which is a buffer zone, extends five kms from the park's western boundary (Figure 3). Covering an area of 265.6 km^2, this zone includes approximately 2,300 households in about 160 villages. The economy and livelihoods of the communities living in the eco-zone of GHNP depends largely on the natural resources and ecosystem services provided by the forest. The major livelihood activities of these communities include medicinal plant cultivation, basket making, vermicomposting, organic farming and ecotourism. Medicinal plants produce that are mostly extracted from the wild are a major source of income for the considerable section of forest-dependent communities. Herbs such as Wild garlic (*Allium ursinum*), Guggal dhoop (*Jurinea macrocephala*) and Patish (*Aconitum heterophyllum*) fetch a good price (between US$ 300 to US$ 2,500 per kilogram) in the market thereby making them a lucrative source of income (Kumar, 2017).

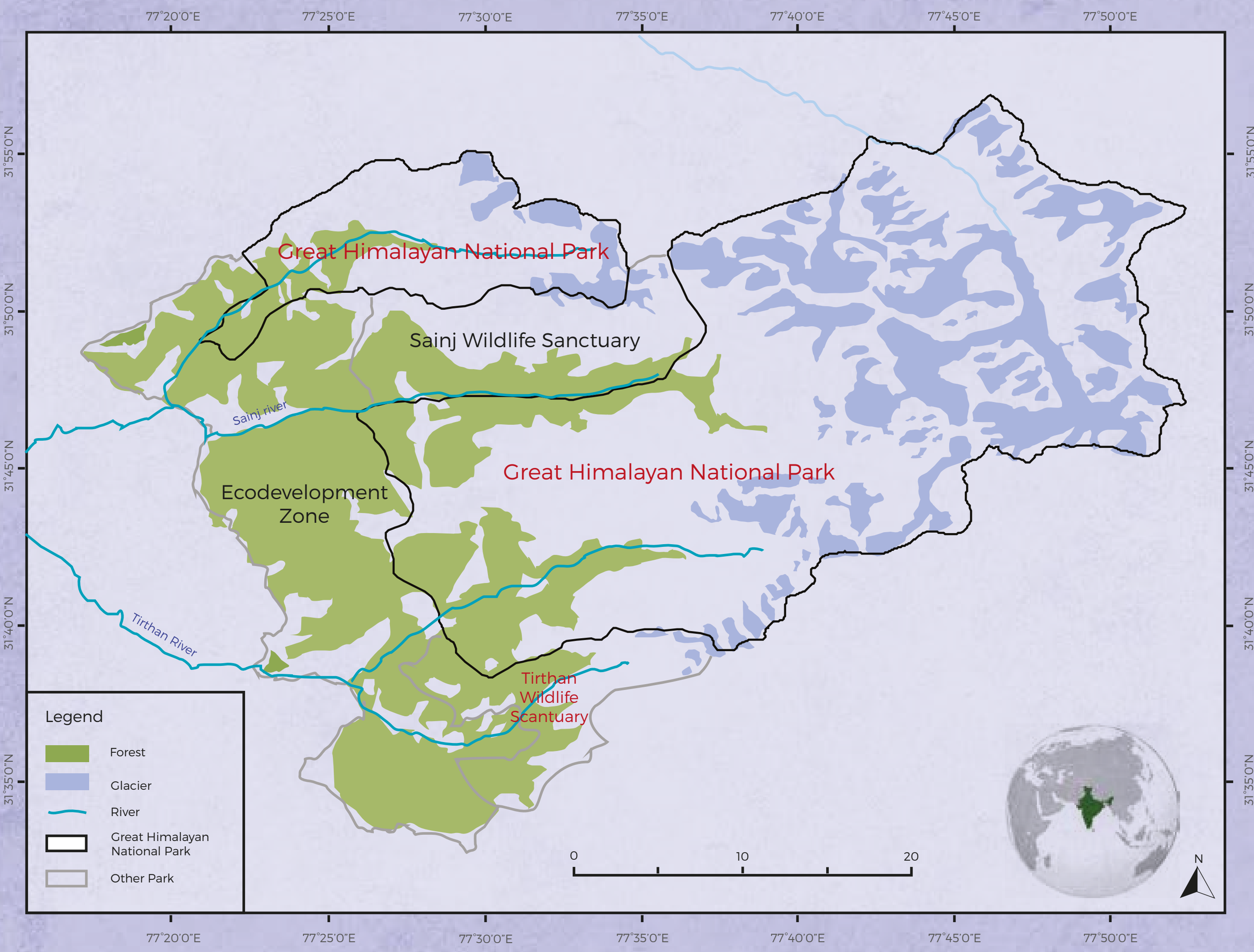


Figure 3 *Map of GHNP showing the different protected areas*

However, anthropogenic pressures together with changes in climatic conditions including weather extremes are having an impact on these biodiversity reserves in GHNP. For example, increased occurrence of landslides in GHNP due to heavy rainfall or forest fires due to extreme dryness causes damage to the flora and fauna of the forest. Impacts of changes in the climate are visible in the form of altitudinal shift of certain plant species such as Indian Horse Chestnut (*Aesculus indica*) and West Himalayan Fir (*Abies pindrow*) (Stevans and Pandey, 2012; IHCAP, 2016). This, in turn, is having repercussions on the ecosystem services provided by the forest.

Specifically, medicinal plant species in GHNP such as Karu *(Picrorhiza kurroa*), Guggal dhoop (*Jurinea macrocephala*), Hathpanja (*Dactylorhiza hatagirea*) and Patish (*Aconitum heterophyllum*) are already facing depletion and degradation because of the destructive harvesting methods. Herbs such as Shingli mingli (*Dioscorea deltoidea*), Jatamashi (*Nardostachys grandiflora*), Ban kakri (*Podophyllum hexandrum*), Rakhal or Birmi (*Texus wallichiana*) are listed as endangered (GHNP, 2017). Majority of these herbs are crucial in preparing traditional and modern medicines. In addition to the anthropogenic pressures, effects of climate change are likely to exacerbate the impacts on medicinal plants. With increasing temperatures, it is anticipated that there may be an overall decrease in medicinal plants in the forest region in long-term and species of medicinal plants are expected to shift to the higher altitudes[6]. The impacts of climate change on the flora and fauna of GHNP are having direct consequences on the livelihoods of the communities as well. According to the communities in GHNP, shifting of medicinal plant species like Karu (*Picrorhiza kurroa*) and Jatamashi (*Nardostachys grandiflora*) to higher altitude due to increase in ambient temperature has severely impacted their income generation. Moreover, most of the people living in forest fringe areas (eco-zone) of the national park are marginalized and have limited alternative livelihood options. Thus, these changes are leading to increased encroachment by the communities in the core area of the GHNP for illegal extraction of medicinal plants.

[6]A study by Kaur et al., 2016 demonstrated that changing climatic conditions, that is, increased temperature and reduced precipitation can change the bioactive constituents of medicinal plants like St. John's wort (Hypericum perforatum) and Chamomile (Matricaria chamomilla).

Considering the vulnerabilities faced in GHNP and the high dependency of communities on medicinal plants, an example of an ecosystem-based adaptation response may be to propagate medicinal plants in the eco-zone of the national park. This may help in enhancing the resilience of the ecosystem in GHNP by reducing the dependence of communities on forest resources. The adaptation response may involve promotion of medicinal plants in privately-owned agricultural land or wasteland of the eco-zone of GHNP (Figure 4). The medicinal species may be promoted in the eco-zone in partnership with GHNP authorities and local communities. Interventions for promotion of medicinal plants may include supply of medicinal plants as well as renovation and upgradation of nurseries. In addition, private nurseries may be encouraged through training and capacity building. As the communities will have better access to medicinal plants from the agricultural or wasteland, these interventions may help in reducing their dependence on forest resources in GHNP. Subsequently, due to reduced pressure, these interventions can lead to enhanced quality of forest resources and biodiversity thereby making the forest more resilient to the changing climate.

Increasing the resilience of forests may also assist in enhanced sustainability of ecosystem services provided by GHNP (Figure 4). For instance, healthy forest areas can help in better regulation of water flows in the region. Soil erosion is a continuing threat in GHNP, which commonly occurs on barren slopes where all vegetation has been destroyed. Runoff from uphill carries soil, stones and boulders downhill, thus causing damage to the slopes. This erosion also results in silting of stream beds, reducing their capacity to carry runoff water and sediments and consequently causing floods. Promotion of medicinal plants on barren and agricultural land in the eco-zone of GHNP may help in reducing the water and soil run off thereby reducing the exposure to natural hazards such as landslides and flash floods. Communities in the region may be directly benefitted through better provisioning of such ecosystem services. Moreover, the promotion and conservation of medicinal plants may also ensure sustainable livelihood means and better income generation for the forest-dependent community. Construction of storage and processing units along with the development of market linkage will further strengthen community initiatives. This may help in making the local communities more resilient and adaptive to any natural and anthropogenic hazard. The scientific propagation of medicinal plants, along with the creation of market and value chain, will generate economic and social benefit to support livelihood of the forest-dependent communities.

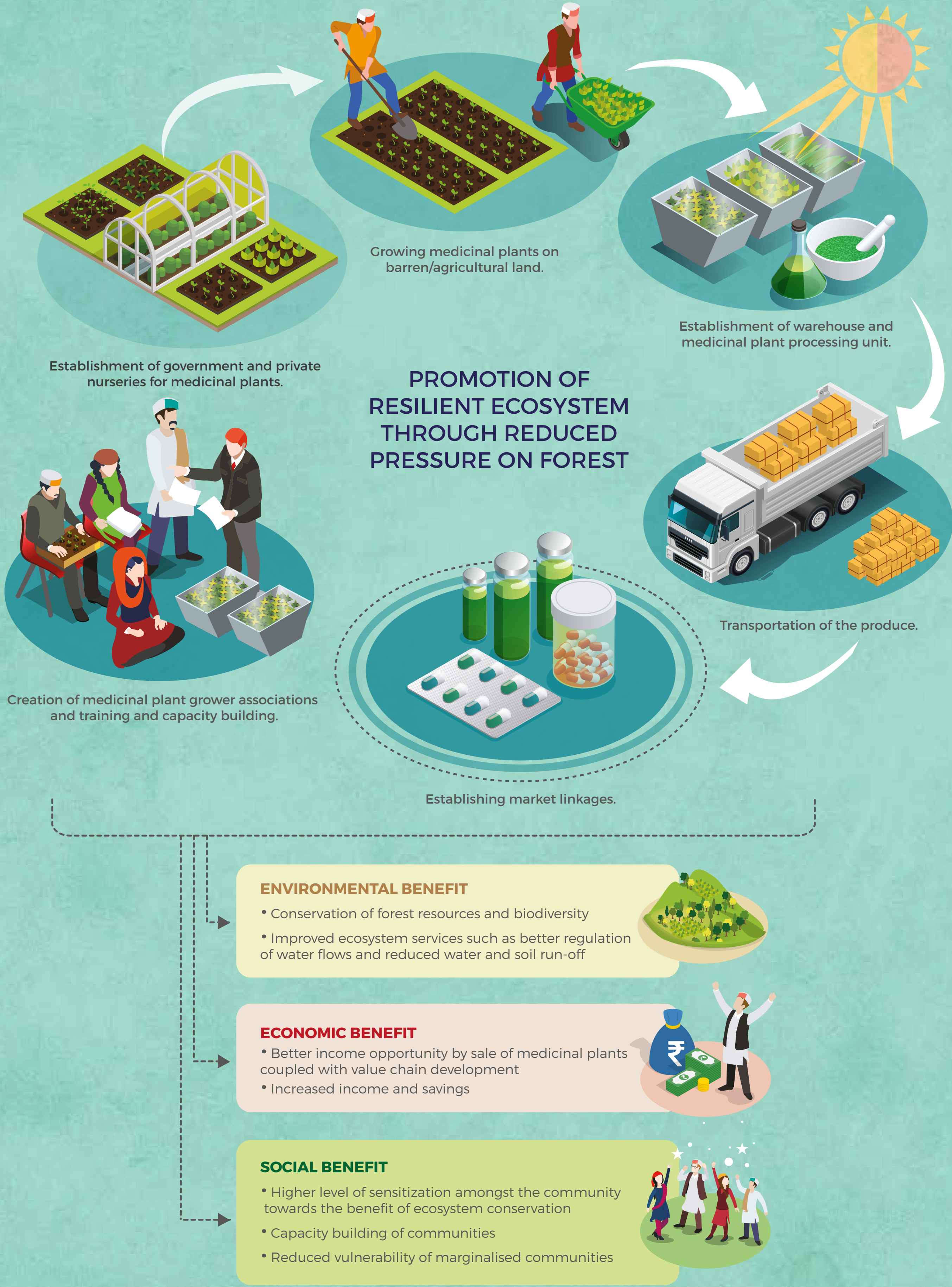


Figure 4 *Example of EbA concept in GHNP, Kullu indicating the key benefits for the ecosystem and the communities*

RECOMMENDATIONS:

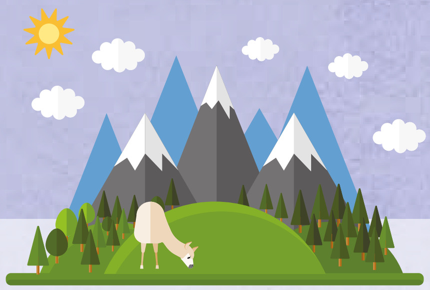
Considering the high vulnerability of ecosystem and communities in IHR, **the implementation of EbA is crucial to restore degraded ecosystems and assure the future provision of ecosystem services.** EbA provides a no-regret approach towards adaptation of socio-ecological systems and livelihoods of communities to future climate conditions. Some of the specific recommendations in the context of EbA are as follows:

- **Integrated approach:** EbA allows **an integrated approach involving a wide range of ecosystem management, restoration, and conservation activities** for achieving the objectives of adaptation to climate change. The EbA concept for GHNP is an example of having an integrated approach as it includes activities ranging from promotion and cultivation of medicinal plants to value chain development and capacity building of communities, thus reducing pressure on forests. EbA therefore contributes towards increased resilience and reduced vulnerability of both socio-economic and ecological components of the ecosystem.

- **Flexibility:** One of the biggest advantages of applying an EbA approach is flexibility in implementation. **EbA allows accommodating adjustments and incremental implementation depending on the level and degree of climate change across the lifespan of the project (planning to implementation).** As the costs involved in the implementation of EbA interventions are relatively low, adjustments in plans can be made in order to address the uncertainties related to climate change. For example, in case of EbA concept for GHNP, if the propagation of a certain species of medicinal plants fails to deliver the desired results in case of changing climate, then suitable adjustments can be made. This may include promoting an alternative species which is more suited to the changed climatic conditions.

- **Iterative approach:** From an implementation perspective, EbA allows **an iterative process with regular monitoring to address the uncertainties involved in climate change.** Monitoring and evaluation (M&E) frameworks and protocols pre-defined at the beginning of the project and integrated in the overall adaptation implementation plan help in ensuring that the process is iterative. Regular monitoring of the interventions such as in the example of EbA concept for GHNP can help to track their impacts and any deviations arising due to the changing climate. EbA enables utilizing the existing institutional set up to be used for another EbA intervention with relatively fewer issues as compared to other adaptation strategies.

- **Targeted Research:** Owing to limited knowledge on impacts of climate change on ecosystems in IHR, **there is a requirement of further research on EbA to facilitate formulation of more concrete and specific adaptation options.** The scientific knowledge generated through research should be combined with traditional knowledge to help in having a complete understanding of climate risks, impacts and required adaptation measures.



Evidence-based planning and implementation of adaptation measures is a pre-requisite for building resilience of mountain communities and ecosystems in the Indian Himalayan Region (IHR). Recognizing the pervasive and complex challenge that the communities face in IHR, the Swiss Agency for Development and Cooperation (SDC) together with the Department of Science and Technology (DST), Government of India, initiated the Indian Himalayas Climate Adaptation Programme (IHCAP). Under IHCAP, a pilot study was done for Kullu district, Himachal Pradesh in coordination with the Department of Environment, Science and Technology (DEST), Government of Himachal Pradesh, to provide an integrated assessment of climate vulnerability, hazards and risk for climate adaptation planning. This series of Science Briefs on specific topics represents the key messages drawn from the outcomes of the Indo-Swiss scientific studies for Kullu in simplified language to inform decision making.

REFERENCES

Andrade, A:, Cordoba, R, Dave, R, Girot, P, Herrera F.B, Munroe R, Oglethorpe, J, Paaby, P, Pramova, E, Watson, J, Velgara, W. (2011). *Draft Principles and Guidelines for Integrating Ecosystem-based Approaches to Adaptation in Project and Policy Design: a discussion document.* IUCN- CEM, CATIE. Turrialba, Costa Rica, pp. 30. Available at http://cmsdata.iucn.org/downloads/draft_guidelines_eba_final_7_12.pdf [Accessed 15 June 2017]

Estrella, M. and Saalismaa, N. (2013) 'Ecosystem-based Disaster Risk Reduction (Eco-DRR): An Overview'. In: Renaud, F., Sudmeier-Rieux, K., and Estrella, M (eds.) *The role of ecosystems in disaster risk reduction.* Tokyo: UNU Press.

FSI (2015) *Forest and Tree Resources in States and Union Territories.* In: India State of Forest Report. India: Forest Survey of India. Available at: http://fsi.nic.in/details.php?pgID=sb_62 [Accessed 15 June 2017].

GHNP (2017) Great Himalayan National Park. Available at: http://www.greathimalayannationalpark.org/ [Accessed 18 April 2017].

IHCAP (2016) *'Climate Vulnerability, Hazards and Risk: An Integrated Pilot Study in Kullu District, Himachal Pradesh'* Synthesis Report. India: Indian Himalayas Climate Adaptation Programme (IHCAP). Available at http://ihcap.in/resources.html

Kaur, T., Bhat, R. and Vyas, D. (2016) Effect of contrasting climates on antioxidant and bioactive constituents in five medicinal herbs in Western Himalayas. *Journal of Mountain Science* 13(3), pp. 484-492.

Randhawa, S. S., Ruiz-Villanueva, V., Allen, S.K., Arora, M., Myint, M., Rana, P., and Stoffel, M. (2016) Risk & Hazard Assessment (Floods): Kullu District, Himachal Pradesh under Indian Himalaya Climate Adaptation Programme (IHCAP), Executive Summary. In: IHCAP, 2016. *Climate Vulnerability, Hazards and Risk: An Integrated Pilot Study in Kullu District, Himachal Pradesh.* Synthesis Report, Annexure. India: Indian Himalayas Climate Adaptation Programme (IHCAP). Available at http://ihcap.in/resources.html [Accessed 16 February 2017].

Samant, S. S., Kuniyal, J. C., Gosavi, V. E., and Kumar, K. (2016a). Mapping Community Perceptions on Risks, Hazards, Vulnerability and Climate Change in the Selected Sites of Kullu district, Himachal Pradesh. IHCAP, Executive Summary. In: IHCAP, 2016. *Climate Vulnerability, Hazards and Risk: An Integrated Pilot Study in Kullu District, Himachal Pradesh.* Synthesis Report, Annexure. India: Indian Himalayas Climate Adaptation Programme (IHCAP). Available at http://ihcap.in/resources.html [Accessed 12 January 2017].

Samant, S. S., Kuniyal, J. C., Gosavi, V. E., and Kumar, K. (2016b). Vulnerability Assessment of Biodiversity and Natural Ecosystems in the Selected Sites of Kullu district, Himachal Pradesh. IHCAP, Executive Summary. In: IHCAP, 2016. *Climate Vulnerability, Hazards and Risk: An Integrated Pilot Study in Kullu District, Himachal Pradesh.* Synthesis Report, Annexure. India: Indian Himalayas Climate Adaptation Programme (IHCAP). Available at http://ihcap.in/resources.html [Accessed 12 January 2017].

Secretariat of the Convention on Biological Diversity (2009). *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change.* Montreal, Technical Series No. 41, pp. 126. Available at https://www.cbd.int/doc/publications/cbd-ts-41-en.pdf [Accessed 15 June 2017]

Stevens, P. R. and Pandey S. (2012). Where the Road Ends: The majestic mountains of the Great Himalayan National Park. *Sanctuary Asia,* October 2012, pp. 52-57.

Kumar, S. (2017) 'Saving precious medicinal herbs', *The Statesman,* 17 February. Available at http://www.thestatesman.com/features/saving-the-precious-medicinal-herbs-1487323328.html [Accessed 15 June 2017]

Indian Himalayas Climate Adaptation Programme (IHCAP)

Embassy of Switzerland
Swiss Cooperation Office India, Nyaya Marg, Chanakyapuri, New Delhi – 110021, India
Phone: +91-11-49959570 E-mail: info@ihcap.in