Consilience: The Journal of Sustainable Development
Vol. 21, Iss. 1 (2019), Pp. 66-85

Environmental Crisis in the Eastern Himalayan Landscapes in India

Dr. Sayan Bhattacharya

Dr. Sayan Bhattacharya is currently working as an Assistant Professor in the School of Ecology and Environment Studies, Nalanda University, Rajgir, India. He completed his MSc and PhD in Environmental Science from the University of Calcutta. He completed two years of post-doctoral research at Presidency University, India. He has published 30 international journal papers, 10 book chapters, 45 international conference proceedings, and many national conference proceedings, and delivered lectures at the University of Oxford, University College London, University of Indonesia, Vietnam National University, and Jadavpur University, among others. He has over 10 years of teaching experience at the University of Calcutta, Rabindra Bharati University, Viswa Bharati University, and Vidyasagar University, India.
sbhattacharya@nalandauniv.edu.in

Abstract

The Eastern Himalayas in India demonstrate vast ecological diversity in its varied range of flora and fauna. The local communities also form an integral part of the ecological landscape, deriving various services from the forest and mountain ecosystems. Recently, however, due to severe anthropogenic pressure and unplanned developmental activities, the Eastern Himalayans have displayed signs of rapid habitat destruction. This photo essay aims to discuss the nature of the challenges in the Eastern Himalayas which pose a palpable threat to the local ecology and environment, and to establish how a more sustainable approach is necessary to salvage this ecologically unique region.

Keywords: Eastern Himalayas, biodiversity, ecology, sustainable development

Introduction

The mountainous regions of India have always played a significant role in the climatic and physiographic features of the country. The Eastern Himalayas are considered the meeting ground of the Indo-Malayan, Palaearctic, and Sino-Japanese bio-geographical realms with diverse ecological and altitudinal gradients and an equally diverse range of flora and fauna (ICIMOD, 2010). The Eastern Himalayan rivers and landscapes provide valuable ecosystem services such as soil retention, climate regulation, carbon sequestration, etc. The welfare of millions of people downstream is inextricably linked to the natural resources of the Eastern Himalayas. Shaped by their natural environment, the indigenous communities in the region have a rich blend of religious, cultural, and local traditions. These societies derive various ecosystem services from the forest resources. These include provisioning (finding food and fodder), cultural (aesthetic, religious), supporting (soil formation and water cycle), and regulatory (erosion, climate) services (Chettri *et al.*, 2007). The main challenge, however, lies in using these natural resources sustainably.

The glaciers of the Eastern Himalayas are important sources of several rivers in Asia, including the Yangtze, the Indus, and the Ganges. People across the continent depend on the Himalayan water sources for drinking, irrigation, industry, and power generation (WWF, 2018).

The *Dooars* are alluvial floodplains in the foothills of the Eastern Himalayas in North-East India. The *Dooars* valley is home to many wildlife sanctuaries such as *Gorumara* National Park, *Chapramari* wildlife sanctuary, *Buxa* Tiger Reserve, and *Jaldapara* Sanctuary, which together represent the ecological wealth of the region (Bhattacharya *et al.*, 2016).

However, unplanned developmental activities like hydro-electrical projects, road construction, the establishment of tea gardens, and mining activities lead to calamities such as landslides, forest fires, etc. These factors have an incremental effect on the fragility of the Himalayan ecosystems. Furthermore, poaching wild animals, livestock grazing, overexploitation of forest resources, and pollution in the Eastern Himalayas are major threats to biodiversity and natural resources (Bhattacharya and Ghosh, 2014).

Many of the dams built in the region are located in high-seismic zones, which are prone to landslides, flashfloods, and earthquakes. The construction of several dams has been undertaken and/or proposed without a proper environmental impact assessment. This may lead to arable lands in a biodiversity hotspot being submerged in water. The Himalayas are highly prone to erosion and the rivers carry heavy silt loads. The accumulation of sediment behind these dams also deprives downstream plains of nutrients and silt deposits that are a source of their fertility. Unsustainable developmental activities like these are destroying the Himalayan ecosystem, and can force-displace the indigenous population who have been the traditional drivers of conservation.

The construction of roads and infrastructure activities also pose major threats to the biodiversity and ecological corridors of the forests. Well-built roads naturally attract tourist inflow, as they enable easier access to the area, but also open up the possibility of commercial developments like hotels, guest houses, and other permanent establishments that lead to severe pollution in the area, which would ultimately endanger the ecology of the region.

The Eastern Himalayas, with its unique ecological conditions and geomorphic characteristics, may not support the excessive concentration of an urban population in its towns and cities. The carrying capacity assessment and the sustainability of tourism are critical issues in the Eastern Himalayas (Bhattacharya and Ghosh, 2014).

Climate change, too, has a considerable impact on the local communities in the Eastern Himalayas. Recent studies in the region indicate less snow in the mountains and intense but short episodes of rainfall, which cause increased run-off, poor water recharge, and the consequent drying up of water sources. More than 75% of the local inhabitants in and around Darjeeling Himalaya believe that water sources are drying up, and 60% of them feel that there has been a reduction of snow in the mountains over time (Chaudhary et al. 2011). Traditional water springs have dried up, leading to water crises in different hamlets of the Eastern Himalayas. Warmer temperatures and changing humidity have increased the occurrence of pest attacks and disease in areas where they were previously absent.

The photo essay aims to discuss the nature of the challenges in the Eastern Himalayas which pose a palpable threat to the local ecology and environment, and establish how a more sustainable approach could salvage this ecologically exceptional region.

Methods and Materials

Photographs have been taken in different parts of the Eastern Himalayas in India. Nikon DX format DSLR cameras (D5100, D7000 and D7100) and a Canon DSLR camera (EOS Rebel T5) were used. These were take using Nikkor lenses (18-140 mm. F/3.5-5.6 G ED VR, 18-105 mm. F/3.5-5.6G ED VR, 55-300 mm. F/4.5-5.6G ED VR) and Canon lenses (EF-S 55-250 mm. f/4-5.6 IS II). The Manual and Program mode of the cameras was used. The images have been processed using Adobe Photoshop 7.0 and Olympus Master 2.0 image editing software. Minor corrections in color, contrast, and sharpness have been made.

Essay

The following photographs demonstrate the diversity of the Eastern Himalayan region and how different factors, natural and anthropogenic, play together to affect the natural landscape. In a nutshell, the Eastern Himalayan landscape is a vast platform of complex interplay between natural resources, climate, ecotourism, and human development, and a fine balance between all is essential for the sustainable development of the region.

Photos 1 and 2 demonstrate the diverse natural landscape of the Eastern Himalayas, both in the mountain ranges and foothills.

Figure 1: Kanchenjunga, the world's third largest mountain range, is situated in the Eastern Himalayas. The Kangchenjunga transboundary landscape is shared by Bhutan, China, India, and Nepal, and contains 14 protected areas with a total of 6,032 km^2. The protected areas are habitats for several species of ecological importance.

Figure 2: The *Dooars* are the floodplains in the foothills of the Eastern Himalayas. During floods, there is huge amount of erosion on the banks of rivers

and streams. Of all the Eastern Himalayan rivers in India, Teesta has the highest sediment yield (CSE, 1991). The Eastern Himalayan rivers and landscapes provide valuable ecosystem services such as soil retention, climate regulation, carbon sequestration, etc.

The next two photos portray how the water and snow content of a river and a lake, respectively, have altered in recent times, which may have a significant impact on local biodiversity and on the geological and geographical characteristics of the landscape.

Figure 3: A dry riverbed in the foothills of the Eastern Himalayas in India. Recent changes in climatic conditions significantly affect water inflow in the Himalayan rivers. Changes in water flow can significantly impact Himalayan biodiversity and local livelihoods.

Figure 4: Tsomgo lake in Sikkim, India. The amount of snow has been significantly reduced in recent times, according to local sources. The photo was taken in December 2016. Hardly any snow is present, as opposed to some years back when the entire lake would be frozen.

The following four images display the potential of the Eastern Himalayas as an ecotourism destination and recent initiatives undertaken in ecotourism with the example of community-based ecotourism in the Darjeeling district of the Eastern Himalayas.

Figure 5: A forest in the Eastern Himalayas in Darjeeling, India. Many scattered hamlets are found in the Eastern Himalayas and most of them are proximate to the forests enriched with endemic biodiversity. Many hamlets with indigenous inhabitants are in the forest areas. The spectacular view of the Himalayan ranges, forests, and biodiversity attracts tourists from different parts of the world.

Photo 6: Darjeeling, India is one of the most popular tourist destinations in the Eastern Himalayas. The town experiences huge population pressures and tourist inflows.

Among the administrative units, Darjeeling is the most vulnerable compared to Sikkim, eastern Nepal, and western Bhutan.

Figure 7: Tourism activities in the Eastern Himalayas have recently increased. The number of home stays and hotels has increased exponentially in the past ten years in many parts of the Eastern Himalayas. A surge in nature-based activities like trekking and hiking, bird watching, and camping and unrestricted tourist inflow can increase waste generation and consumption of water resources, which in turn can affect local biodiversity.

Figure 8: Community-based ecotourism in *Lamahatta* village, Darjeeling District, India. Ecotourism activities in Darjeeling district have been rapidly increasing. The carrying capacity assessment and sustainability of tourism are critical issues in the region as they will form the basis for resource allocation and future development.

Photos 9 through 13 illustrate the adverse effects of unplanned ecotourism, such as water crises, waste generation, and air pollution.

Photo 9: Local stream water flow has decreased during the summer and negatively impacted water availability for domestic use and irrigation. Ecotourism further increases water demand as tourist inflow is greatest during the summer. This image shows a local initiative of summer rainwater harvesting in one of the home stays in Darjeeling (Bhattacharya *et al.*, 2019).

Photo 10: In the Eastern Himalayan hamlets, solid waste is collected in bins. Every community burns their solid waste once a week or buries the waste

underground. Waste burning is a daily practice for many homestays with high tourist pressure. The burial and burning of bottles and plastic packets may have serious effects on the local ecosystem and biodiversity (Bhattacharya *et al.*, 2019).

Photo 11: Trekking is common in the Eastern Himalayas, which leads to plastic pollution and waste deposition in the mountain areas. Inorganic solid waste can create health hazards in human and livestock populations and can harm the growth of vegetation and crops. The problem of solid waste management (SWM), particularly in trekking areas, is one of the major issues to be tackled in the Eastern Himalayas.

Photo 12: One of the consequences of plastic pollution in the Himalayan foothills: a dog choking on a plastic jar, found in the riverbed. Separate waste collection and disposal systems should be operated by the government to safeguard the sensitive ecosystems of the areas. Effective management design should be implemented for plastic waste generated in these mountain hamlets.

Photo 13: Air pollution in the Eastern Himalayas. The number of vehicles has increased significantly with tourist growth. The vehicles used in these areas should be monitored regularly so that pollution can be checked. The installation of modern

devices in vehicles for pollution control as well as routine and random checks may help this cause.

The final photos of this essay highlight recent developmental and construction activities in the Eastern Himalayas and how these activities, along with population pressure, pose a grave threat to local ecosystems, biodiversity, and indigenous communities.

Photo 14: Road construction has led to soil erosion, slope destabilization. and landslides. Railway tracts run through forest areas in the Himalayan foothills. Consequently, railway accidents result in deaths of wild animals. Railway and road construction in the region should be inspected thoroughly after proper study of the corridor networks and management strategies.

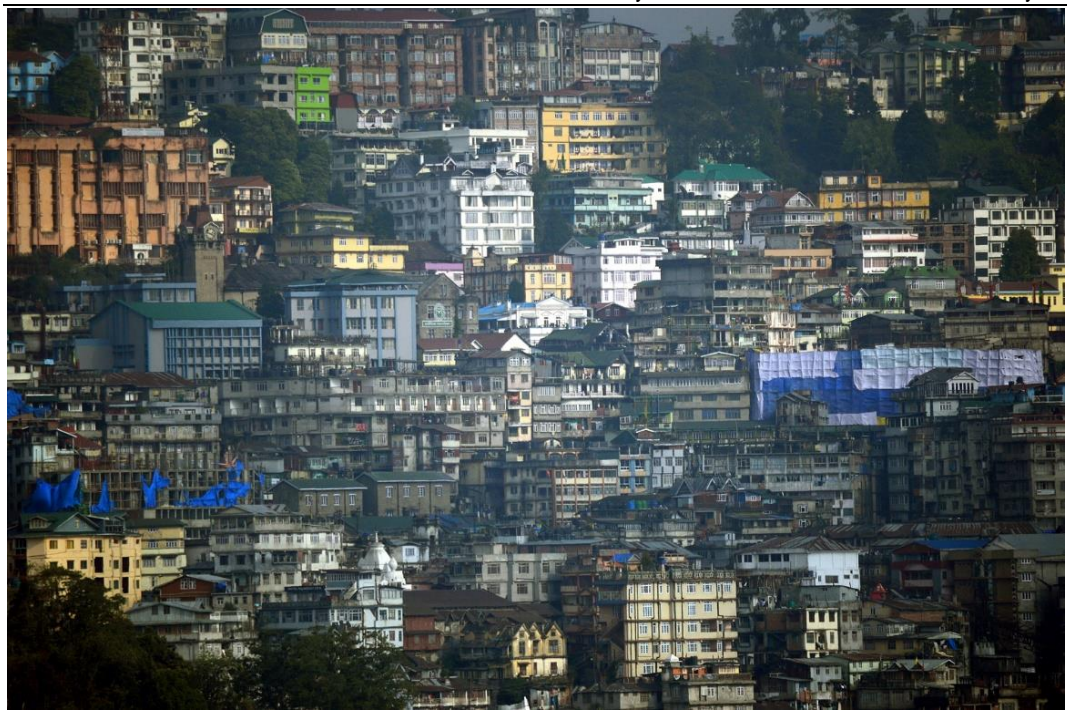

Photo 15: Areas in *Kalimpong* district are overpopulated. *Kalimpong* city has recently been experiencing periodical water crises. Population pressure in these areas is a serious issue, which has adverse effects on natural resources and biodiversity and can increase the occurrence of natural and anthropogenic disasters like landslides and earthquakes. Technology and funding to develop low-cost earthquake-resistant and energy-efficient housing would be beneficial.

Photo 16: Landslide in the *Kalimpong* district in India due to the construction of roads. The eroded rocks and soil are deposited in the *Teesta* river. Some areas of the

Eastern Himalayas are understood to be at seismic risk, in Zone V of the earthquake hazard conation (Bhattacharya *et al.*, 2016). The seismicity of this area loosens the hillsides, causing rockslides and siltation in riverbeds. The vegetative control measures of soil conservationists should be adopted to prevent further damage to the landscape.

Photo 17: The Hydel power project in the Eastern Himalayan foothill region. The construction of numerous dams without proper environmental impact assessments might lead to the submergence of arable lands in a biodiversity hotspot.

Conclusion

The forest and mountain regions of the Eastern Himalayas have become attractive tourist destinations for pleasure trips, trekking, camping, biological and geographical excursions, and medical research projects. Despite the beginnings of consolidated conservation efforts, there are considerable gaps in managing and conserving forest resources and biodiversity. There is an urgent need for sustainable management planning in these areas in order to ensure holistic socio-ecological conservation.

The effects of climate change are more severe in the Himalayas than compared to other regions (IPCC, 2007). The annual and seasonal temperature trends in the Kanchenjunga landscape indicate an increase at the rate of 0.01 – 0.015^{o} C/year, with higher altitudes experiencing greater warming (Singh *et al.,* 2011). Extensive study is required on the effects of climate change on the Eastern Himalayan biodiversity, with special focus on the forests enriched with endemic species and medicinal plants.

An integrated approach is necessary to revive the Eastern Himalayan landscape. Taking action for the revival of hilltop lakes, critical streams, and springs can develop their catchment using rainwater harvesting, including watershed and springshed approaches. Rainwater harvesting structures along hill slopes can be constructed to mitigate water crises. Rooftop rainwater harvesting systems need to be installed in village houses, and household filters can be provided to the local inhabitants for rainwater purification. It is possible to supplement the natural recharge of the spring aquifers by implementing artificial rainwater harvesting in the recharge (springshed) areas in the Eastern Himalayas. Resource mapping of the springs on a GIS platform and the preparation of a spring atlas in all the villages of the Eastern Himalayas need to be initiated. Water storage and micro-irrigation equipment businesses can be developed for the use of local inhabitants. In some areas, local indigenous groups appear to have been formed and trained to identify particular issues and implement solutions accordingly. However, the recognition of these groups by financial service providers such as banks, challenges from local government, and the establishment of proper training facilities remain major challenges in this context (Sandhu and Sandhu, 2014). This initiative may be taken up on a larger scale.

Enhancing ecosystem services can lead to improvement of food and nutrition security in the Himalayan landscape. This can be achieved by implementing sustainable methods such as crop rotation with legumes to fix atmospheric nitrogen in soil instead of nitrogenous fertilizers (Wratten *et al.,* 2013). Promoting organic farming in Eastern Himalayan villages can stabilize both ecology and economy. The establishment of community seed banks and preservation of the germplasm of indigenous crop varieties can ensure availability of food resources in the future. However, the impacts of climate change on these varieties must be identified.

Pit toilets should be re-designed using appropriate technology under the specifications provided by WHO. This can reduce groundwater, soil, and stream water pollution (WHO, 2013). Local youth can be trained for the technical skills required to construct and manage pit toilets and to understand how the right technology can minimize impacts on the surrounding ecosystems. However, the key challenge is procuring financial assistance to help local entrepreneurs learn technical skills and to start the small-scale business (Sandhu and Sandhu, 2014).

The use of energy-efficient and smokeless cook stoves should be promoted to increase fuel efficiency, to reduce cooking time, and to reduce pollution from fuel wood (Barnes *et al.,* 1993; Pandey *et al.,* 1990). The pellet fuel required for these cook stoves can be made from the biomass waste of agricultural activities. It can prevent the unsustainable harvest of wood and fuelwood from the forest. Biogas plants and the use of solar cookers in the villages can also reduce the pressure on fuel wood.

There is a lack of awareness among villagers about the advantages of afforestation in the hill areas. Specific trainings and awareness campaigns from the Forest Department have to be undertaken to educate people on the adverse effects of deforestation. Plant varieties should be increased in the silviculture units and modern methods of conversation should be implemented in association with gene banks and genetic and molecular databases. Ecological restoration should focus on the damaged, degraded areas destroyed by landslides. Priority should be given to the protected areas critically important to floral and faunal habitat, water catchments, and areas important to indigenous social and cultural values.

The forest areas of the Eastern Himalayas suffer from illegal cattle grazing, firewood collection, and poaching. More intense surveys and management practices should be initiated to mitigate these anthropogenic threats.

The factors responsible for the depletion of medicinal plant diversity in the Eastern Himalayas include the shrinking of natural habitat due to population pressure and developmental activities; the overexploitation of natural resources; forest fires; illegal trading; livestock overgrazing; cutting of medicinal trees for fuel and timber; and changes in climate and weather patterns. The sustainable conservation of medicinal plants is necessary, considering the factors responsible for their depletion. Extensive genetic databases need to be prepared and local centres for conservation of medicinal plants need to be established. Biopiracy is a major problem in the Eastern Himalayas which can affect endemic plant diversity. *Neora valley* national park and *Senchal* Wildlife Sanctuary are considered among the richest medicinal plant diversity zones in the Eastern Himalayas. Initiatives should be taken to promote medicinal resources and to provide economic support to build up private nurseries, where several varieties of important plant species may be preserved.

The Eastern Himalayas are prone to landslides due to natural and anthropogenic factors. The vegetative control measures of soil conservationists should be adopted to restrict further damage of land in the Eastern Himalayas. The promotion and implementation of vermicomposting techniques in this area can maintain the soil structure, increase agricultural productivity, and reduce waste (WWF, 2009). Technology supported by funding to develop earthquake-resistant and energy-efficient housing would also be beneficial.

The number of automobile vehicles has been increasing significantly in the ecotourism destinations of the Eastern Himalayas. These vehicles should be monitored regularly to mitigate pollution in the forest areas. Modern antipollution devices should be installed in vehicles and routine checking systems should be implemented.

Separate waste collection and disposal system should be operated by the government in all the villages of the Eastern Himalayas, especially those near forests. Effective management practices are necessary for plastic waste and hazardous waste. Proper management of solid waste through collection, storage, transportation, recycling, and disposal should be implemented to promote sustainable development.

There remains the need for a clearer understanding of resource flows to and from mountain areas. This will lead to the increased income of mountain communities and a fairer distribution of earnings from natural resource services and exploitation. A number of innovative mechanisms allowing a greater share of the proceeds from mountain-based economic activities to reach mountain people must be continuously invented and evolved. Markets which channel local products and the establishment of distribution systems with strong communication could uplift local village economies.

Specific components of cultural tourism can be promoted in the Eastern Himalayan hamlets including fairs and festivals, arts and crafts, and village tourism. A portfolio of tourism products should be developed based on their unique ecological assets. The development of handicrafts made from forest bioresources could be beneficial for the socio-economic development of local communities. The carrying capacity assessment and sustainability of tourism in the Eastern Himalayan villages should be an important component of ecotourism studies; it will form the basis of resource allocation and future development (Karmakar, 2011).

Roads and infrastructure are development priorities that also pose major threats to biodiversity, and to animal movement corridors in particular. Road networks would enable easier access to the area but would also open the site to commercial development and tourist inflow, which can damage ecological assets. A number of PWD roads, including a National Highway, NH 31C, pass through the forest areas of Eastern Himalayas. Consequently, wild animal deaths due to accidents have also increased. Railway and road construction should be inspected thoroughly after proper study on the corridor networks and their management strategies (Chaudhury, 2015).

Over the years, the incidences of cattle grazing in the villages of Eastern Himalayan foothills have exponentially multiplied. With an increase in households, cattle numbers have also increased rapidly. Reduction in cattle grazing in the forest areas can increase soil stability, reduce erosion, and balance the ecosystems. However, a management strategy like rotational grazing might be preferable instead of sticking to the strategy of reduction and curtailing villagers' rights to forests, especially within protected areas.

It is a challenge for ecologists and environmental scientists to ensure that modernization of the native cultural values in the Eastern Himalayas happens through a careful, step-by-step transformation. The aim should be to provide lasting, synergistic benefits for the local population and their economy and culture in rural and semi-urban landscapes. Extensive investigations in the hill areas should be carried out so that necessary measures can be undertaken for their conservation. Bringing local communities into protected area management will also have a significantly positive impact on long-term biodiversity conservation in the trans-boundary Himalayan landscapes.

References

Barnes, D.F., Openshaw, K., Smith, K.R., van der Plas R.. 1993. The design and diffusion of improved cooking stoves. World Bank Research Observer 8: 119–141.

Bhattacharya, S., Maity, R., Sarkar, G., Ghosh, G., Mukherjee, D., Mukhopadhyay, C. 2016. Socio-Environmental survey of an ecologically important forest edge hamlet in Buxa Tiger Reserve, West Bengal, India. International Letters of Natural Sciences, 52: 67-83.

Bhattacharya, S., Ghosh, U.C., 2014. Socio-Environmental Surveys of Tinchuley and Takdah: Two Emerging Ecotourism Hamlets of North Bengal, India. International Letters of Natural Sciences, 23: 9-26.

Bhattacharya, S., De, S., Shome, A., Dutta, A. 2019. Socio-environmental survey of a forest hamlet proximate to Neora Valley National Park in the Eastern Himalayas, India. Indonesian Journal of Environmental Management and Sustainability, 3: 1-13.

Chaudhary, P., Bawa, K.S. 2011. Local perceptions of climate change validated by scientific evidence in the Himalayas. Biology Letters 7(5): 767-770.

Chaudhury, K. Wildlife management in Buxa Tiger Reserve Rhino Resource Centre. Accessed on March 2019; accessed from: http://www.rhinoresourcecenter.com/pdf_files/138/1382156557.pdf

Chettri, N., Sharma, E., Shakya, B., Bajracharya, B. 2007. Developing Forested Conservation Corridors in the Kangchenjunga Landscape, Eastern Himalaya. Mountain Research and Development, 27(3):211-214.

CSE. 1991. State of India's Environment: Floods, Flood Plains and Environmental Myths. Centre for Science and Environment, New Delhi, India.

ICIMOD, 2010. Biodiversity in the Eastern Himalayas: Status, Trends and Vulnerability to Climate Change. Climate Change Impact and Vulnerability in the Eastern Himalayas – Technical Report 2. Kathmandu, Nepal.

IPCC. 2007. Climate Change 2007: Impacts, adaptation and vulnerability. Cambridge University Press, Cambridge, UK.

Karmakar, M., 2011. Ecotourism and its impact on the regional economy-a study of North Bengal(India). Tourismos 6(1): 251-270.

Pandey, M.R., Neupane, R.P., Gautam, A., Shrestha, I.B., 1990. The effectiveness of smokeless stoves in reducing indoor air pollution in a rural hill region of Nepal. Mountain Research and Development 10: 313–320.

Sandhu, H., Sandhu, S., 2014. Linking ecosystem services with the constituents of human well-being for poverty alleviation in eastern Himalayas. Ecological Economics, 107: 65–75.

Singh, S.P., Bassignana-Khadka, I., Karky, B.S., Sharma, E. 2011. Climate Change in the Hindu Kush-Himalayas: The State of Current Knowledge. International Centre for Integrated Mountain Development. Kathmandu, Nepal.

World Health Organisation (WHO). 2013. Simple Pit Latrines. Accessed on March 2019:

http://www.who.int/water_sanitation_health/hygiene/emergencies/fs3_4.pdf

World Wildlife Fund (WWF). 2009. Annual Activity Report, 2008: Project SERVE. Darjeeling Field Office, WWF-India.

World Wildlife Fund (WWF). Eastern Himalayas. Accessed on August 10, 2018; accessed from: https://www.wwf.org.uk/where-we-work/places/eastern-himalayas

Wratten, S., Sandhu, H., Cullen, R., Costanza, R., (eds.), 2013. Ecosystem Services in Agricultural and Urban Landscapes. Wiley-Blackwell, Oxford, UK.