7 Conclusion

The Eastern Himalayas is vulnerable to climate change due to its ecological fragility and economic marginality. Recent studies confirm its vulnerability, with analysis and predictions showing increasing magnitude of change with elevation, both in mean shifts in temperature and in greater stretch in precipitation variation. As a biodiversity hotspot, the source of the headwaters of four major Asian river systems, and home to millions of the poorest in the world, the Eastern Himalayas presents a unique case in which poverty is not always correlated with desertification and degradation, nor does it seek paybacks from the downstream majority thriving on the ecosystem services flowing out of it. Climate change is poised to alter this status quo with far-reaching consequences for the condition of biodiversity, quality of ecosystem flow downstream, and the wellbeing of the people in the region.

The impact of climate change on biodiversity must be assessed in conjunction with coexistent impacts on the other components of ecosystems and on the socioeconomic condition of the human population occupying the same geographic space. Similarly, just as climate change is coupled with other environmental changes, vulnerability must be assessed in the context of the dynamic flux of both socioeconomic and biophysical factors. The environmental changes the region is experiencing do not influence biodiversity in isolation. Rather, the diversity in ecosystems and the variability in environmental factors like weather, climate, and water interact in a mutually reinforcing manner to create the diversity of life and the huge variety of ecosystem services that emanate from such interactions. However, this ecological equilibrium in the flow of material and energy and the mechanism of connections and feedbacks are being rapidly eroded by human interference with the climate system.

According to current trends and future climate projections, higher temperatures, greater rainfall variability, increased concentration of atmospheric CO_2, and more frequent extreme events are likely scenarios until the end of the 21st Century. The environmental consequences of this faster than natural evolution of climate are going to impact on all spheres of life and life support systems on Earth.

It is becoming clear that the EH can expect major transformations in biodiversity across all systems (terrestrial, freshwater) and all levels (genetic, species, ecosystem) under a changing climate. It is now more urgent that ever to identify clear management objectives to guide management priorities. Our experiences and lessons suggest that maintaining ecosystem resilience, while focusing on the underlying structure, functions, and processes of ecosystems, should be a priority. Creating protected areas and biodiversity networks, minimising habitat fragmentation, and managing invasive species are the obvious starting points for biodiversity management in response to climate change. The scope for better options for managing biodiversity with climate change than we already know is rather limited. In short, we know in principle what to do; what is not well known is where, when, and how to do it.

Many of the impacts elucidated here are based on imperfect knowledge from limited species and location responses to climate change factors. There are conflicting inferences about the response of ecosystems to CO_2 enrichment under climate change, which remain unresolved. However, a new understanding is emerging that the impact of elevated CO_2 will vary with elevation and is unlikely to be a long-term response. This is corroborated by the limitation in the non-structural carbon pool and observations that CO_2 concentration is lower at higher altitudes. Investigation into some of the alpine species carbon assimilation mechanisms suggested that their growth is not always limited by low temperature/ low CO_2 conditions; stomatal conductance was found to be regulated more by endogenous biorhythms than by atmospheric conditions in some alpine species. Vegetation dynamic models do not always take non-climatic factors into account, making predictions about species distribution and range shifts questionable. Some species have wider altitudinal spreads and do not pose an immediate threat of colonising vegetation belts higher up, while other species represent edaphic (soil-related) rather than climatic climax. These are some of the issues that need further scientific investigation.

In the EH, past changes in climate have been recorded and future projections are available; these can provide a starting point for assessing the types of climate stressors that will impact on various biodiversity management endpoints in terrestrial and freshwater systems. It is high time that we moved beyond the planning and background reporting stage; we need to move from concepts and theories into the sphere of implementation. The priorities must be explicit and achievable, without being vaguely all-encompassing, and management options must be considered on a case-by-case basis. There is a need to guard against management inactivity in the face of the major uncertainties raised by climate change. In all cases we should be looking for 'no-regret' actions. These are actions that perform well irrespective of climate change. Features of no-regret options are their relatively low lifecycle cost, short completion horizon, and limited risk to other management objectives.